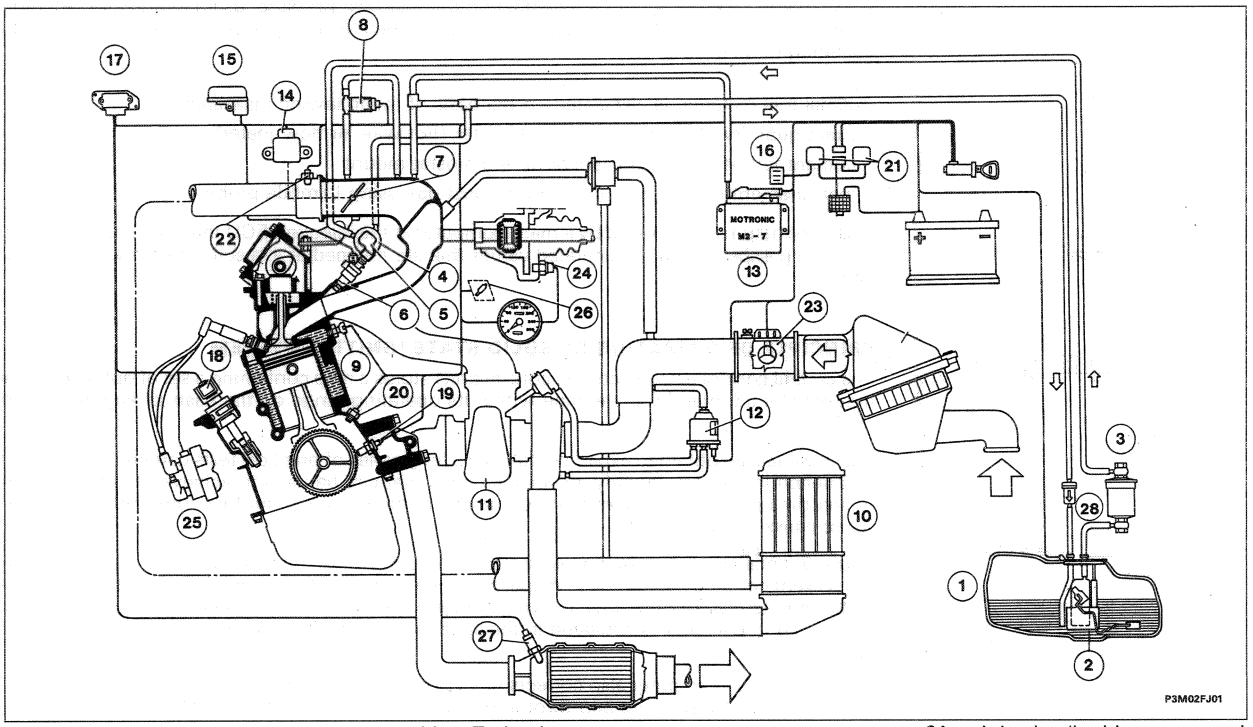
BOSCH MOTRONIC M2.7 MPI INTEGRATED INJECTION-IGNITION SYSTEM

Introduction

The injection-ignition system fitted to the 1372 turbo engine belongs to the generation of integrated fuel injection-ignition systems developed by Bosch.

The injection system is multipoint with one injector per engine cylinder, supplied at low pressure and governed directly by the control unit in a SEQUENTIAL, STAGED manner.
This device ensures operating efficiency, running economy and maximum control of harmful emissions because all Bosch Motronic M2.7 systems meet USA '83 emission control legislation.
It is also important to note that this type of system does not involve any type of adjustment i.e.: idle speed; throttle valve sensor position - and exhaust emission CO level.

DIAGRAM OF BOSCH MOTRONIC M2.7 INJECTION-IGNITION SYSTEM



1 – Fuel tank
2 – Electric fuel pump
3 – Fuel filter
4 – Fuel manifold
5 – Fuel pressure regulator
6 – Injectors
7 – Throttle case
8 – Engine idle speed regulation actuator
9 – Engine coolant temperature sensor
10 – Intercooler
11 – Turbocharger
12 – Three-way turbocharging control solenoid (Pierburg)
13 – Electronic control unit
14 – Throttle position sensor
15 – Absolute pressure sensor (barometric capsule)
16 – Diagnostic socket
17 – Ignition power module
18 – Injection timing sensor
19 – Rpm/TDC sensor
20 – Knock sensor
21 – Injection/ignition system relays
22 – Intake air temperature sensor
23 – Air flow meter (hot wire debimeter)
24 – Speedometer sensor (on gearbox)
25 – Ignition coil
26 – Injection-ignition system failure warning light
27 – Lambda probe
28 – Anti-reflux valve

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PRINCIPLE OF OPERATION OF INJECTION SYSTEM

The essential conditions to be satisfied in the preparation of a air-fuel mixture for efficient operation of controlled ignition engines are mainly two:

1) metering (air/fuel ratio) must be maintained as close as possible to a stoichiometric ratio in order to ensure combustion takes place quickly without useless waste;

2) the mixture must be made up of fuel vapours diffused through the air as finely and evenly as possible.

The nozzles of the Bosch Motronic M1.7 system perform the task of distributing the fuel by nebulizing it into minute droplets. Because the input air may be under a range of absolute pressure conditions, the amount of fuel to be injected should be adjusted in order not to alter the weight ratio between air and fuel. A constant ratio is obtained by adjusting the fuel feed pressure, using a regulator, according to the vacuum in the inlet duct so that the difference between the two pressures is constant under any engine operating condition.

Optimal fuel metering is calculated on the basis of the following measurements:
- exact quantity of air taken in by debimeter (hot wire air flow meter)
- coolant temperature from sensor on thermostat mount
- measurement of oxygen content of exhaust gas using Lambda probe.

This information is processed by a microcomputer in the injection ECU that calculates baseline injection time using experimentally calculated values that are mapped in a specific memory of the above control unit.

PRINCIPLE OF OPERATION OF SOLID STATE IGNITION SYSTEM

The central control unit (electronic control unit) stores a map containing a set of optimal advance values that may be adopted by the engine within its operating range on the basis of engine rpm and load.

These values are obtained experimentally by a long series of practical tests carried out on prototypes at a test bench in order to identify advance settings that can be used to achieve the best compromise between the contrasting requirements of maximum power, minimum fuel consumption and harmful exhaust emission abatement.

These optimal advances are then saved in the system control unit. During engine operation, the control unit is kept continually informed on speed (engine rpm) and load conditions. On the basis of these it selects from its memory the advance value required by the engine and governs the ignition unit power module so that a spark is activated in the spark plug of the cylinder in combustion phase with optimal advance.

The control unit computer also corrects this value on the basis of other factors such as engine temperature, intake air temperature and throttle position in order to obtain an optimal ignition point.

The igntion system consists of:

a) **A power module** outside the control unit that is responsible for sending a current to the primary winding of the ignition coil until it is completely energized and then cutting off the current instantly so that an extremely high voltage is set up in the secondary winding and a spark is sent to to the plug.

b) **An ignition coil** with four high tension terminals, made up of two primary windings (supplied by battery voltage) and two secondary windings (high tension) whose outputs are directly connected to the spark plugs of cylinders 1-4 and 3-2 respectively, which send out high tension whenever the primary winding is demagnetized by the power module.

The high tension that supplies two spark plugs simultaneously is of different intensity due to the characteristics of the secondary winding circuit (spark plugs in series). This is due to the fact that periodically one of the two spark plugs is under conditions of higher pressure (compression stage) in relation to the other (exhaust stage). Because the current must overcome a higher dielectric gradient in the spark plug in compression stage, a more powerful spark is produced whereas the spark in the other is negligible (thus restricting fuel consumption).

The information required by the central control unit for governing the power module is transmitted by means of electrical signals produced by the following two sensors:

a) **Rpm and TDC sensor** which produces an alternating single phase signal whose frequency indicates engine rpm and identifies TDC position of the piston pairs of cylinders 1-4 and 3-2.

b) **Air flow meter (debimeter)** which converts this value to an electrical signal on the basis of the amount of air taken up by the engine (engine load) and sends it to the electronic control unit.

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COMPONENTS OF BOSCH MOTRONIC M2.7 SYSTEM

The Bosch Motronic M2.7 injection-ignition system is made up of four interdependent circuits

A Fuel supply circuit
B Air intake and turbocharging circuit
C Electric/electronic circuit
D Circuit for checking harmful exhaust emissions

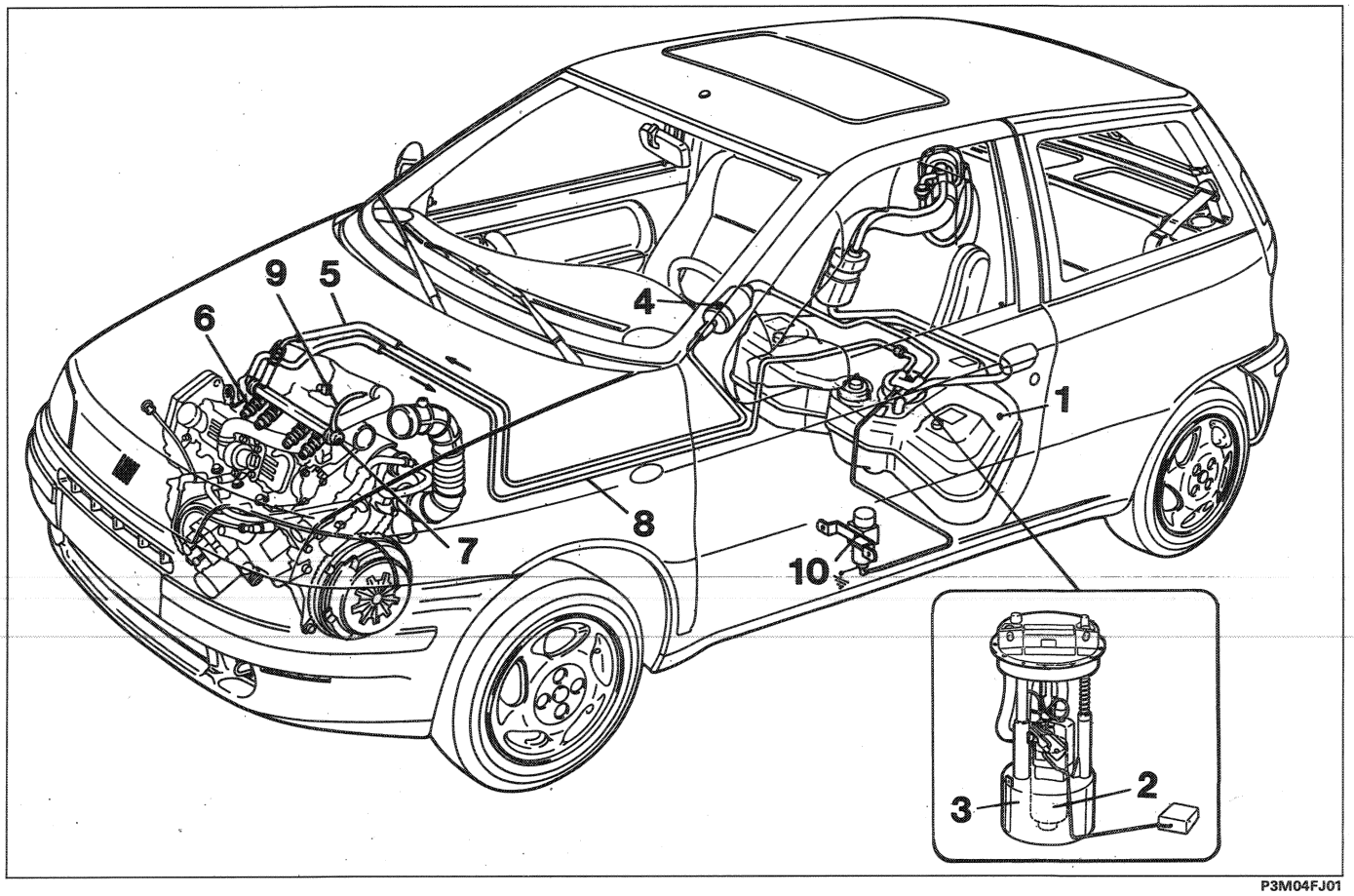
Two devices and their circuits strictly related to the injection system are also present. These are also designed to reduce vehicle harmful emissions in line with USA '83 standards. These are as follows: **fuel evaporation control and vapour recovery circuit; crankcase vapour recirculation and recovery circuit.**

A. FUEL SUPPLY CIRCUIT

This consists of the following parts:

1. reservoir
2. pump submerged in tank
3. mesh prefilter on pump intake
4. paper main fuel filter
5. outlet line
6. four injectors
7. fuel pressure regulator
8. return line with one-way recirculation valve or anti-reflux valve
9. vacuum point for fuel pressure regulator
10. inertia safety switch

This system also incorporates an electrical device for injector cooling



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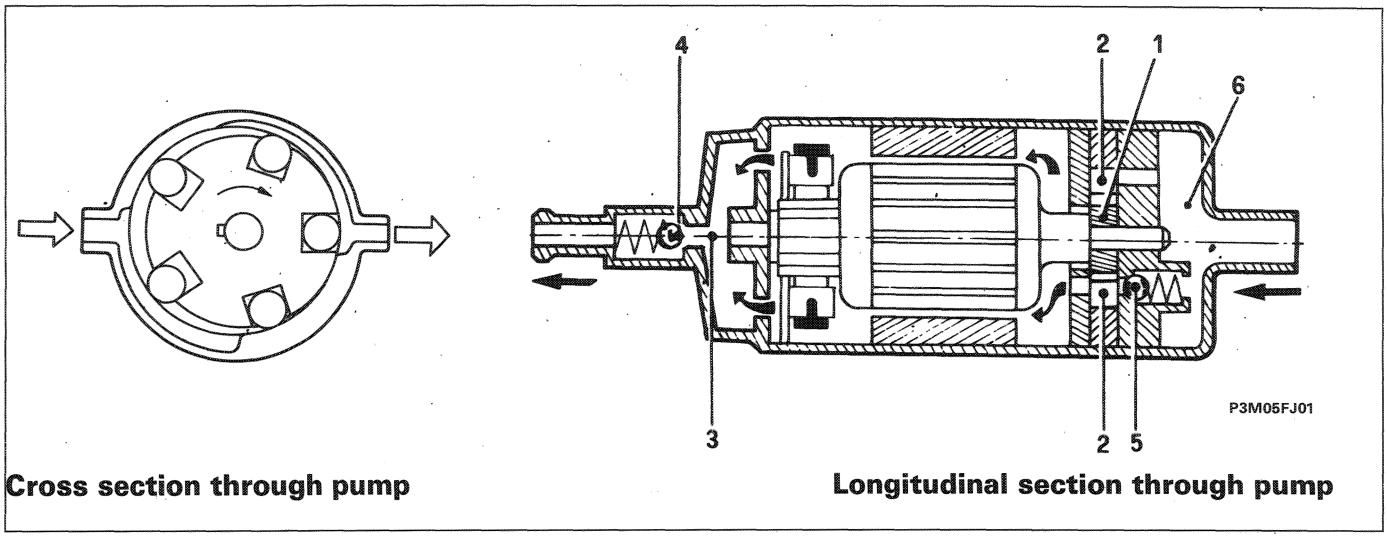
ELECTRIC PUMP

The submerged suction head fuel pump is located inside the pump, housed in a support on flexible mounts.
The pump is chamber with roller type, operated by an electric motor with permanent magnet exitation, submerged in the fuel pump.
A disc rotor (1) located eccentrically in the pump case contains metal rollers (2) in chambers around its circumference. These are pushed against the outer race by centrifugal force in order to ensure a water-tight seal.



Cross section through pump **Longitudinal section through pump**

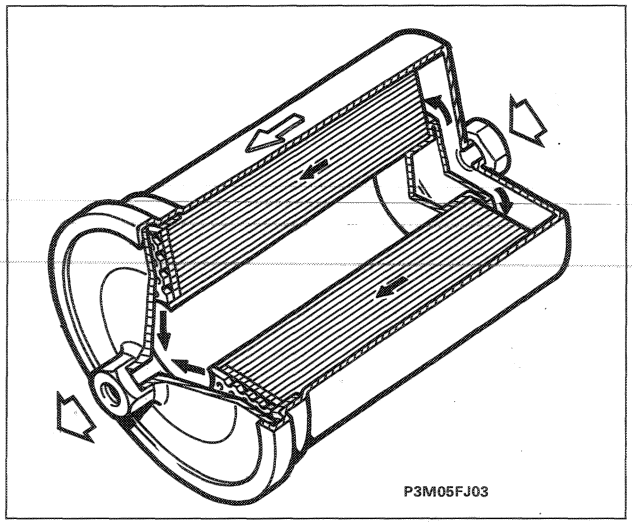
The fuel flows into the empty compartments and is compressed in outlet duct (3). Check valve (4) prevents the outlet pipe emptying with the engine off.
Pressure relief valve (5) short circuits the flow to intake chamber (6) when the pressure exceeds 7 bar.

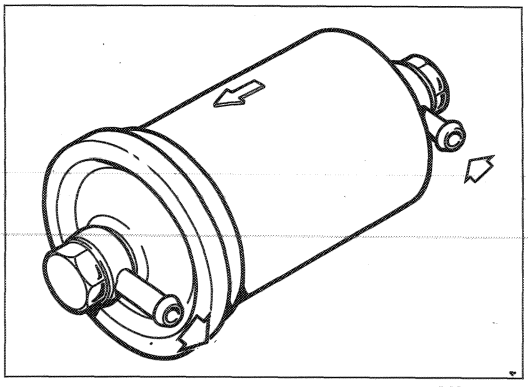
The electrical pump begins to operate when the ignition switch is moved to AVV. Once start-up is over, the pump continues to operate with the igntion switch turned to MAR, unless engine speed drops below 225/min, or the ignition switch is turned back to STOP.

If the engine stops for any reason, with igntion switch in MAR position, pump operation stops automatically for safety reasons.

FUEL FILTER

This is paper type with high filter capacity, essential due to the sensitivity of the injectors to foreign bodies.





Longitudinal perspective section through fuel filter and external view

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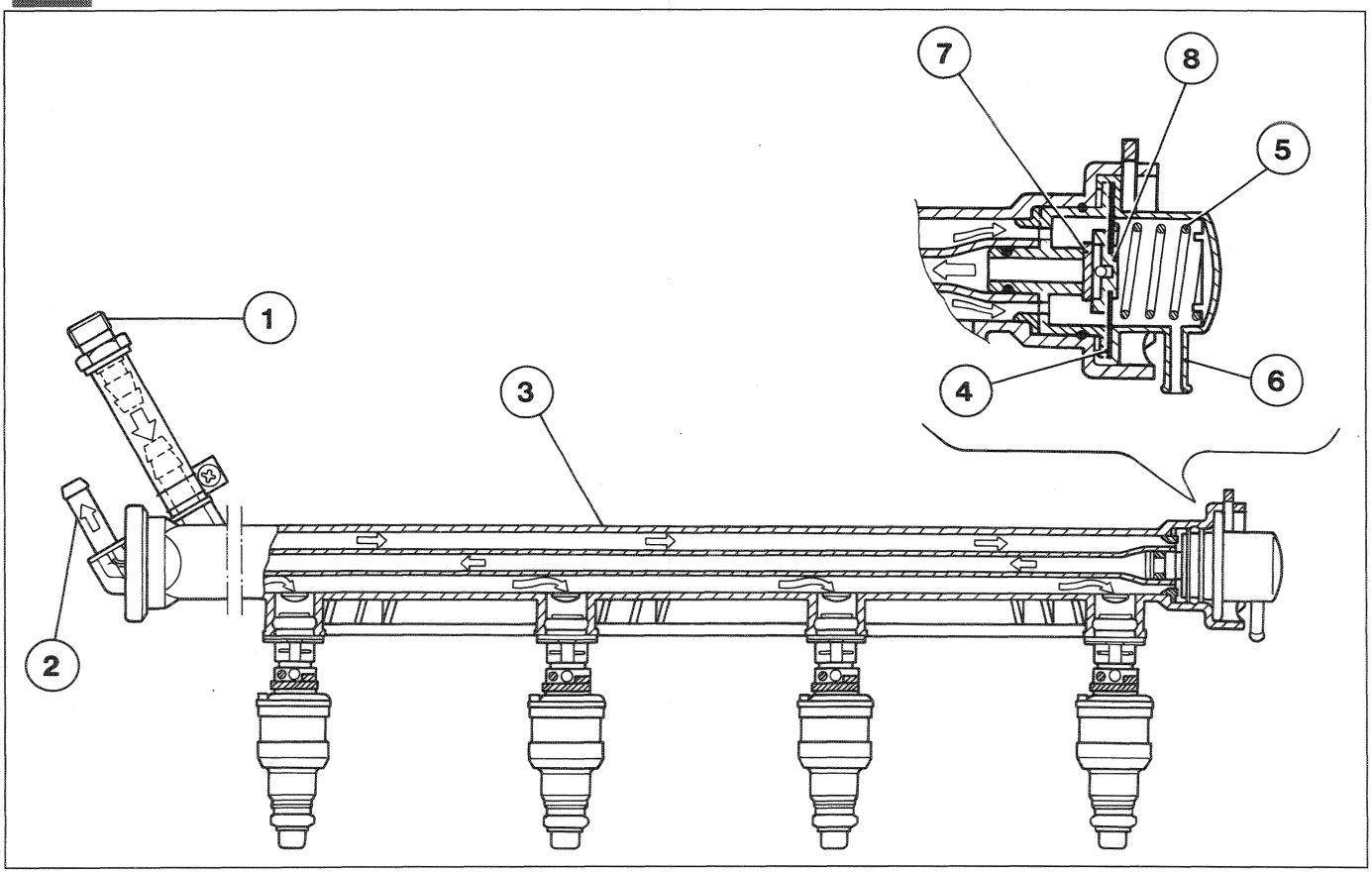
PRESSURE REGULATOR AND FUEL MANIFOLD

The mechanical, membrane-type pressure regulator is fitted downstream of the fuel manifold and cannot be adjusted.
The fuel manifold consists of a single body that supports both injectors and pressure regulator. The fuel return line is fitted inside the manifold.

The pressure regulator consists of a metal case that contains a mobile unit made up of metal body (8) and membrane (4) loaded by spring (5). After overcoming a set force, made up of the vacuum on the other side of the membrane and load of spring (5), the fuel pushed by the pump opens valve (7) to allow excess fuel to flow through pipe (2) to the tank.

The spring housing chamber communicates with the engine intake duct (6) (vacuum signal). This feature maintains a constant difference between fuel pressure and intake manifold vacuum throughout all engine service conditions.

Pressure regulator setting: 3±0.2 bar
With engine idling 2.5±0.2 bar (vacuum about 0.5 bar).



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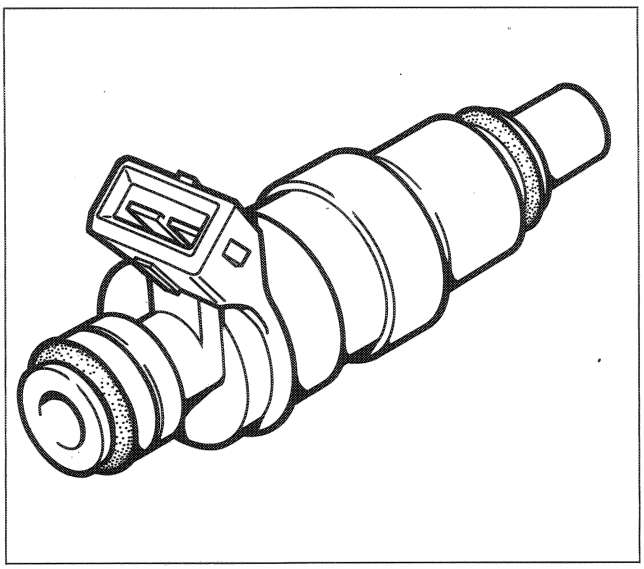
1. Fitting connected to fuel inlet pipe
2. Fitting connected to fuel return pipe
3. Injector support and fuel manifold
4. Membrane with reflux valve
5. Regulating spring
6. Pipe connected to vacuum in intake manifold
7. Reflux valve
8. Metal case



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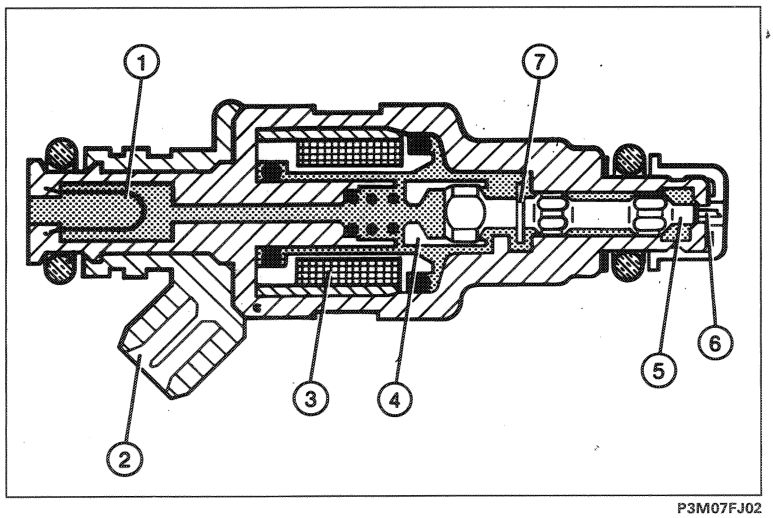
INJECTOR

The injectors are fitted to the inlet ducts immediately before the inlet valve.

The injector nozzle is positioned so that the fuel jet strikes the intake valve directly.

The injectors are held in place by the fuel manifold, which presses the injectors into their seats in the inlet ducts. They are also anchored to the fuel manifold by safety clips. Two rubber rings seal the inlet duct and fuel manifold.



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Lonitudinal section through electromagnetic injector

1. Filter
2. Supply connector
3. Magnetic winding
4. Magnetic core
5. Needle nozzle
6. Spray pin
7. Abutment plate

The injectors are responsible for metering the amount of fuel necessary to the engine.
These devices may take up only two stable conditions - either open or closed.
They consist of a nozzle controlled by a solenoid and return spring.
In rest position needle (6), which is integral with core (4) is pushed by the spring against the injector tip in order to close the hole and ensure a seal to prevent fuel emerging.

As soon as the winding is excited, core (4) is attracted, the spring is compressed to open the nozzle hole and permit fuel to emerge.
Assuming fuel physical properties (viscosity and density) and the pressure gap (pressure regulator) to be constant, the amount of fuel depends only on injector opening time (Tj).
The injector needle is non-oxidizable and thus unaffected by any impurities (water, methanol, ethanol, etc.) in commercial fuels.

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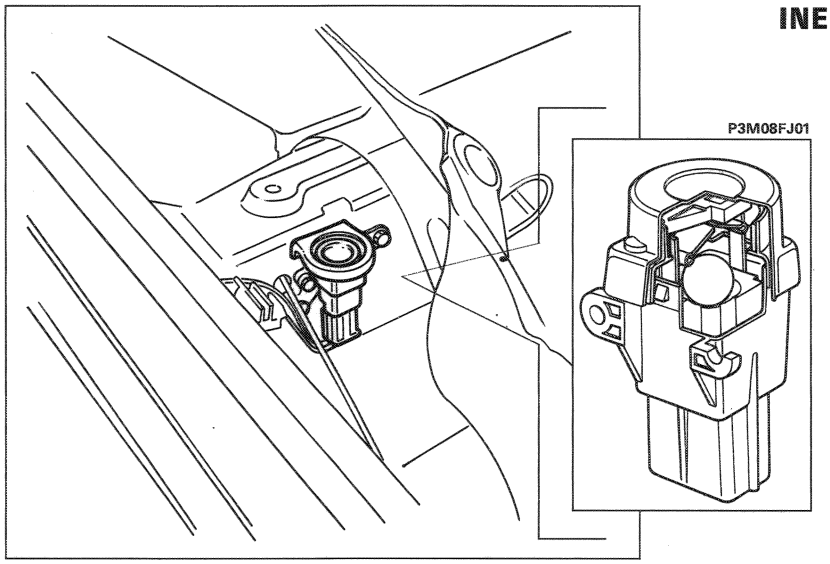

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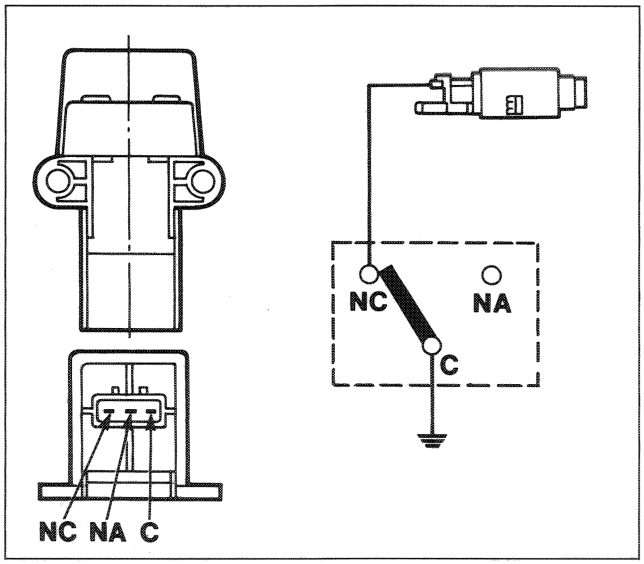
P3M05GJ01

INERTIA SAFETY SWITCH

Foreword

This switch is located alongside the driver's seat on the left hand side and triggered in the case of vehicle collision to cut off the earth connection to the fuel pump and thus the supply to the injection system.



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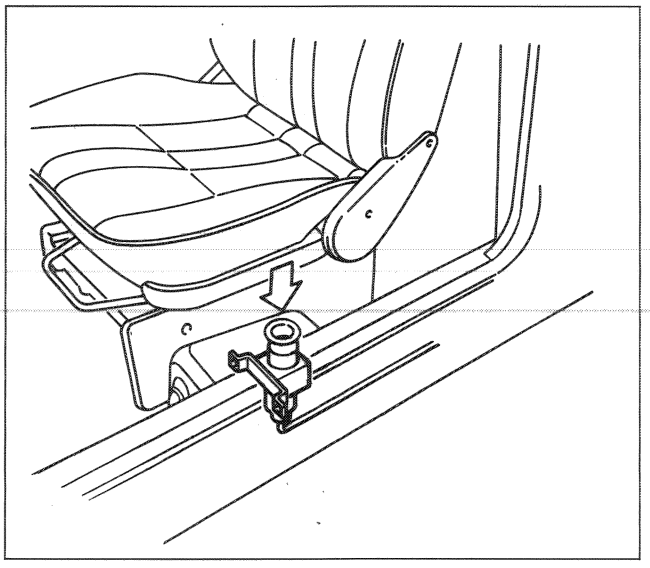
Principle of operation

A steel ball fitted inside a tapered housing is normally held in locked position through the attractive force of an adjacent magnet. In the case of specific acceleration loads, the ball is released from the magnetic attraction and gradually emerges from the tapered mount, following an upward movement according to cone angle.
A quick-release mechanism above the ball makes up a normally closed (N.C.) electrical circuit. When the mechanism is struck by the ball, it changes position from an N.C. circuit to a normally open circuit (N.A.) and thus breaks the fuel pump earth circuit.

In the case of a collision in any one the three orthogonal directions, the switch will operate at a peak value of over 12 g equivalent to a speed of about 25 Km/h.
The switch may be reset by pushing the button protected by a flexible cover (used also to protect against foreign bodies that could impede operation or cause reprogramming to occur).



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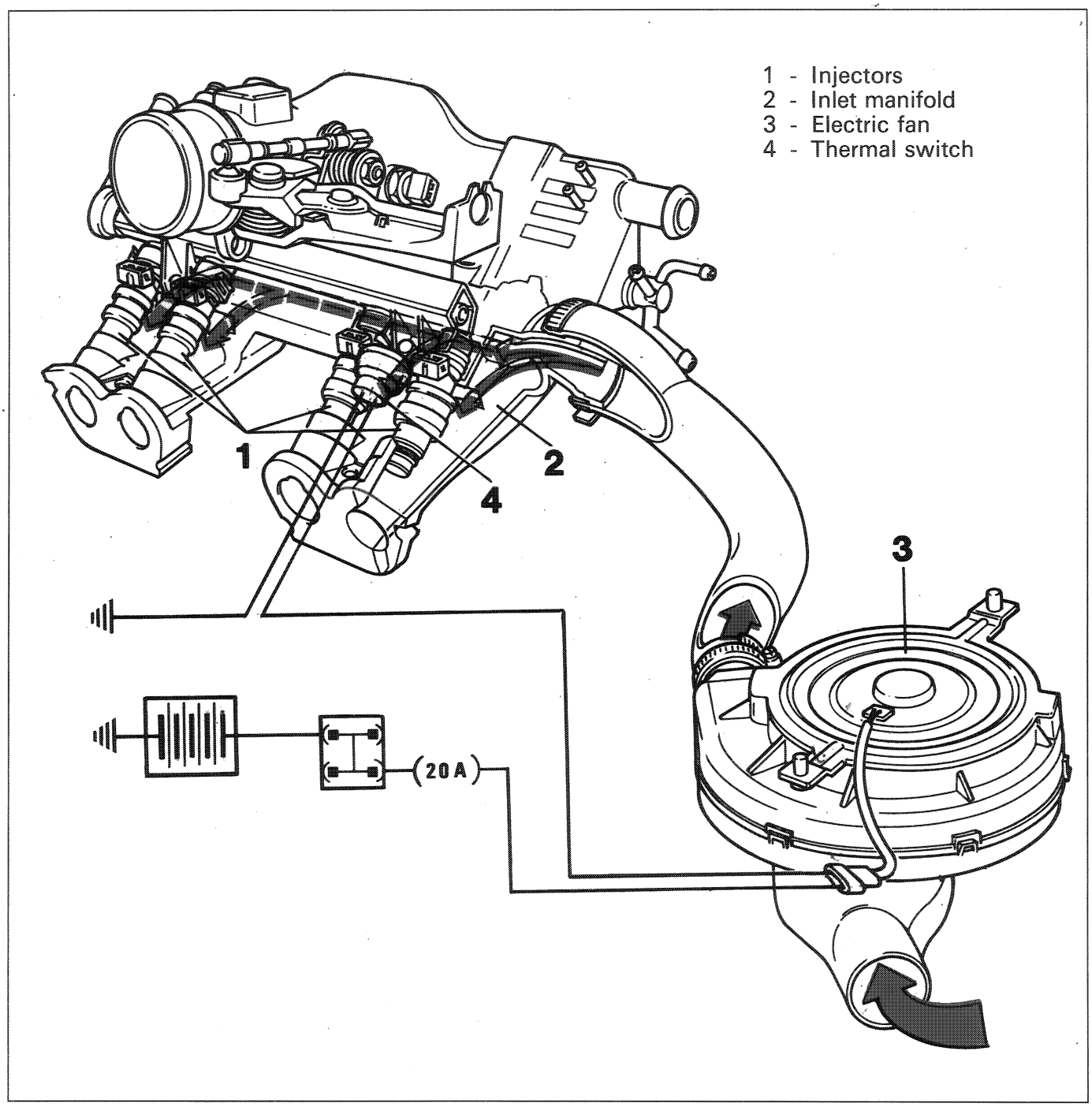
After even an apparently light collision, if a smell of petrol is noted or fuel leaks are seen, do not activate the switch again until the fault has been found and corrected in order to avoid the risk of fire.

If no leaks are noted and the vehicle is able to start, press the button to re-activate the pump.

INJECTOR VENTILATION AND COOLING DEVICE



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The device cools the injectors when they reach dangerous temperatures due to the formation of vapour-lock inside and operating efficiency is therefore affected.
The device consists of fan (3), which sends cool air to intake manifold (2), which contains ducts that carry ventilation directly to the injector case.
The fan is activated by thermal switch (4) when the temperature in the area around the injectors exceeds ~ 110°C and disconnected when temperature drops to ~ 95°C.

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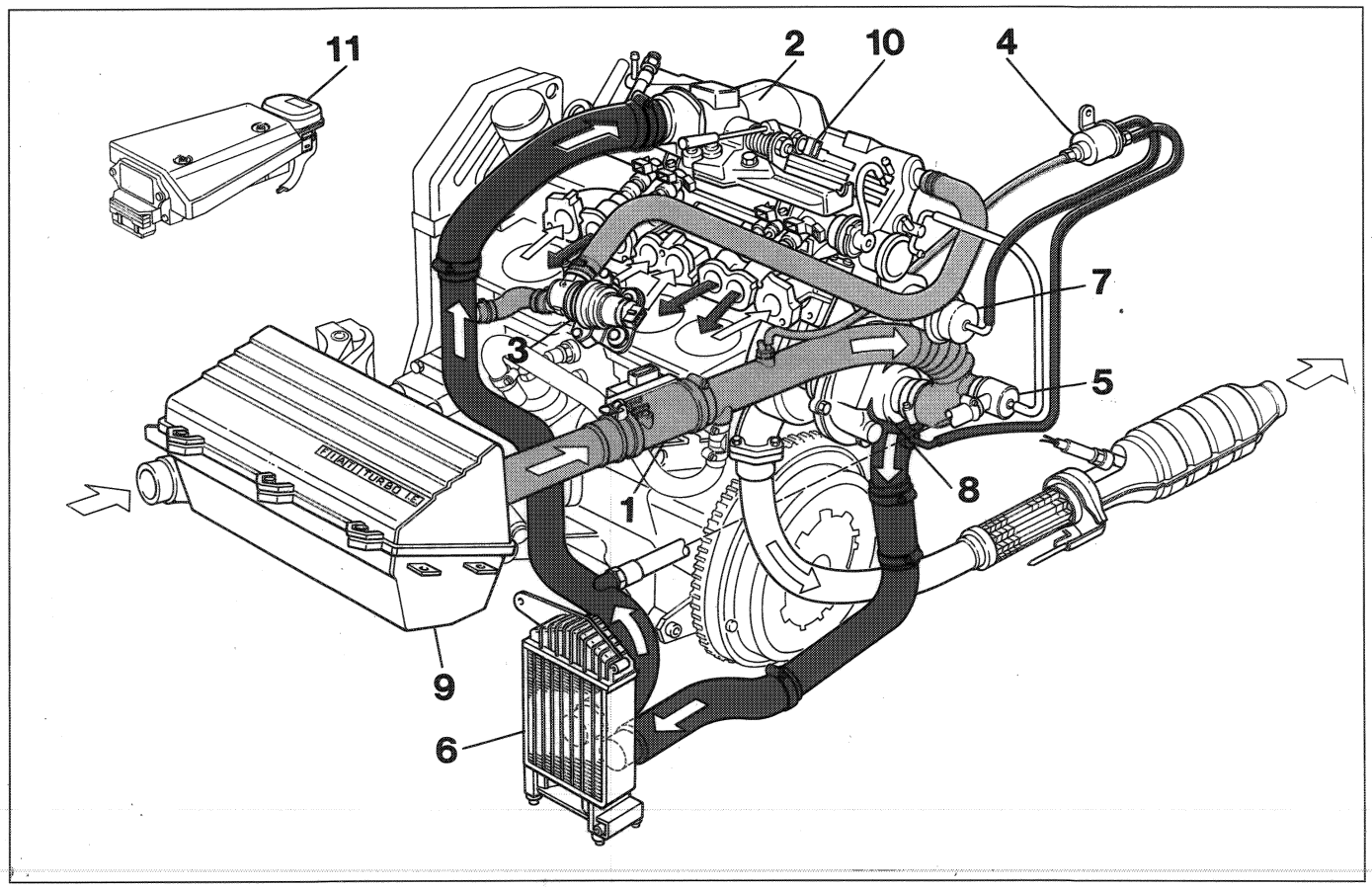
B - INTAKE AND TURBOCHARGING CIRCUIT

This consists of the following main components

1 - Hot wire air meter (debimeter);
2 - Throttle case;
3 - Engine idle speed actuator;
4 - Three-way turbocharging control solenoid;
5 - Turbo by-pass valve;
6 - Intercooler (intercooler);
7 - Turbo regulation actuator (Waste-gate);
8 - Turbocharger;
9 - Air cleaner;
10 - Intake air temperature sensor;
11 - Absolute pressure sensor or barometric capsule.

Two sensors are also present; **inlet air temperature sensor (10), absolute pressure sensor or barometric capsule (11). Despite being included in the electric/electronic circuit, these are responsible for controlling turbocharging.**

AIR INTAKE CIRCUIT DIAGRAM



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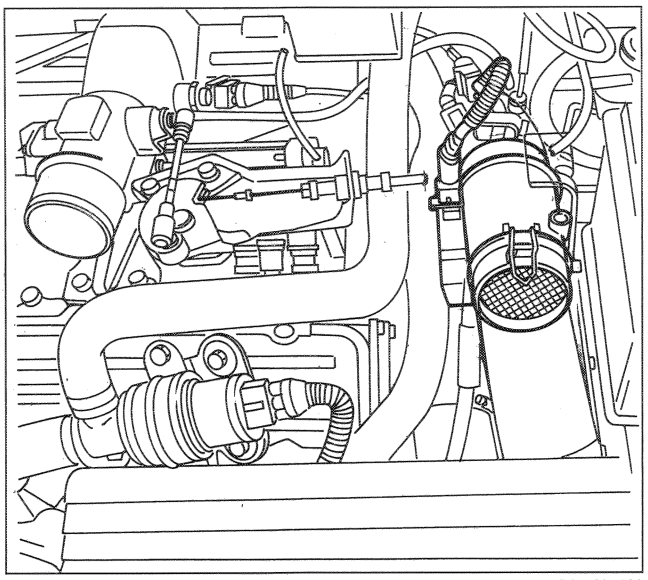
Compressed air circuit

Intake air circuit



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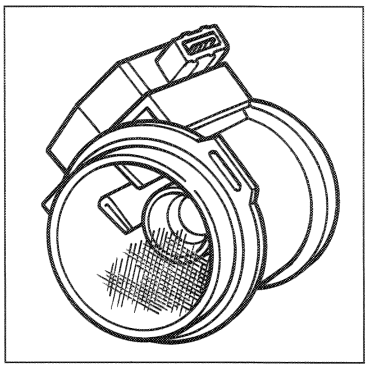
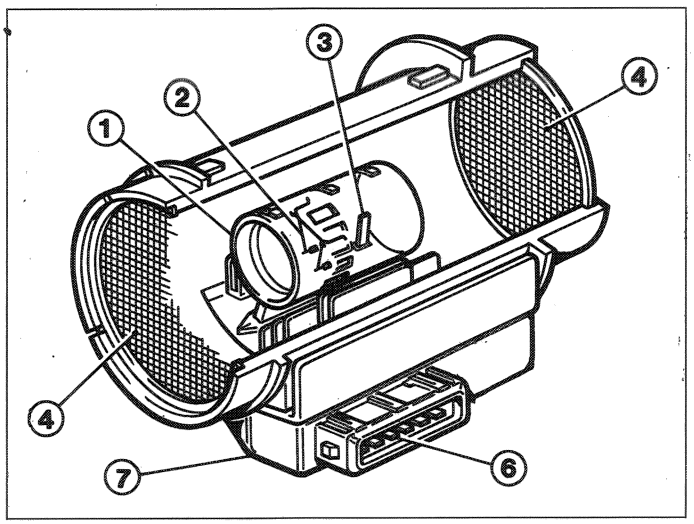
HOT WIRE AIR METER (DEBIMETER)



P3M11FJ02

1. Support conveying air to hot wire
2. Platinum filament or hot wire
3. Resistance (constantan) for comparing hot wire temperature
4. Filter mesh
6. Supply terminal
7. Meter ECU in aluminium case



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Direct measurement of the air mass taken in by the engine is carried out by a hot wire debimeter.

Air taken in by the engine strikes a filament maintained constantly 100°C above intake air temperature by an electrical current, despite the cooling experienced by the filament when the intake air volume increases.

The volume of air taken in by the engine can be established by the amount of this change.
The hot wire current variation is proportional to intake air volume, density and speed. Barometric changes due to high altitude do not therefore affect intake air volume directly.

Hot wire temperature and current changes are closely related because the hot wire forms part of a precision measuring circuit made up of a Wheatstone bridge and an electronic amplification system of which two components: hot wire (2) and constantan comparison resistance (3) are in contact with the mass of air taken into the engine, whereas the other parts of the circuit (resistances) are located in the top part (7) of the meter inside an aluminium container.

Pyrolysis

Whenever the engine stops after speeds in excess of 2400/min, filament (2) carries a current governed by the ECU for about 1 second that takes the temperature to 1000°C in order to burn off all the carbon deposits on the wire because otherwise these would alter the 100°C hot wire maintenance current and thus the exact air-fuel ratio calculated by the ECU.

If the hot wire is broken, the engine may continue to work (with very rich mixtures) using data stored in the ECU. This allows the vehicle to be driven to a repair workshop (RECOVERY function). Engines being recovered must not be allowed to cool because otherwise they will not be able to start again.

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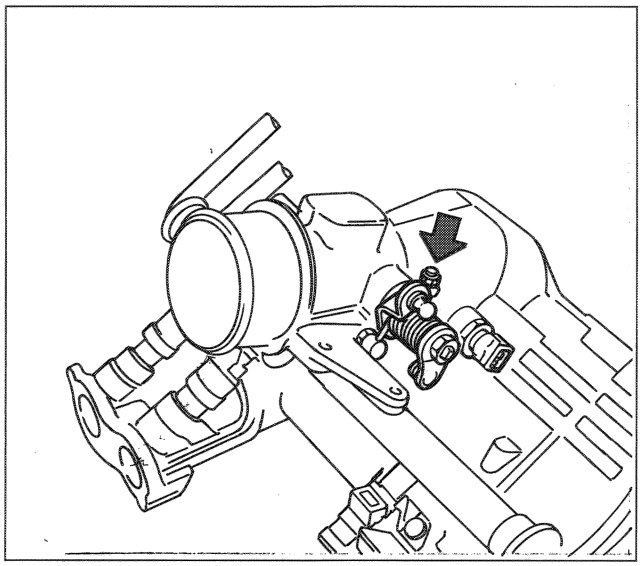

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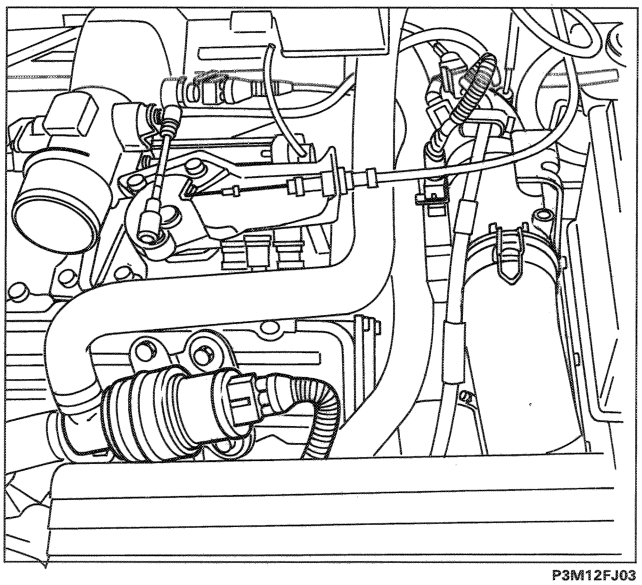
ACCELERATOR THROTTLE CASE (THROTTLE CASE)

The amount of air taken in is determined by the opening of a throttle at the beginning of the intake manifold. The throttle is controlled by the accelerator pedal. Air necessary to keep the engine idling (with throttle closed) and appliances activated is regulated and by-passed solely by the engine idle speed actuator.

The arrowed screw is used to adjust throttle closure correctly in order to prevent fouling against the surrounding circuit; **this screw should not be used to adjust idle because it is set by flushing during manufacture and must never be tampered with.**



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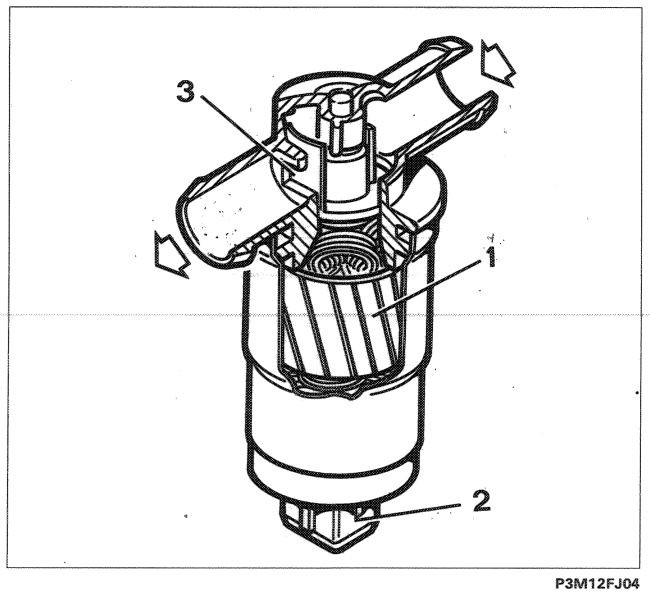
ENGINE IDLE SPEED ACTUATOR

This consists of an electric motor, with armature (1) visible, a supply terminal block (2) and rotary distributor (3). By opening supplementary air passage - in parallel with leakage flow from throttle (with accelerator released) - in the throttle case by varying amounts, this keeps engine idle speed constant automatically whatever the engine load (supplementary appliances on or off, engine warm or cold etc.).

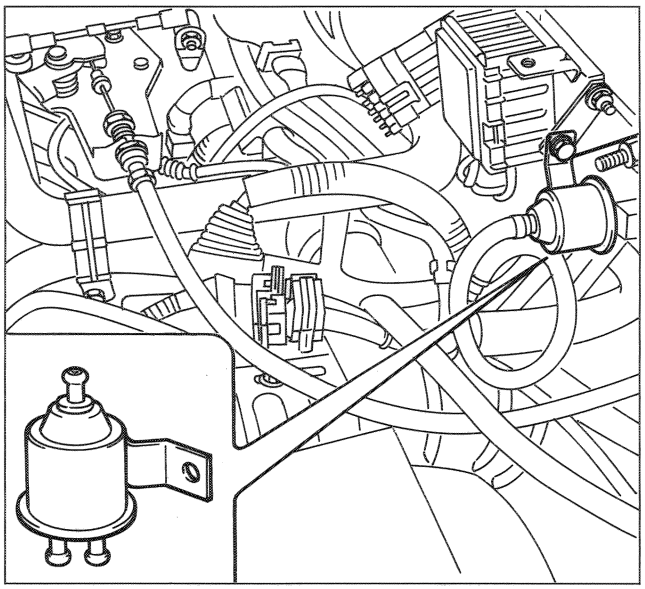
The passage opening brought about by distributor rotation is governed by electrical pulses processed by a special section of the injection ECU, which turns the distributor one way or another according to engine speed.



P3M12FJ04

The actuator must be positioned correctly upon installation. Air flow through the valve is shown by an arrow.

1. Armature winding
2. Connector
3. Rotary distributor



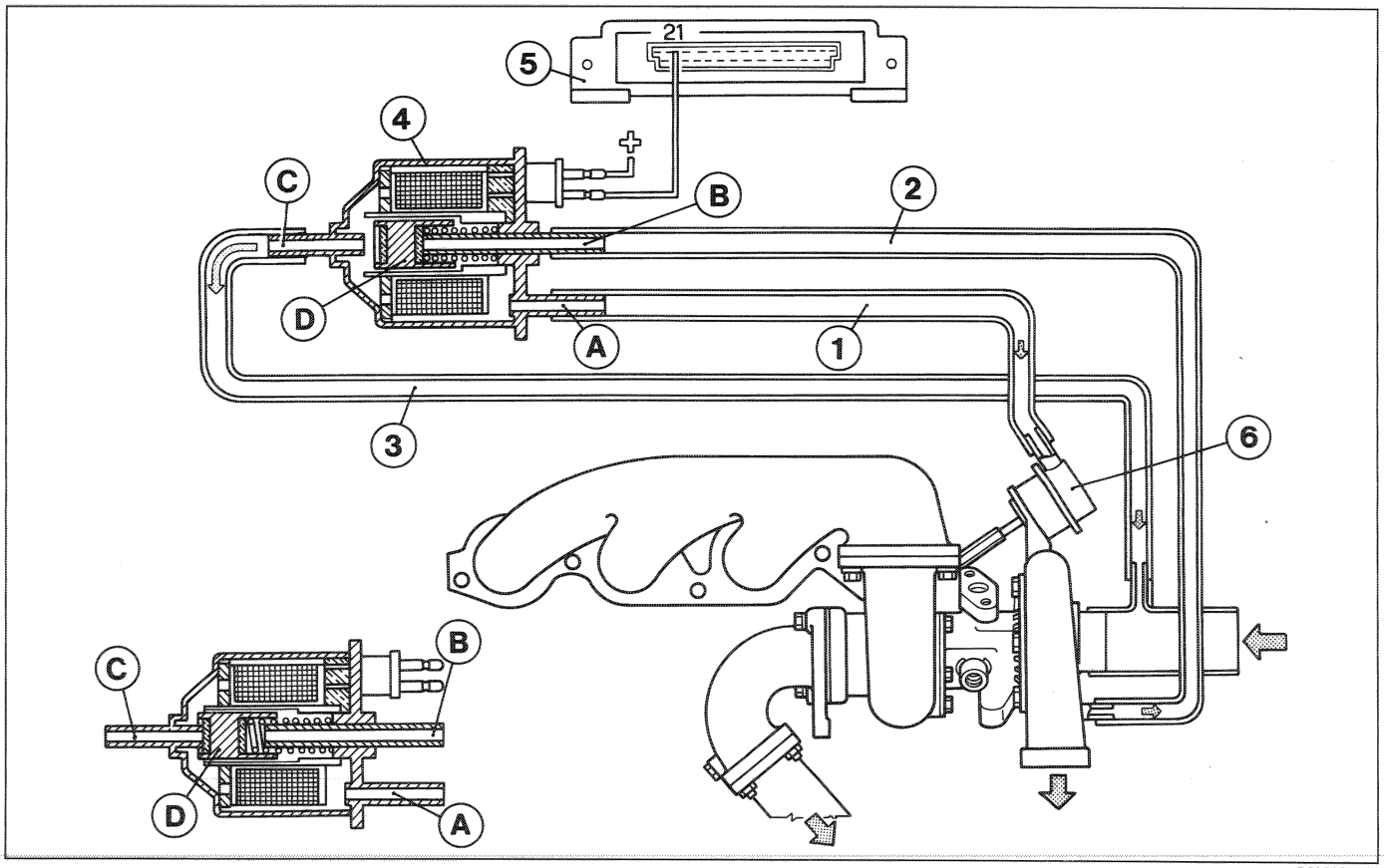
P3M13FJ01

TURBOCHARGING PRESSURE REGULATION SOLENOID (PIERBURG)

This solenoid, controlled permanently by the ECU, carries out direct, continuous control of turbo pressure according to engine rpm and throttle position. Maximum possible turbo pressure (absolute) is 2200 mbar.

The ECU is also able to correct these pressure values in the presence of other values such as inlet air temperature, knock and barometric pressure.

TURBOCHARGING REGULATION SOLENOID CONNECTION DIAGRAM



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Operation of piloted turbo device

Turbo device control solenoid (4) is piloted permanently by injection-ignition control ECU (5) via terminal 21.
Control solenoid (4) is three-way (A-B-C).
Duct A is connected by sleeve (1) to actuator (6) of the Wastegate valve.
Duct B is connected to turbo pressure relief duct by sleeve (2).
Duct C is connected by sleeve (3) to turbo intake duct.

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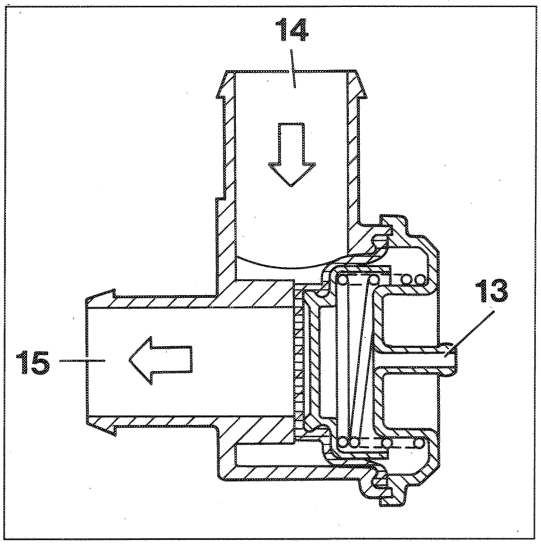
When the solenoid is activated by the ECU, cylinder (D), magnetized by the coil winding, begins to pulse upon piloting by a duty-cycle signal: pulsing of the cylinder releases duct (B) and closes duct (C) to allow excess pressure from the turbocharger to reach wastegate actuator (6) through pipe (2) and pipe (1) and modulate the excess supply pressure.

Conversely, when cylinder (D) closes duct (B) and opens up duct (C), the pressure that previously acted on actuator (6), is drained through pipe (3) in the turbo intake duct to increase turbo pressure.

Duct A of the three-way solenoid is marked with a spot of blue paint and duct B with a spot of red paint.
In the case of service operations on this device, take great care to fit correctly, i.e.: duct A (blue spot) is connected to actuator (6); duct B (red spot) is connected to turbo pressure relief duct.



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MECHANICAL BY-PASS VALVE

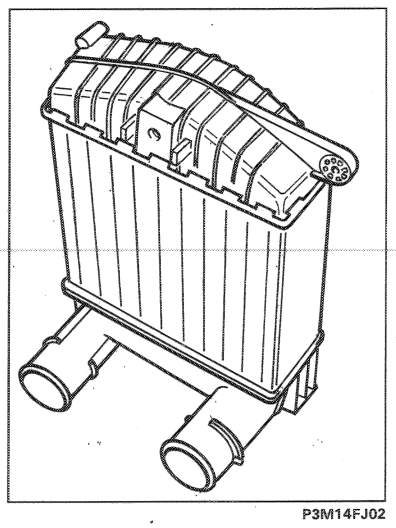
A by-pass between turbo low pressure pipe (intake) and high pressure pipe is responsible for deadening the characteristic compressor noise during over-run.

The vacuum set up upstream of the throttle valve acts on the by-pass valve membrane to open the valve.
The supply system downstream of the turbine is thus put into direct connection with the air cleaner and the excess pressure in the turbocharged circuit section is drained to the outside.
During this stage, a pressure peak occurs due to the sudden drop in air flow required by the system.

When the throttle valve is opened again during acceleration, the by-pass valve closes to restore normal supply circuit operation.

13. Vacuum inlet pipe
14. Superimposed pipe
15. Vacuum pipe

MAIN PRECAUTIONS TO BE OBSERVED FOR PROPER USE OF A TURBOCHARGED ENGINE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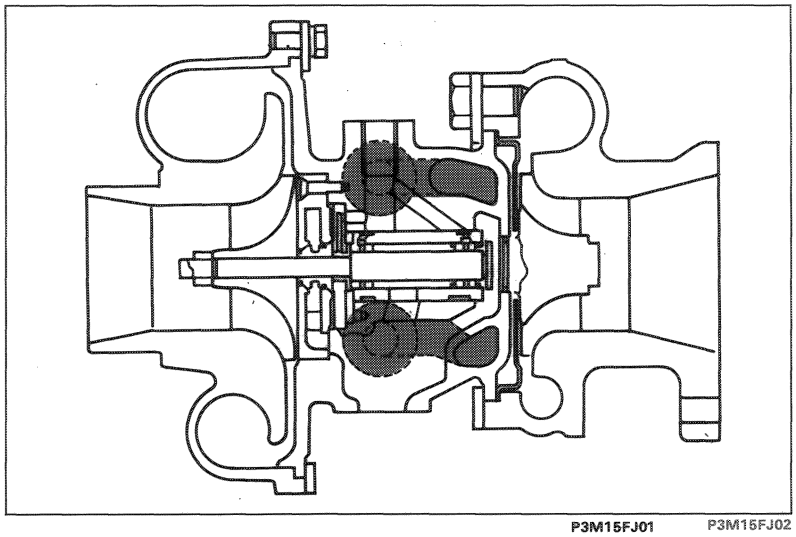
- *Never run the engine without an air cleaner. This could damage the turbocharger due to the extremely high energy acquired by even the smallest foreign particle.*
- *Never turn off the engine at medium-high speeds before it drops to idle speed. The engine would stop too long before the turbine and thus remain without lubrication for a certain period, which would damage it. After a period of sporty driving, run for a few minutes before turning off in order to speed cooling of the turbocharger and exhaust manifold.*

INTERCOOLER

The intercooler between the turbocharger and the inlet manifold cools the charge admitted to the cylinders in order to increase its weight. This ensures the engine power output during combustion is greater.



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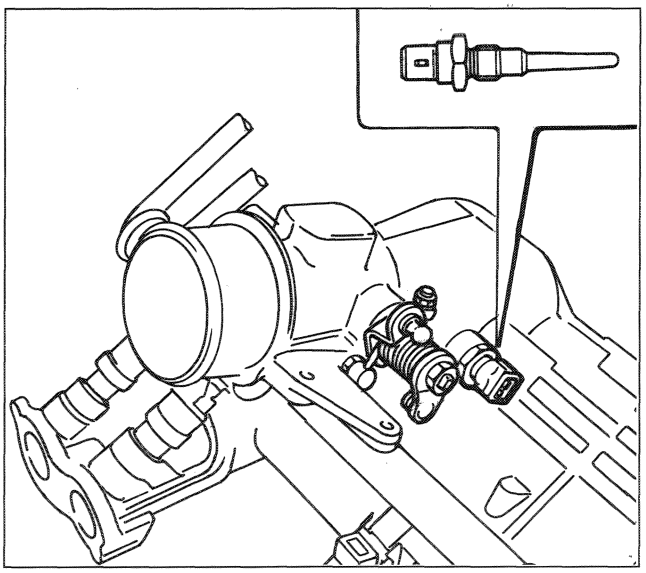
Cross section through turbocharger IHI-VL7
The coloured parts show the route taken by coolant from the engine.

TURBOCHARGER

The turbocharger used on this engine is IHI-VL7 type. It consists essentially of two impellers fitted to the same shaft.

One impeller, known as a turbine, is located on the exhaust manifold and turned by the kinetic energy and pressure of exhaust gases striking it.

The rotating turbine struck by gas also turns the other impeller, known as a compressor and located on the intake duct, at the same speed.
Due to its speed of rotation and the particular shape of its vanes, the compressor takes up air from outside and compresses it in the inlet manifold and then in the engine cylinder.

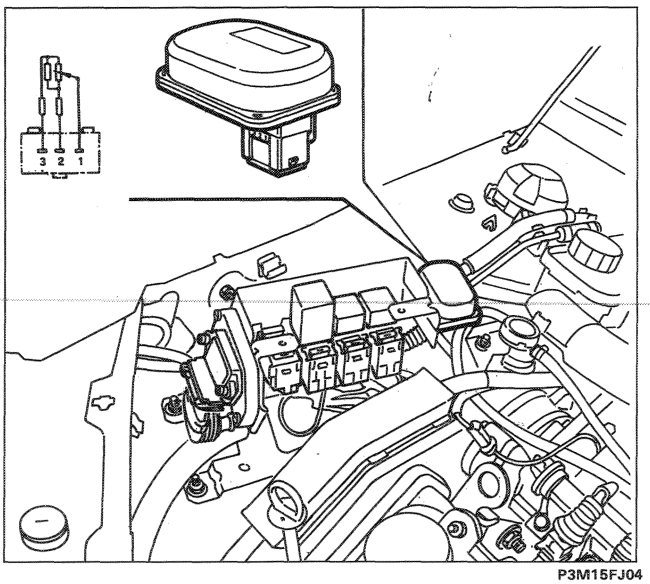


P3M15FJ03

INTAKE AIR TEMPERATURE SENSOR

The intake air temperature sensor is located on the intake manifold downstream of the throttle valve.
This sensor measures the temperature of turbocharged air taken into the cylinders.

Information sent to the ECU is used by the unit to limit turbo pressure if the air temperature reaches excessive levels.



P3M15FJ04

ABSOLUTE PRESSURE SENDER UNIT (barometric capsule)

The absolute pressure sender unit is a sensor that sends the injection-ignition ECU information on changing barometric pressure conditions during vehicle use.

This sensor sends the ECU a signal proportional to the sensor input voltage and barometric pressure.

The information is used to limit turbo pressure at high altitude.

This strategy is necessary to protect against the danger of the compressor turbine turning too fast because rarified air at altitude and excessive performance demands by the driver could force the turbine to turn too fast before achieving the required turbo pressure.

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C. ELECTRIC/ELECTRONIC CIRCUIT

Connects all Bosch Motronic M 2.7 injection/ignition system components and provides them with electricity.

It consists mainly of an **electronic control unit** (control unit) and the following parts.

- Two main control relays (electric fuel pump - control unit)
- Throttle valve position sensor
- Coolant temperature sensor
- Intake air temperature sensor
- Fuel pump submerged in tank
- Four injectors
- Intake air flow meter (hot wire debimeter)
- Engine idle speed actuator
- Rpm and TDC sensor
- Injection timing sensor
- Absolute pressure sensor (barometric capsule)
- Detonation sensor
- Turbo pressure regulation solenoid (Pierburg)
- Detonation sensor
- Lambda probe
- Power module for ignition
- Ignition coil with four high tension outlets
- Four spark plugs
- Solenoid (Bosch) for fuel vapour controla
- Diagnostic socket for Fiat/Lancia Tester
- Injection-ignition system failure warning light

Injection-ignition ECU (control unit)

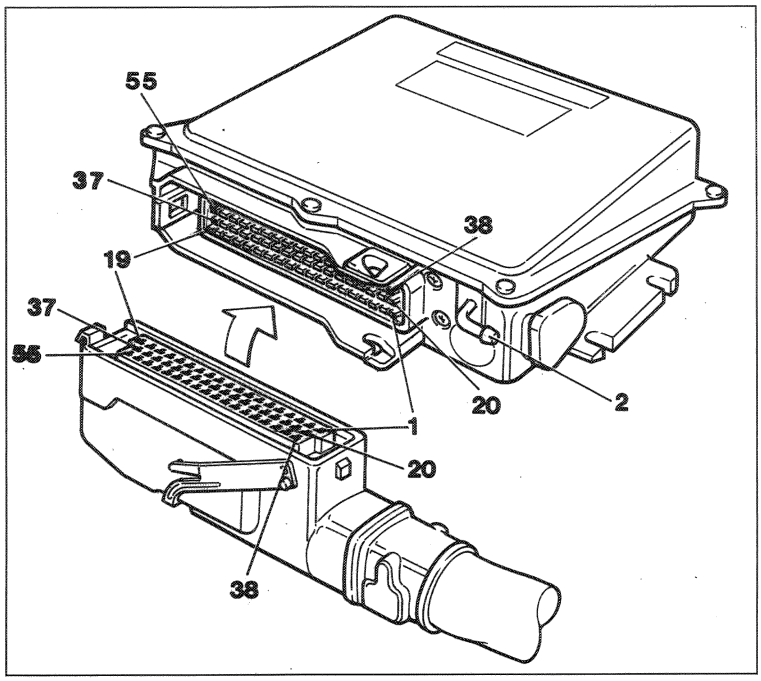
The Bosch Motronic M 2.7 injection-ignition system fitted is specific to this version.

It consists of hybrid thick film circuits and is connected to the electrical wiring by means of a multiple connectora **55 way** (or poles).
These receive data on all engine service conditions from the various sensors:

- inlet air quantity
- inlet air temperature
- coolant temperature
- engine rpm and TDC
- injection timing signal
- throttle valve position
- vehicle speed signal
- knock signal
- lambda signal

According to the signals processed, the ECU pilots the actuators, calculates the optimum ignition advance level and demagnetizes the two ignition coil primary windings.

P3M17FJ01



ELECTRONIC CONTROL UNIT (ECU)

Reference numbers of terminals (pins) on control unit and multiple 55 way connector.

Intake (2) is connected via a pipe to the intake manifold; the pressure signal is used by the control unit to adjust the turbo pressure by piloting the three-way solenoid (Pierburg).

The ECU continually adjusts ignition advance angles and injection pulse duration according to information received in order to perform numerous functions, of which the most important are:

A. System self-adaptation

A fundamental and innovative feature of this system is "self-adaption": it is able to recognise changes occuring in the engine (different internal friction and different temperatures, settling of engine with time etc.) in order to compensate accordingly.
This self-adaptive function also allows inevitable differences to be made up for (due to manufacturing tolerances) due to replacement parts. This allows the entire vehicle to operate at maximum efficiency without specific adjustments and checks.

B. Fuel metering

On the basis of information on air intake quantity, intake air temperature and coolant temperature, the ECU identifies baseline injection time for correct metering by consulting a special memory map.

C. Controlling cold starts

During start-up, the ECU sends the injectors a signal of sufficient duration and frequency to ensure the necessary fuel enrichment for starting.
An anti-flood function is also included, which is controlled by rpm and duration of starting attempt. Injection time is reduced when the engine does not start immediately for some reason.

D. Engine heating

As the engine heats up, the mixture is enriched and injection times are increased in inverse proportion to coolant temperature.

E. Control of enrichment during over-run

When required to accelerate, the ECU increases injection in order to achieve the required load more quickly. This function is achieved via a potentiometer on the throttle that indicates instantaneously to the ECU that a full power request has been made and anticipates a signal from the debimeter recording a signficant increase in air flow to allow an immediate response to be obtained.

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F. Full power

During engine operation at full load (with throttle fully open) baseline injection times are increased to enrich the air-fuel mixture. During this operating stage, the ECU also disenables the Lambda probe function.

G. Fuel cut-off during over-run (cut-off)

With throttle closed and rpm more than a threshold level (about 1200 rpm), the ECU deactivates fuel injection. In this way the number of revs drops quickly to a minimum and fuel is saved for a considerable improvement in fuel economy. **The cut-off threshold varies according to engine temperature.**

H. Idle speed control

Idle speed is adjusted by means of a special actuator that acts on the throttle by-pass.

This also acts as an additional air valve and regulator for the activation of various appliances (e.g. air conditioner compressor); with the throttle closed, the actuator adjusts the by-pass opening to make up the power required by the appliances in order to ensure idle speed is as constant as possible.

The actuator ensures prompt regulation because by-pass opening and closure are both controlled by magnetic coils.
The vehicle speed signal is also considered for the idle strategy; this establishes whether vehicle is idling at a standstill or moving.

NOTE *The system self-adaptation funciton allows any idle speed adjustment to be eliminated. The ECU recognises the "throttle closed" position from the throttle case sensor. This allows it to monitor wear that may arise in the closed position.*

I. Limitation of maximum rpm

The maximum rpm limitation management and control strategy is as follows:
the ECU cuts off injection at 6700/min.

L. Vehicle speed signal

In the M2.7 system, the vehicle speed signal allows the ECU to recognise when 1st gear is engaged. This is achieved by comparing engine rpm with vehicle speed. In this case the ECU's function is to limit turbo pressure in the case of sprint starts to prevent the drive wheels skidding excessively (antispin function.)

M. Connection to antitheft device

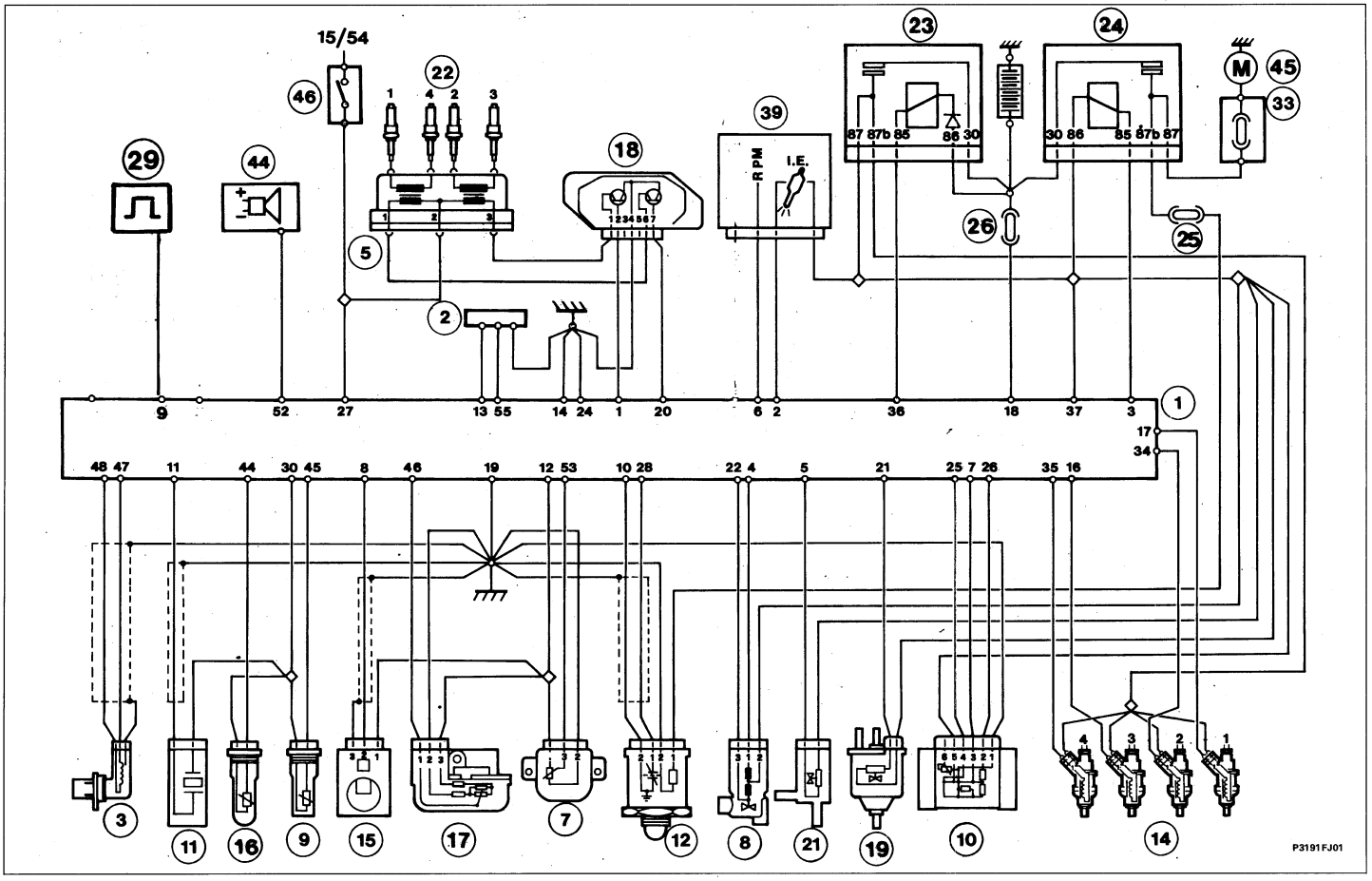
If an antitheft device is fitted and turned on, this automatically inhibits operation of the injection-ignition ECU (Motronic).

N. Control of detonation or knock

Knock (or detonation) is controlled by a sensor housed on the monobloc.

When the engine knocks, vibrations of a certain frequency are set up in the crankcase. The effect causes mechanical repercussions on a piezoelectric crystal in the sensor that sends a signal to the ECU. The ECU carries out selective recognition of detonation cylinder by cylinder via detonation sensor and uses the rpm and TDC sensor to detect the angular position of the crankshaft upon the next cycle, i.e. after two crankshaft rotations. Then upon the exhaust stage of the same cylinder, the ignition advance is reduced (the delay occurs 3° by 3° to a maximum of 12°).

CONTROL UNIT-SENSOR-ACTUATOR ELECTRICAL CONNECTION DIAGRAM



1. Electronic injection-ignition control unit Bosch Motronic M2.7
2. Diagnostic socket for Fiat/Lancia tester
3. Rpm and TDC sensor
5. High tension coil with four outlets
7. Throttle valve position sensor
8. Engine idle speed regulation actuator
9. Coolant temperature sensor
10. Air flow meter (debimeter)
11. Detonation sensor
12. Lambda probe
14. Injectors
15. Injection timing sensor
16. Inlet air temperature sensor
17. Absolute pressure sensor (barometric sensor)
18. Ingition power module
19. Three-way turbocharging control solenoid
21. Vapour recirculation solenoid
22. Spark plugs
23. Injection-ignition system relay Motronic (injector control unit, idle adjustment actuator, vapour recirculation solenoid, turbo control solenoid, air flow meter, system failure warning light)
24. Injection-ignition system relay Motronic (electric fuel pump, Lambda probe heating)
25. Fuse protecting Lambda probe preheating circuit
26. System fuse (injection-ignition)
29. Speedometer signal on gearbox
33. Fuse electric fuel pump
39. Instrument panel
44. Antitheft device
45. Electric fuel pump
46. Ignition switch

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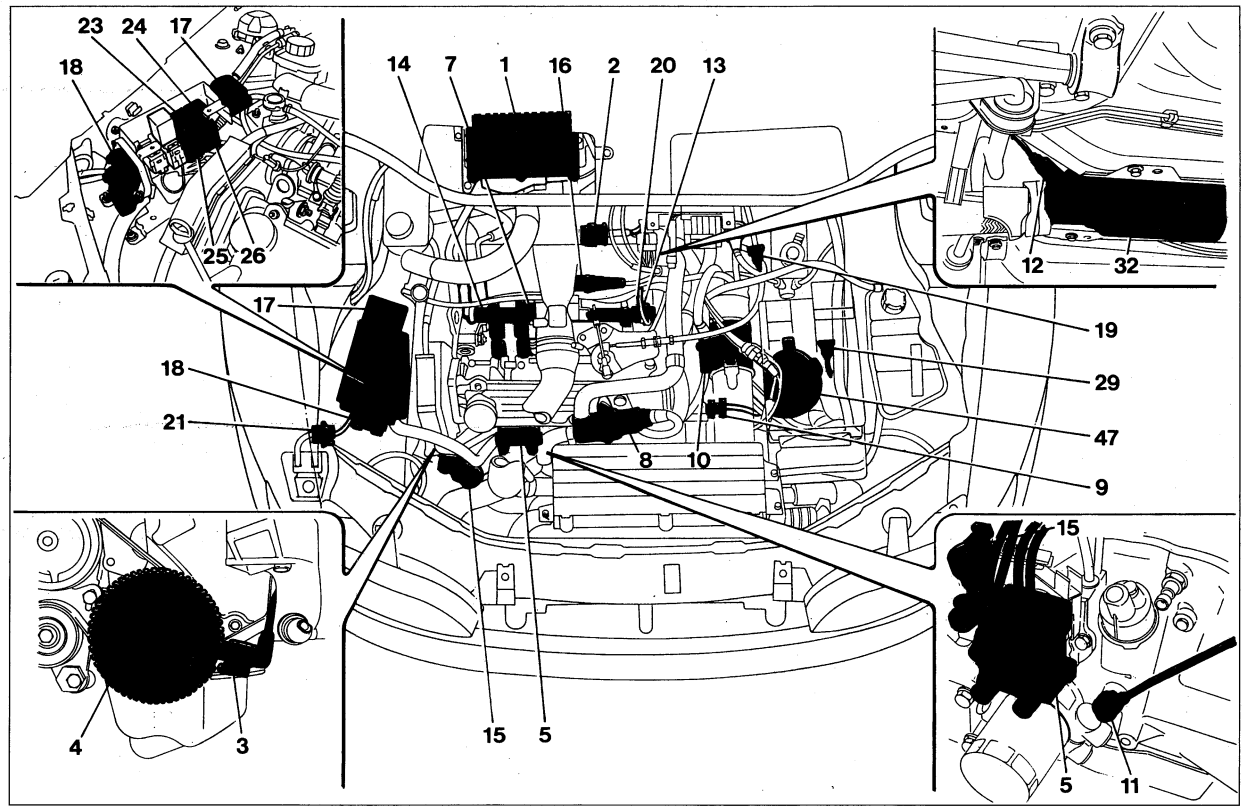
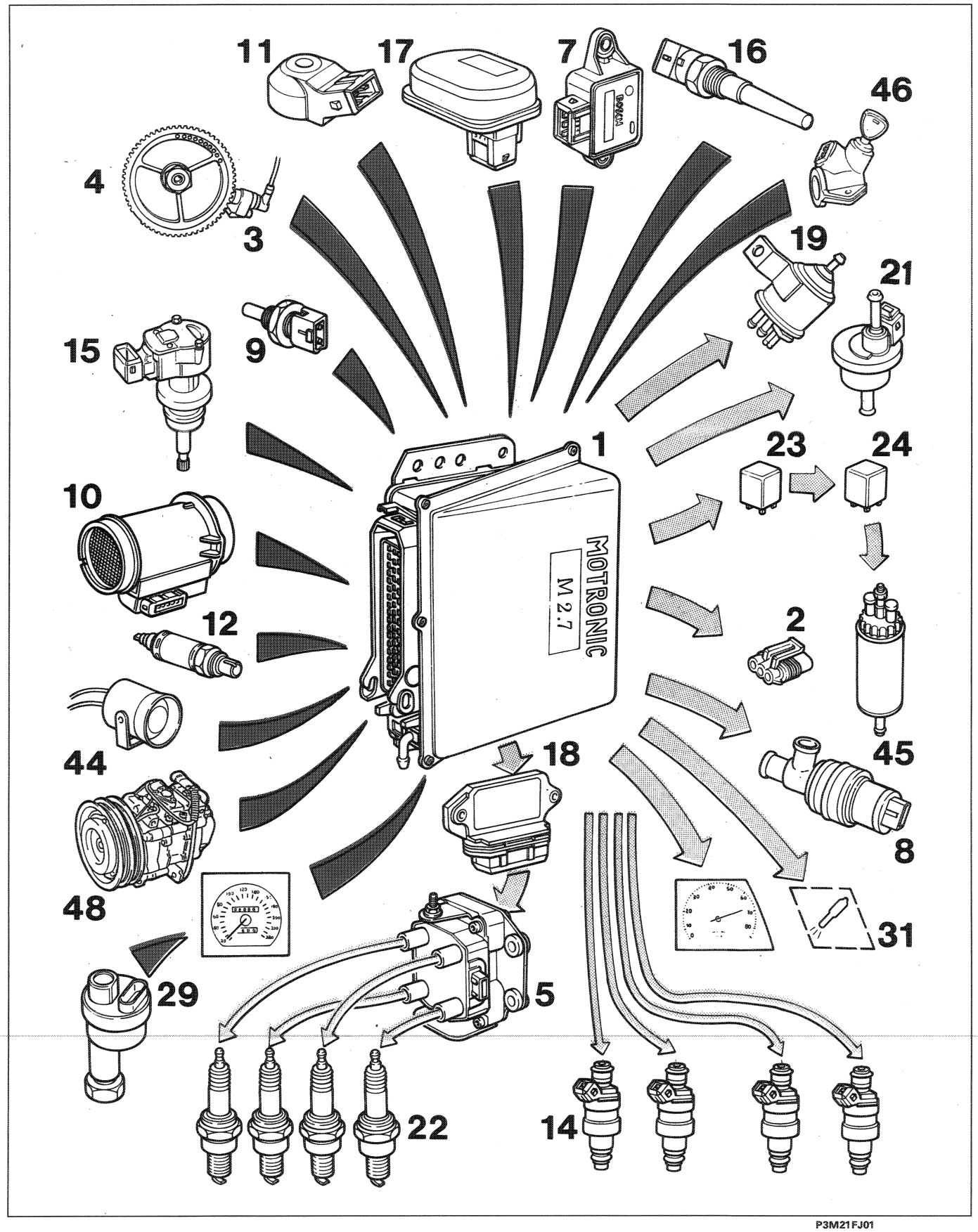
LOCATION OF BOSCH MOTRONIC M2.7 INJECTION-IGNITION SYSTEM COMPONENTS IN ENGINE BAY



1. Electronic injection-ignition control unit Bosch Motronic M2.7
2. Diagnostic socket for Fiat/Lancia tester
3. Rpm and TDC sensor
4. Engine pulley ring gear (phonic wheel)
5. High tension coil with four outlets
7. Throttle valve position sensor
8. Engine idle speed regulation actuator
9. Coolant temperature sensor
10. Air flow meter (debimeter)
11. Detonation sensor
12. Lambda probe
13. Fuel pressure regulator
14. Injectors and fuel manifold
15. Injection timing sensor
16. Inlet air temperature sensor
17. Absolute pressure sensor (barometric sensor)
18. Ignition power module
19. Three-way turbocharging control solenoid
21. Fuel vapour recirculation solenoid
22. Spark plugs
23. Injection-ignition system relay Motronic (injector control unit, idle regulation actuator, vapour recirculation solenoid, turbo control solenoid, air flow meter, system failure warning light)
24. Injection-ignition system relay Motronic (electric fuel pump, Lambda probe heating)
25. Fuse protecting Lambda probe circuit
26. System fuse (injection-ignition)
29. Speedometer sensor on gearbox
31. System failure warning light
32. Catalytic converter
44. Antitheft device
45. Electric fuel pump
46. Ignition switch
47. Injector cooling fan
48. Air conditioner compressor

DIAGRAM OF INPUT AND OUTPUT BETWEEN ECU AND SYSTEM SENSORS AND ACTUATORS FOR BOSCH MOTRONIC M2.7



P3M21FJ01

10.

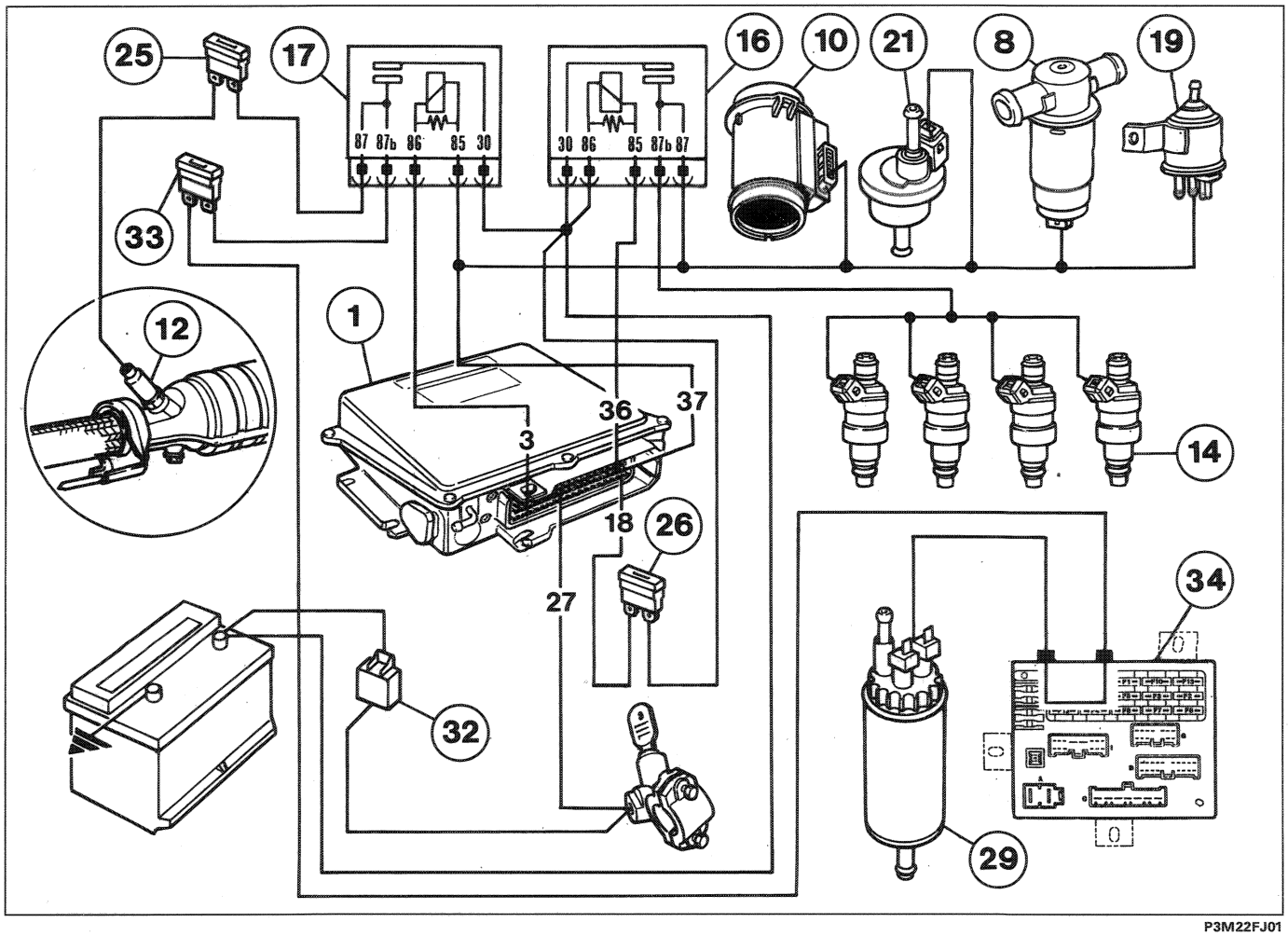
BOSCH SYSTEM RELAYS M 2.7

The exitation circuit of the 2 relays is supplied by turning the ignition key to MARCIA.

The operating strategy is as follows:

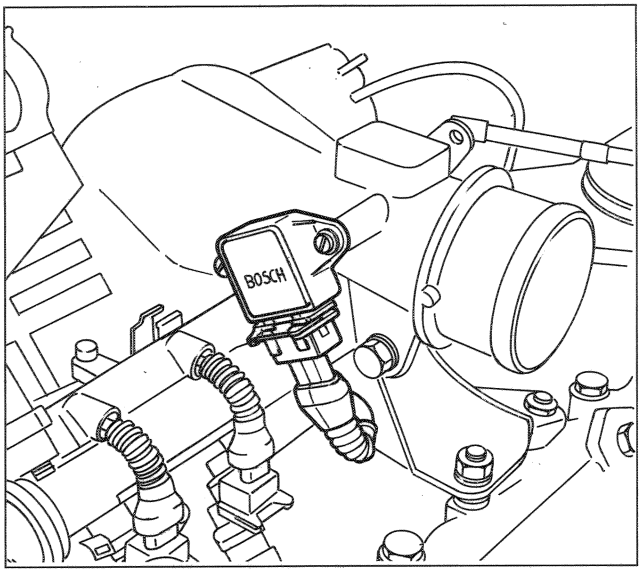
a. With ignition key in MARCIA position, the ignition switch supplies (from 15/54) the ECU, which in turn closes exitation circuit of relay (16) through terminal (pin) 36. This suplies injectors, control unit, fuel vapour recirculation solenoid, engine idle speed actuator, hot wire debimeter, turbo control solenoid and exitation circuit of fuel pump relay (17).

b. The exitation circuit of relay (17) is supplied by relay (16), while the circuit is closed by terminal (pin) in order to control the fuel pump operating strategy. Relay (17) also supplies the Lambda probe preheater coil.



P3M22FJ01

1. Electronic injection-ignition control unit
8. Engine idle speed regulation actuator
10. Air flow meter (debimeter)
12. Lambda probe
14. Fuel injectors
16. Relay supplying control unit, injectors, engine idle adjustment actuator, fuel vapour recirculation solenoid, air flow meter, turbo control solenoid
17. Relay supplying electric fuel pump and lambda probe heating
19. Turbo control solenoid
21. Fuel vapour recirculation solenoid
25. Lambda probe fuse
26. Control unit fuse
29. Electric fuel pump
32. Connector block
33. Fuel pump fuse
34. Fuse block

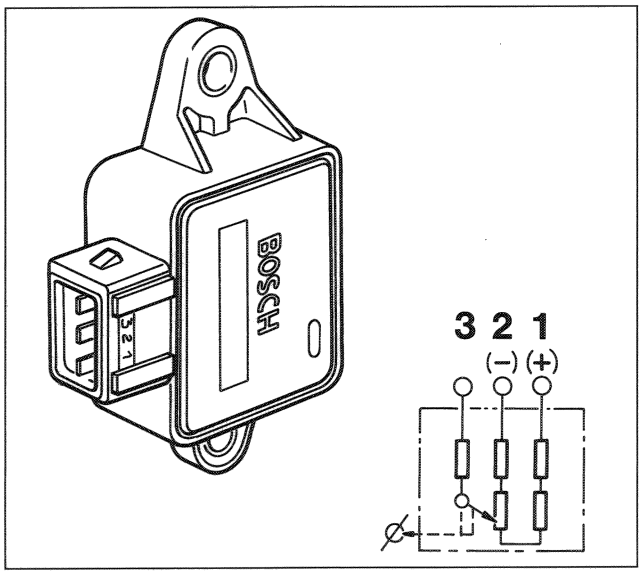


P23M23FJ1

THROTTLE VALVE POSITION SENSOR

This consists of a potentiometer whose mobile part is controlled by the throttle valve spindle.
During operation, the ECU supplies the potentiometer with a voltage of 5 Volts applied to pins (1) and (2).
A voltage inversely proportional to throttle opening position builds up on pin 3. According to the voltage sent by pin 3, the ECU recognises the throttle valve opening condition and corrects mixture concentration accordingly.

With the throttle closed, an electrical signal of about 0.5 Vots is sent to the ECU, which recognises idling and cut-off conditions (differentiating between them on the basis of engine rpm).
The sensor automatically recognises throttle closure contact position by means of a self-adaptive function. **This eliminates potentiometer regulation operations** and allows wear on throttle closure position to be monitored if necessary.



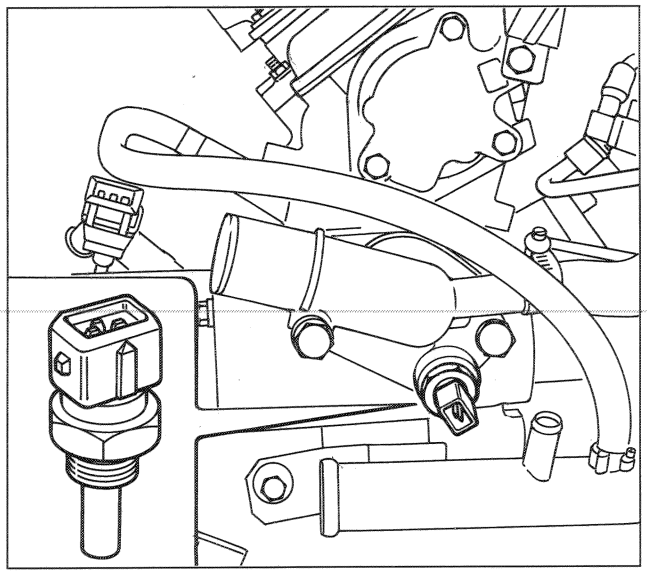
P23M23FJ2

COOLANT TEMPERATURE SENSOR

The sensor is fitted with its sensitive part in contact with the coolant. It provides the ECU with a voltage that varies according to engine temperature in order to correct air output information.

On the basis of a signal received by the sensor, the ECU is able to pilot fuel injection for longer in order to ensure the enrichment necessary for compensating for fuel loss due to the condensation of fuel particles in the inlet ducts while the engine is warming up.

This sensor therefore ensures safe engine operation in the stage following start-up by adding further enrichment with intensity and duration dependent on coolant temperature; this also permits correct engine operation during acceleration with the engine cold.



P23M23FJ3

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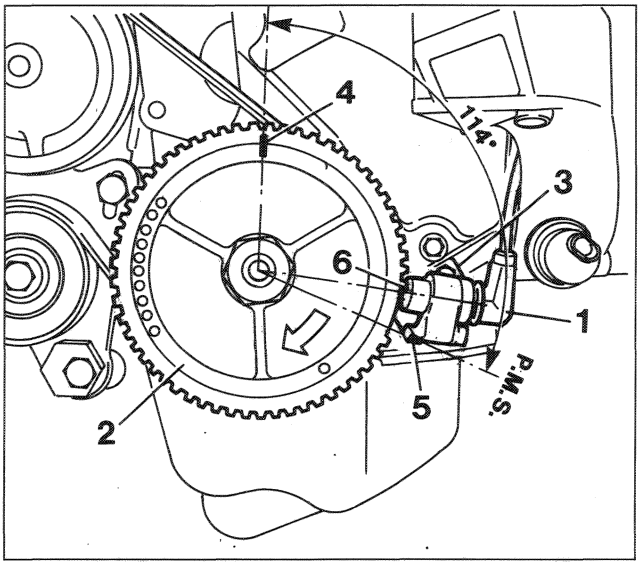
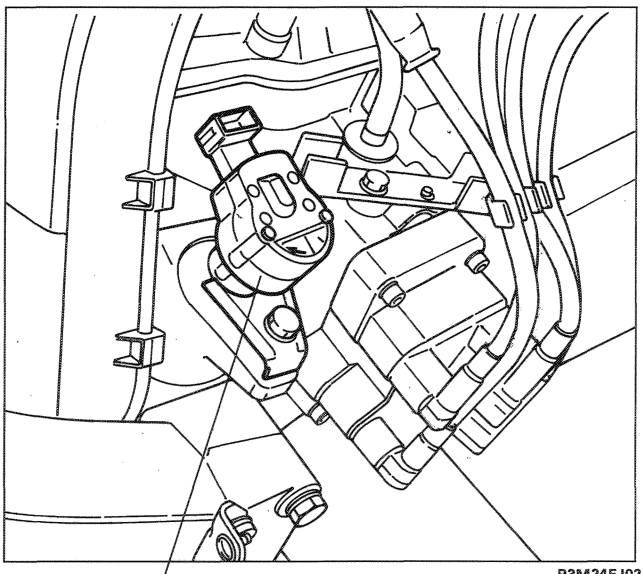
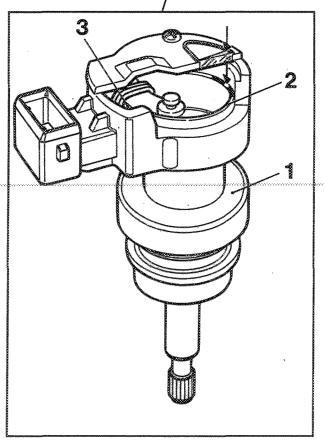


P3M24FJ01

1 - Sensor
2 - Phonic wheel
3 - Sensor mount
4 - TDC reference notch on phonic wheel
5 - TDC reference notch on sensor mount
6 - Synchronism tooth



P3M24FJ02



1 - Sensor support or case
2 - Rotor or ring
3 - Hall effect transducer

RPM AND TDC SENSOR

The phonic wheel consists of 58 teeth plus a space equivalent to the bulk occupied by two suppressed teeth.
The reference defined by the space of the two missing teeth is used as a basis for measuring the synchronism point (TDC).
The synchronism point is delimited by tooth (6). When this passes beneath the sensor, the crankshaft is located with piston pair 1-4 at 114° before TDC.
This signal is used by the ECU to compute the ignition advance angles.

INJECTION TIMING SENSOR

The Bosch Motronic M2.7 system is sequential and phased, i.e. fuel injection takes place in sequence for each cylinder during the intake phase.

To achieve this, the ECU uses a signal that determines the injection point on the basis of a signal from the rpm and TDC sensor.

The signal sent to the ECU is produced by a sensor fitted to the auxiliary shaft.

The sensor consists of a Hall effect transducer, a rotor and a cover.

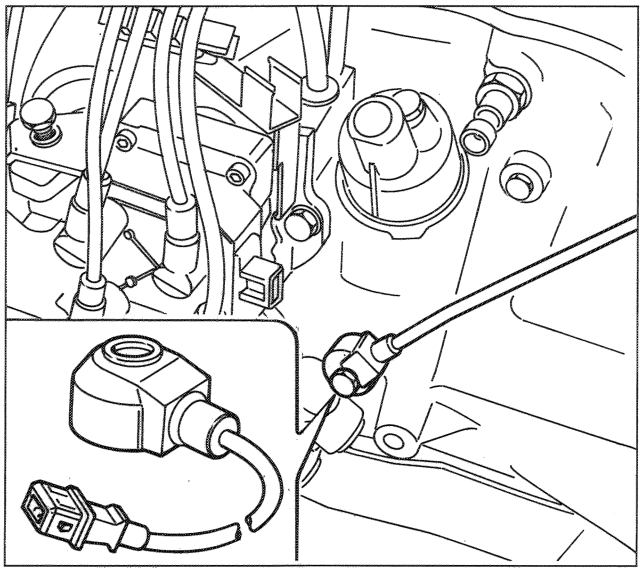
Hall's principle;

"A semiconducting crystal with current flowing through it, within a normal magnetic field (force lines at right angles ot current direction) generates a potential difference at its terminals, known as the Hall voltage."
The rotor consists of a sheet steel ring with a slot (missing part). The rotor ring moves to cover the transducer and set up a high signal (5V); when the Hall transducer is free (missing part) a low signal is generated (0V)

Low and high signals therefore alternate once every two crankshaft turns and specifically when cylinder no. 4 is in compression phase 108° before TDC.

This signal, together with the rpm and TDC signal, allows the ECU to recognise the cylinders and determine the point of injection.

NOTE *See following pages for exact sensor positioning (timing adjustment)*



P3M25FJ01

DETONATION SENSOR

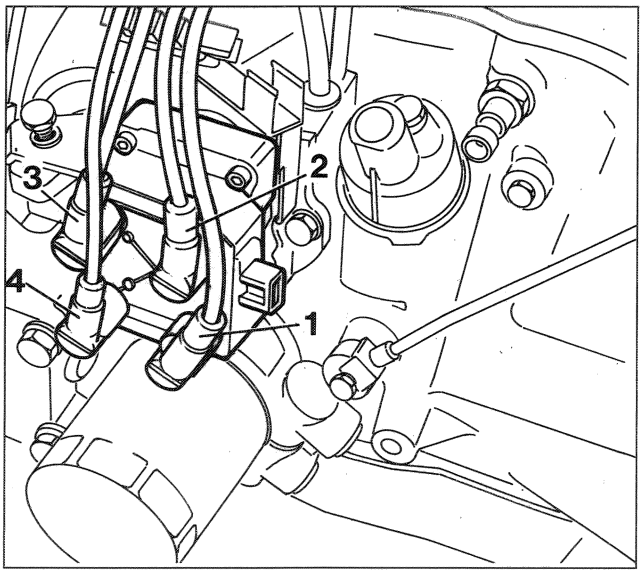
The knock sensor is located on the monobloc under the inlet manifold.

This sensor has a through bush to prevent incorrect tightening.

If the sensor is replaced, do not fit washers or shims between crankcase and sensor mating surfaces.

When engine knock occurs, vibrations of a certain frequency are set up in the crankcase.

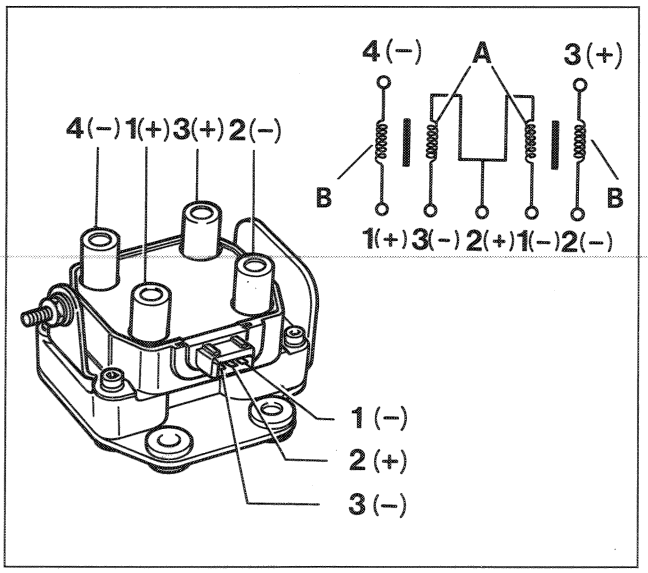
The effect generates mechanical repercussions on a piezo-electric crystal that sends a signal to the control unit. On the basis of this signal, the ECU implements an ignition delay strategy as described in the previous paragraph.



P3M25FJ02

SOLID STATE IGNITION SYSTEM WITH HIGH TENSION FOUR OUTPUT IGNITION COIL

Solid state ignition does not use the distributor as a component for distributing high tension to the spark plugs. This is carried out by two ignition coils within a single block, each controlled by a power module located outside the ECU.



P3M25FJ03

Each coil controls two spark plugs of different cylinders (1-4 2-3) (solid state breakerless ignition).

A. Primary winding
B. Secondary winding

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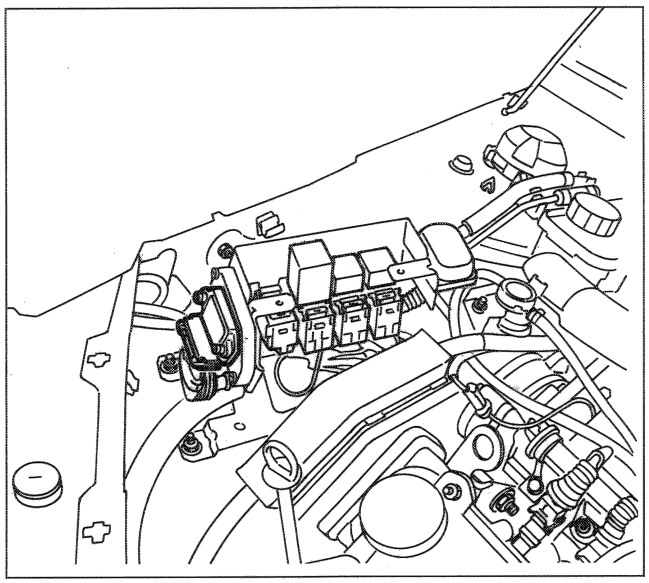
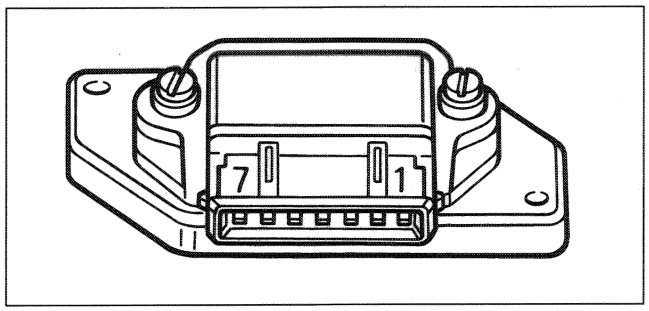


P3M27FJ01



P3M27FJ02

POWER MODULE FOR IGNITION

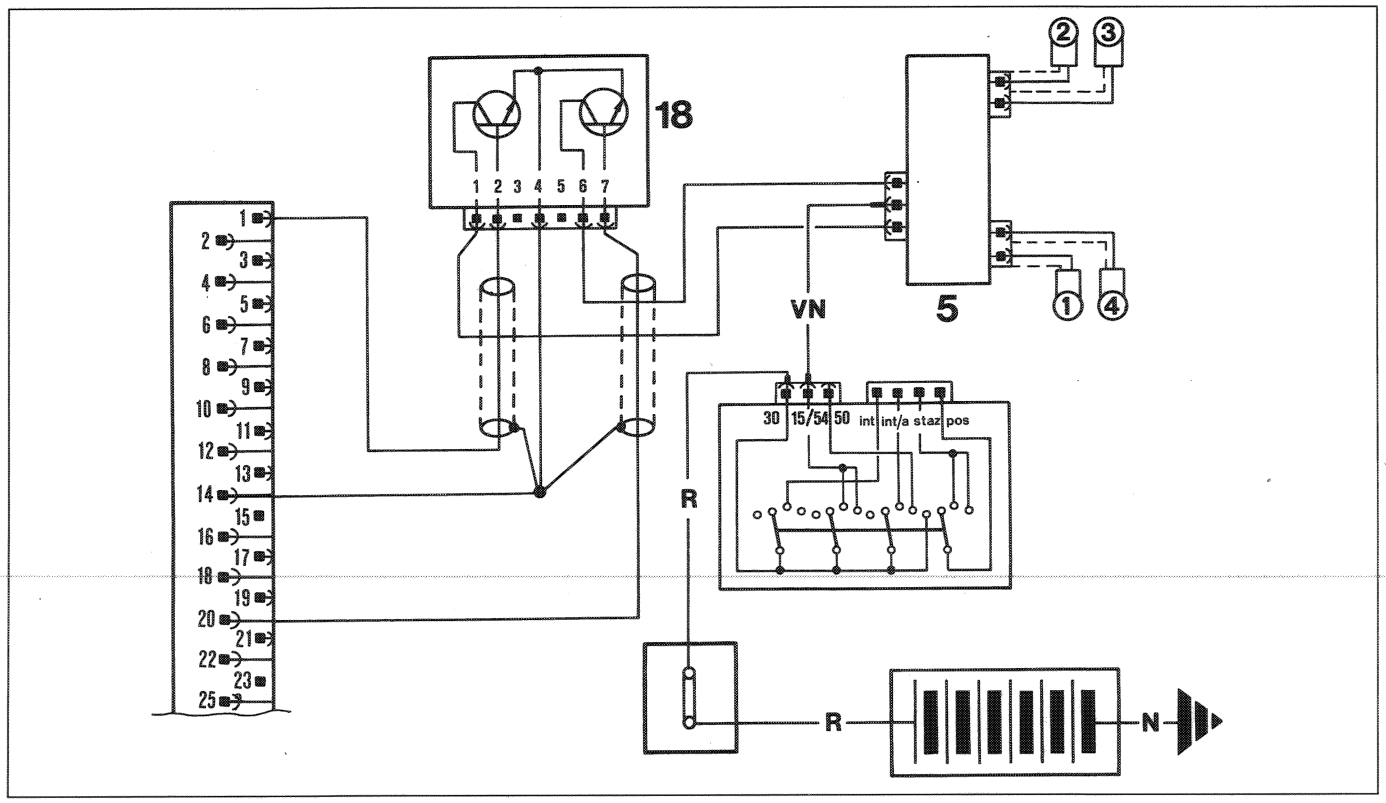
1. Power module
2. Heat dissipating plate

Location of power module in engine bay

In practice, the power module operates as an electronic switch that controls current in the ignition coil primary winding by means of ignition pulses from the control unit.

The power module also regulates current through the coil so that a constant level of 7.5A is maintained regardless of battery voltage and engine speed. In this way, the coil is always fully charged and the spark produced by the plugs is always optimum.

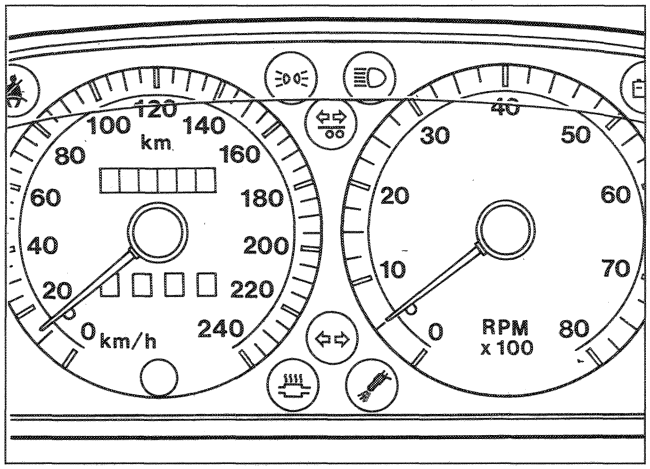
To prevent coil overheating if the ignition is triggered with the engine off, the power module is fitted with a resting cut-off device that almost completely cuts out the flow of current to the coil when ignition pulses from the control unit cease.



P3M27FJ03

Ignition power module connection diagram

AUTOMATIC DIAGNOSIS OF BOSCH MOTRONIC M2.7 SYSTEM



P3M27FJ02

The control unit is equipped with an automatic diagnosis system that monitors signals from the sensors and compares them with permitted thresholds.
If the levels are not as specified, the system recognises the fault. A failure warning light comes on on the dashboard and, in the case of certain faults, engine rpm is also restricted.

If sensors are faulty, the system activates a signal reconstruction strategy (recovery) in order to ensure engine and catalytic converter operation at an acceptable level without otherwise jeopordizing function.
Under these conditions the vehicle may be driven to a Service centre for testing.

If the lamp goes off, the fault is no longer present. An intermediate defect will therefore cause the warning light to go on and off continually.
The system stores the fault temporarily inside the ECU in order to facilitate service operations.

With ignition switch on "MAR" the warning light comes on; it goes off after about 0.5 seconds once key has been turned to "AVV" if no significant defects have been detected

Diagnosis using Fiat/Lancia Tester

A Fiat/Lancia tester may be used to dialogue with the Motronic M2.7 control unit, using specific memory M 24 - A. The error memory may therefore be read and deleted after restoring any faults.

PARAMETERS DISPLAYED:

1) ENGINE RPM
2) IGNITION ADVANCE
3) LAMBDA PROBE VOLTAGE
4) AIR/FUEL MIXTURE CONCENTRATION
5) INTEGRATOR
6) INTAKE AIR FLOW
7) AIR TEMPERATURE
8) COOLANT TEMPERATURE
9) VEHICLE SPEED
10) THROTTLE VALVE POSITION
11) BATTERY VOLTAGE
12) INJECTION TIME
13) ENGINE LOAD
14) EVAPORATION CONTROL VALVE
15) AIR CONDITIONER

GUIDED TESTS:

1) RPM SENSOR TEST
2) AIR TEMPERATURE SENSOR TEST
3) COOLANT TEMPERATURE SENSOR TEST
4) THROTTLE VALVE POTENTIOMETER TEST
5) BATTERY VOLTAGE TEST
6) AIR CONDITIONER INPUT TEST
7) LAMBDA PROBE TEST
8) LAMBDA PROBE INTEGRATOR TEST
9) SPEED SENSOR TEST

ERRORS DISPLAYED:

1) CONTROL UNIT ERROR
2) INJECTOR ERROR
3) TIMING SENSOR ERROR
4) IDLE ACTUATOR ERROR
5) DEBIMETER ERROR
6) AIR TEMPERATURE SENSOR ERROR
7) COOLANT TEMPERATURE SENSOR ERROR
8) THROTTLE VALVE POTENTIOMETER ERROR
9) FAILURE WARNING LIGHT ERROR
10) EVAPORATION CONTROL VALVE ERROR
11) LAMBDA PROBE ERROR
12) LAMBDA PROBE REGULATION ERROR
13) AIR CONDITIONER COUPLING ERROR
14) RPM SENSOR ERROR
15) VEHICLE SPEED SENSOR ERROR
16) BATTERY VOLTAGE ERROR
17) ALTITUDE SENSOR ERROR
18) PRESSURE SENSOR ERROR
19) TURBO BOOST PRESSURE ERROR
20) TURBO REGULATION VALVE ERROR
21) AIR CONDITIONER INPUT ERROR
22) KNOCK SENSOR ERROR

ACTIVE DIAGNOSIS:

1) INJECTORS
3) IDLE ACTUATOR
4) EVAPORATION CONTROL VALVE

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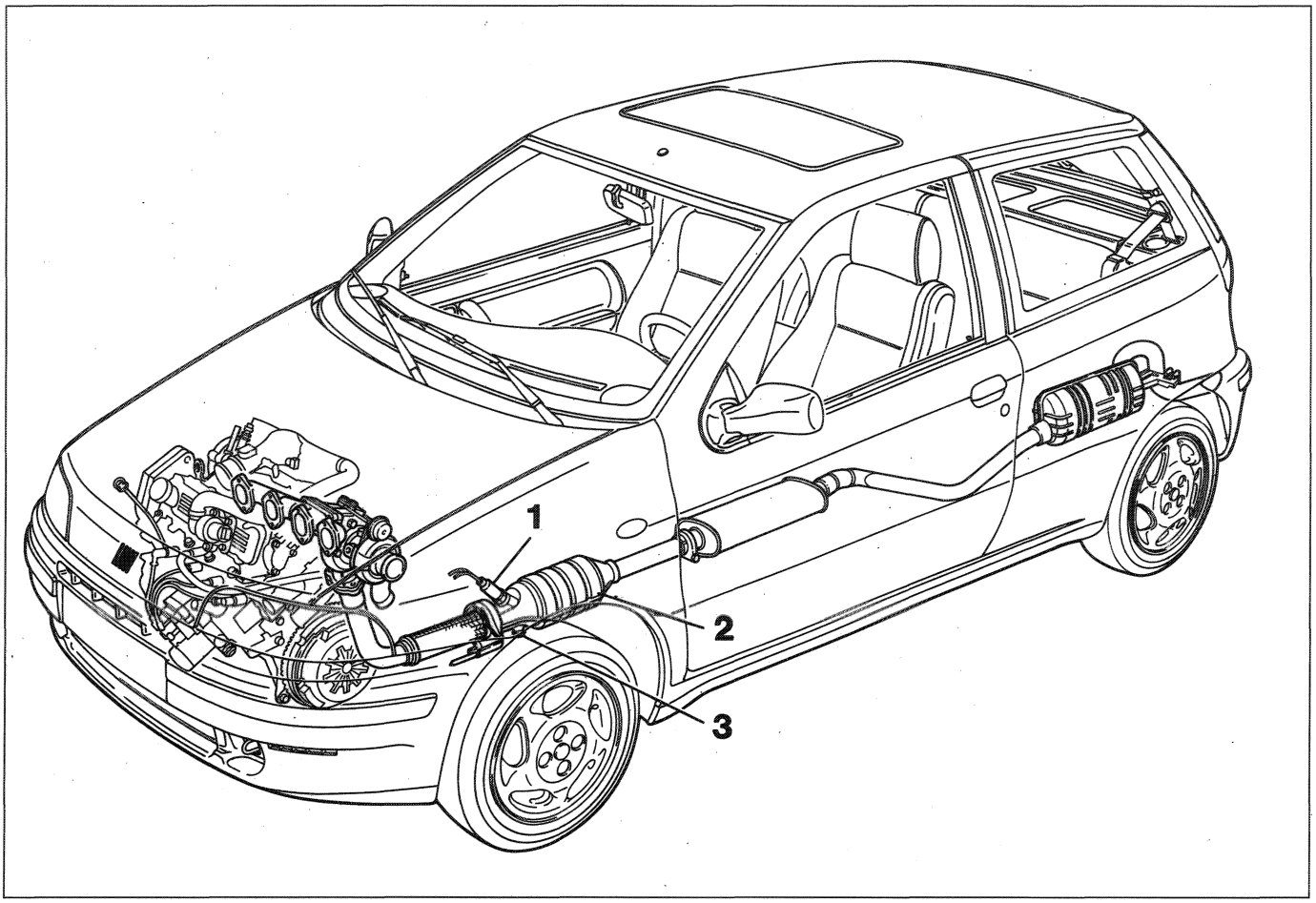
D - CIRCUIT FOR CHECKING HARMFUL EXHAUST EMISSIONS



P3M28FJ01

Engine exhaust assembly with catalytic converter

1. Lambda probe
2. Catalytic converter
3. Point for measuring CO upstream of catalytic converter

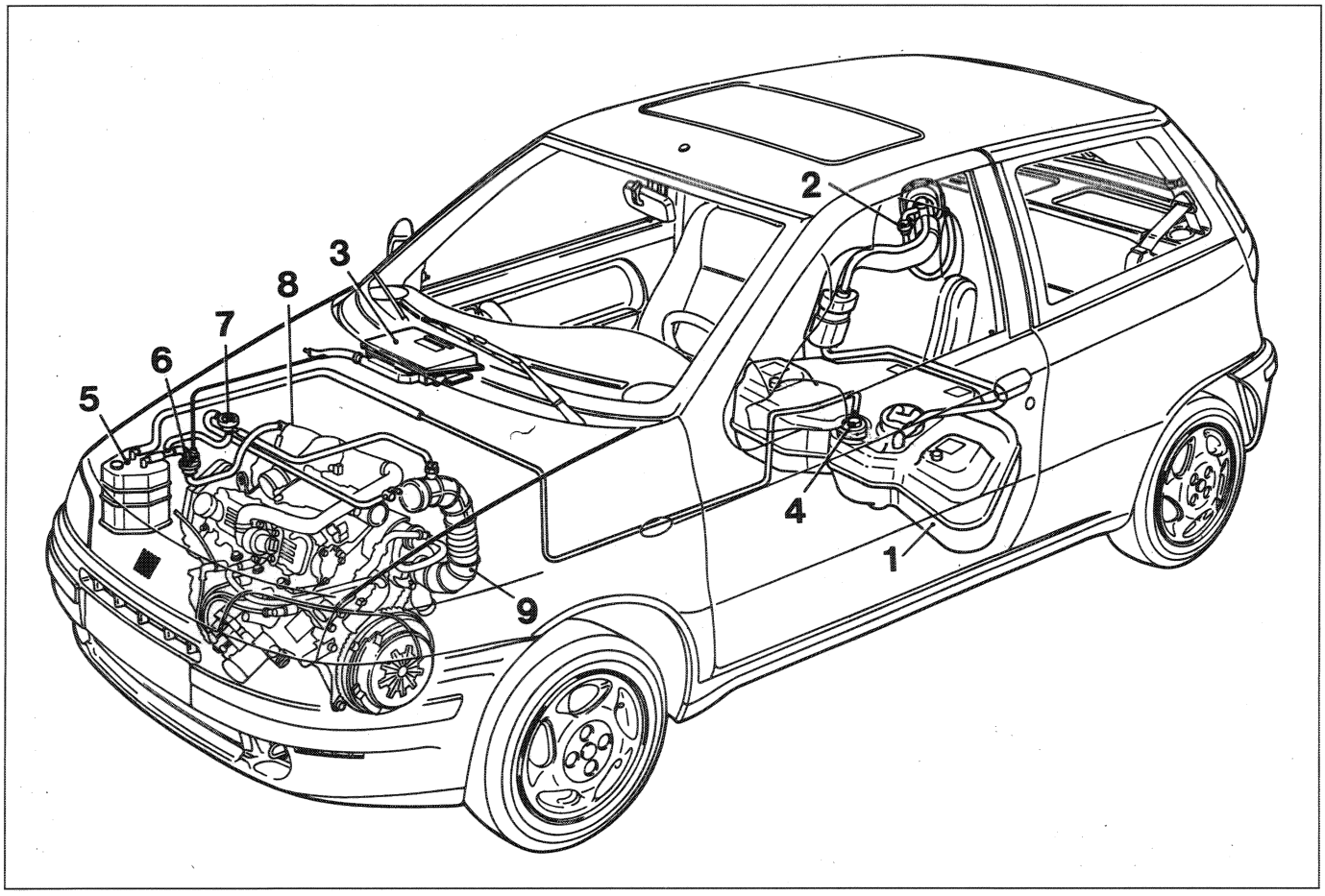
NOTE *For operation of the lambda probe and catalytic converer, consult relevant part of Fuel System chapter on 1108-1242 S.P.I. IAW engines.*

FUEL EVAPORATION CONTROL AND VAPOUR RECOVERY CIRCUIT

The system adopted for tank ventilation is **"closed" type.**
This system prevents fuel vapours formed within the tank and fuel system from entering the atmosphere It also prevents the release of their load of polluting light hydrocarbons (HC).

The system consists of: tank (1) with plug on filler fitting without ventilation hole; a two-way safety valve (2); multifunctional valve (4) for controlling the flow of fuel vapours into the tank; an active carbon filter (or trap) (5); solenoid (Slemens) for cutting off fuel vapours (6), controlled by ECU (3) of IAW injection-ignition system, and lastly injector turret (7).

The system operates when, with high outdoor temperatures, after the vehicle has been at a standstill for a long time, the fuel temperature increases (because the tank is no longer cooled by the car's motion) and brings about a pressure increase inside the tank. This increase may occur with medium-low fuel levels or with the tank full - in particular:



P3M29FJ01

Diagram showing fuel evaporation control system and location of components

1 - Fuel tank (with filler plug without ventilation hole)
2 - Safety valve (two-way)
3 - Injection/ignition control unit
4 - Multifunction valve
5 - Active carbon trap filter
6 - Petrol vapour cut-off solenoid (N.C.) (Bosch)
7 - Pneumatic flushing valve (Siemens)
8 - Inlet manifold
9 - Turbo intake duct

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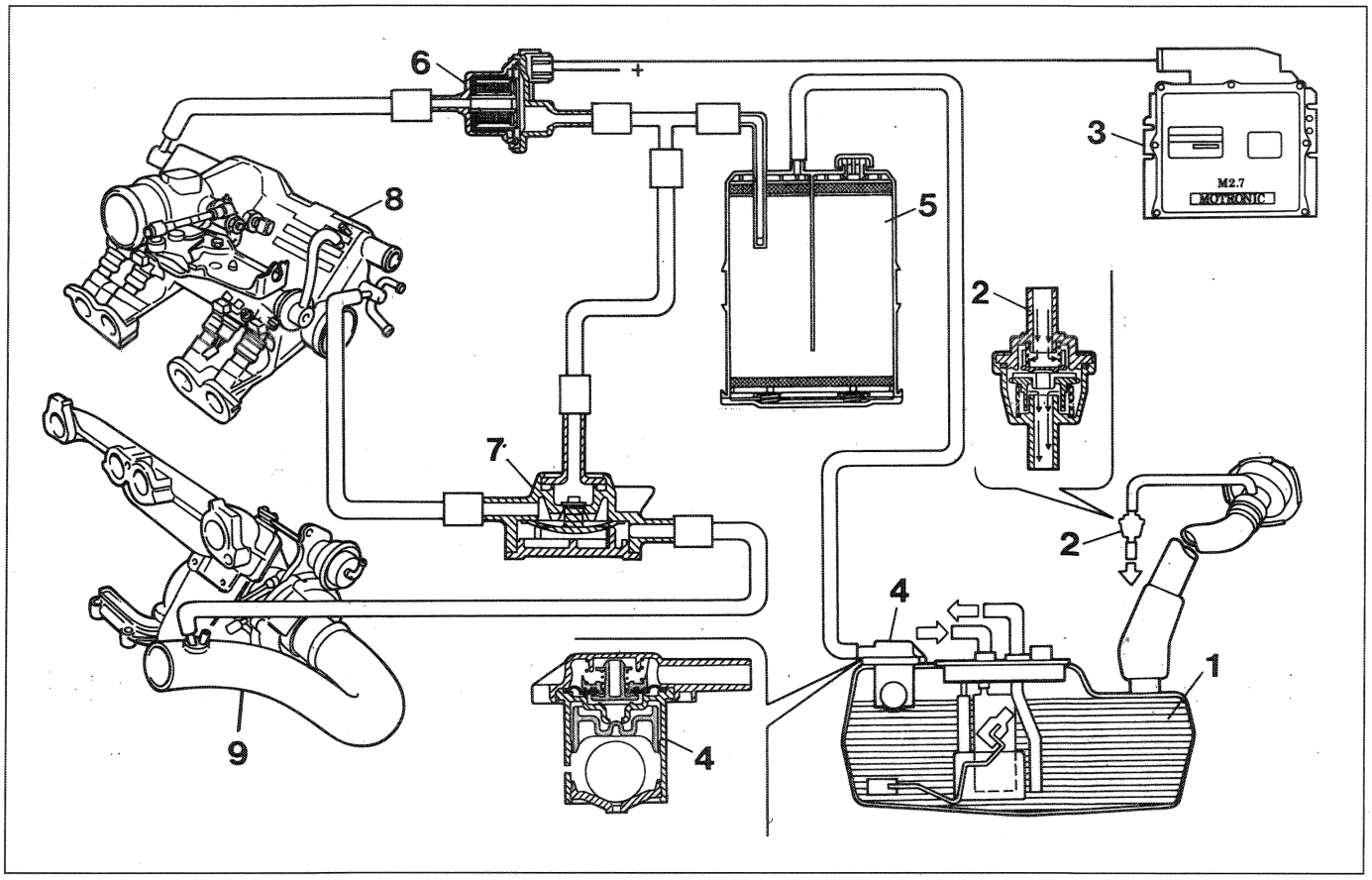
With the tank full multifunction valve (4) is closed and fuel may not go to filter (5) and spoil the active carbon by direct contact. If pressure inside the tank exceeds a certain limit, the two-way safety valve (2) opens to allow excess pressure to vent outside;

With medium-low fuel levels multifunction valve (4) allows fuel vapours to reach filter (5) when they exceed a certain pressure. Here they are absorbed and cleaned by the active carbon granules.

These vapours then flow on to the inlet manifold when the ECU controls opening of solenoid (5) or when the pressure set up in the inlet manifold is sufficient to open the pneumatic flushing valve (7).



P3M3(I

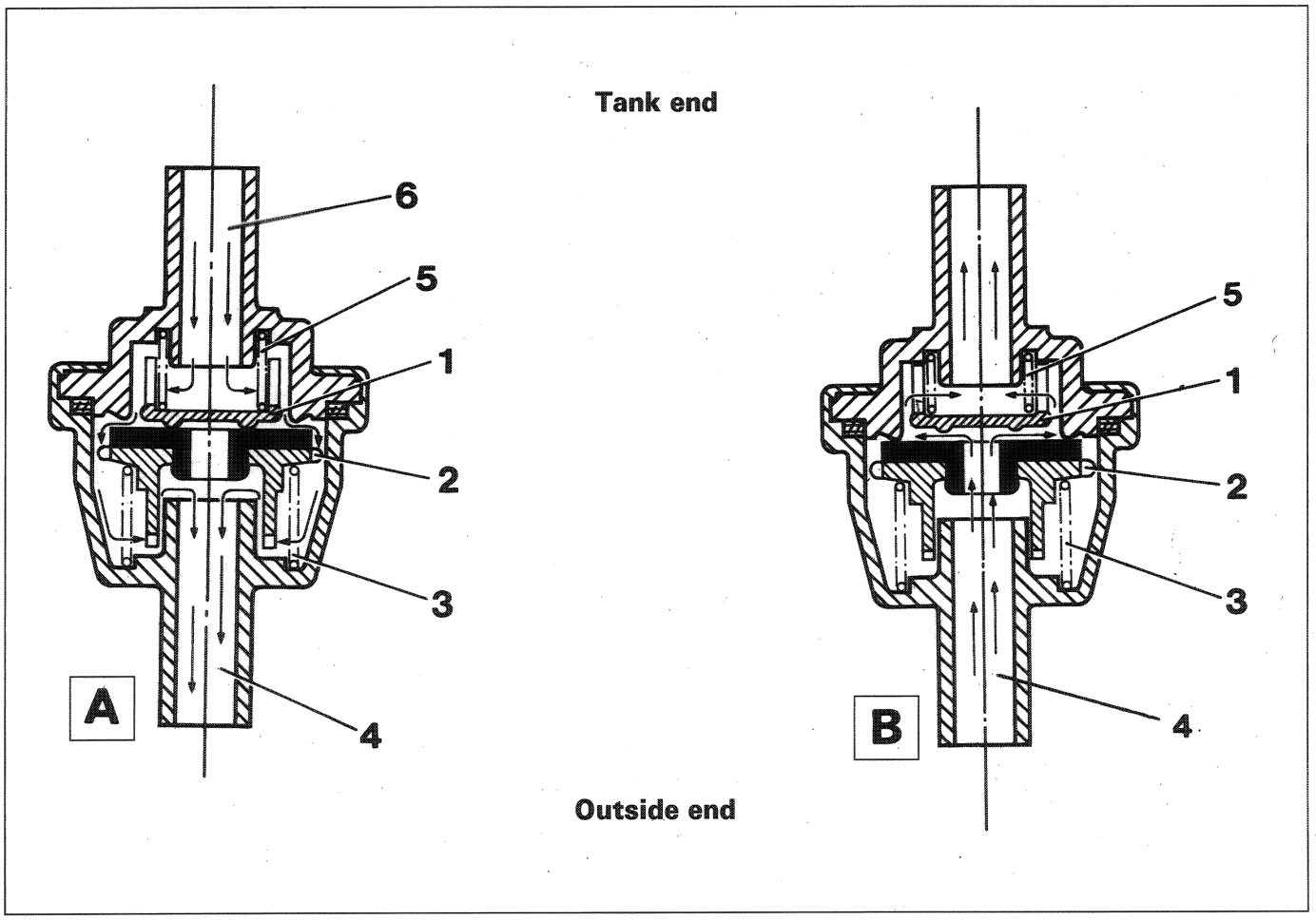
Diagram of evaporation control and fuel vapour recovery circuit

1 - Petrol tank (with fuel cap without ventilation hole)
2 - Tank pressure relief and ventilation valve
3 - Injection/ignition control unit
4 - Multifunction valve
5 - Active carbon trap filter
6 - Petrol vapour cut-off solenoid (N.C.) (Bosch)
7 - Pneumatic flushing valve (Siemens)
8 - Inlet manifold
9 - Turbocharger inlet duct

OPERATION OF MAIN COMPONENTS OF FUEL EVAPORATION CONTROL SYSTEM:

Safety valve (two-way)

This valve operates in two different ways according to the pressure inside the tank:
- When the pressure inside the tank exceeds an established level 130-165 mbar (detail A) it pushes case (2) to overcome the load of spring (3) and allow excess pressure to drain off outside through breather pipe (4) to maintain conditions of safety;
- When a vacuum of < 20 mbar is set up in the tank due to the removal of fuel (detail B), plate (1) overcomes the load of spring (5) to open a passage that allows air from vent pipe (4) to enter the tank and restore the pressure to specified values (ventilation function).



P3M29GJ01

The two-way safety valve is two-coloured (WHITE-LIGHT BLUE) and must be fitted the right way round: the white side bearing the word "TANK" (TANK END) must be postioned toward the tank.

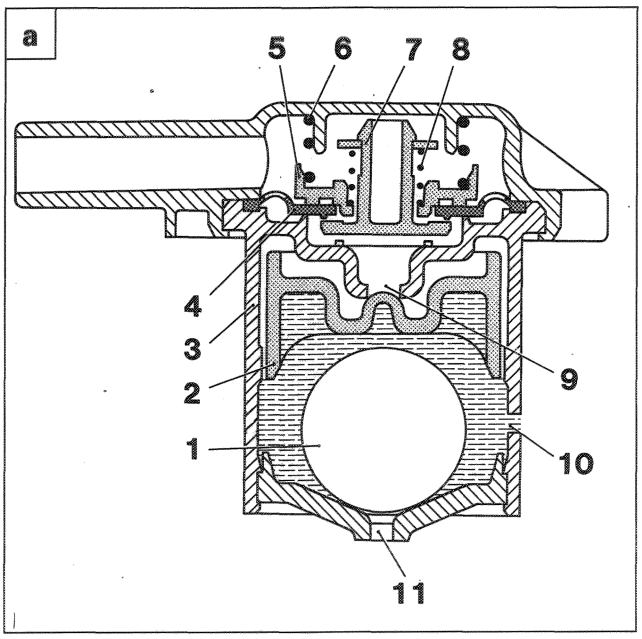
Multifunction valve

This valve performs the following functions:
- prevents fuel flowing out in case the vehicle overturns in an accident;
- vents fuel vapours from tank to the active carbon trap filter;
- ventilates the tank if a vacuum builds up inside.

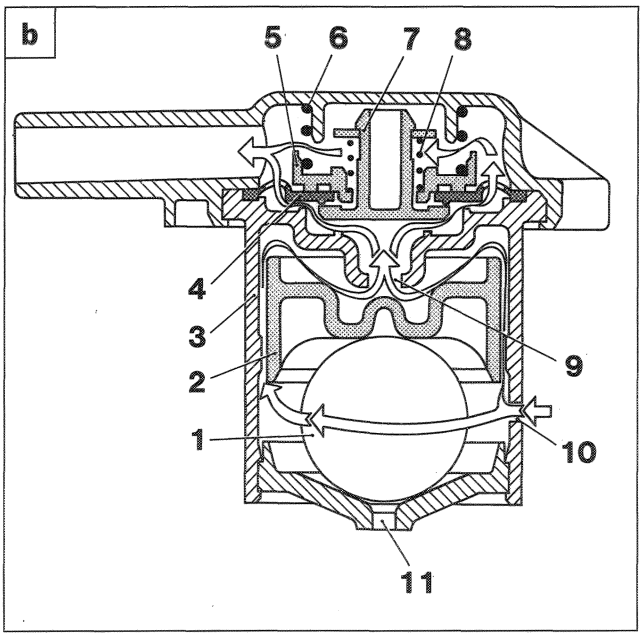
This valve consists of: a float (2); a heavy ball (1); a plate (5), pushed against diaphragm (4) that in turn touches valve case (3); spring (6); plate (7), pushed against diaphragm (4), by spring (6).

With regard to fuel tank filling, multifunctional valve operation is as follows:

a) **if the tank is full** float (2) blocks hole (9) to prevent liquid fuel from reaching active carbon filter and avoid damage to the filter;
b) **the tank fuel level drops,** float (2) is lowered and rests upon ball (1) to open hole (9), which can be reached by gas through ring section between float (2) and inner seat of valve case (3). When the pressure exercised by fuel vapours on plate (7) and free ring section of diaphragm (4) exceeds a level of 0.038 up to 0.053 bar the force set up on (4 and 7) overcomes load of spring (6), to open a ring opening between diaphragm (4) and valve case (3) that allows fuel vapours to emerge from the tank and reach the active carbon filter.



P3M30GJ01



P3M30GJ02

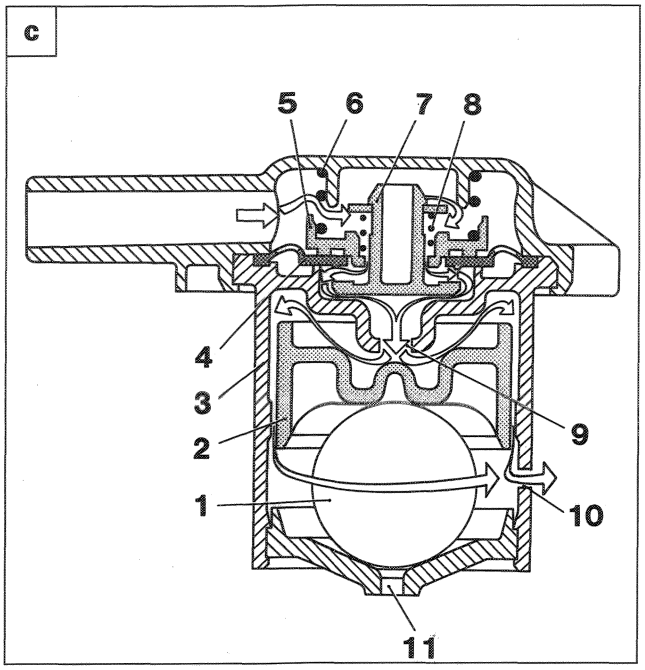
Cross sections through multifunctional valve in service positions a and b

a) Valve closure with tank full

b) Valve opening with vapour flow from tank to active carbon filter.

c) **if the drop in tank fuel level is sufficient to set up a vacuum of 0 up to 0.015 bar** it acts on plate (7) and overcomes load of spring (8) so that this moves down to allow tank ventilation through ring sections opened up between plate (5), plate (7), hole (9), float (2) inner seat of valve case (3) and hole (10).

d) **if the vehicle overturns**, however full the tank, the combined weight of ball (1) and the fuel act on float (2) to push the float against hole (9) and prevent a dangerous flow of fuel to the active carbon filter and then on to the injector turret with the attendant risk of the vehicle catching fire.



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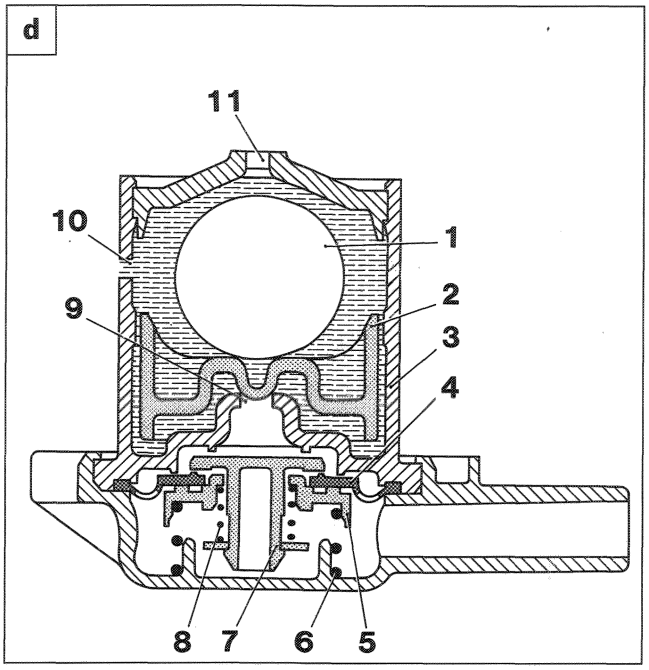
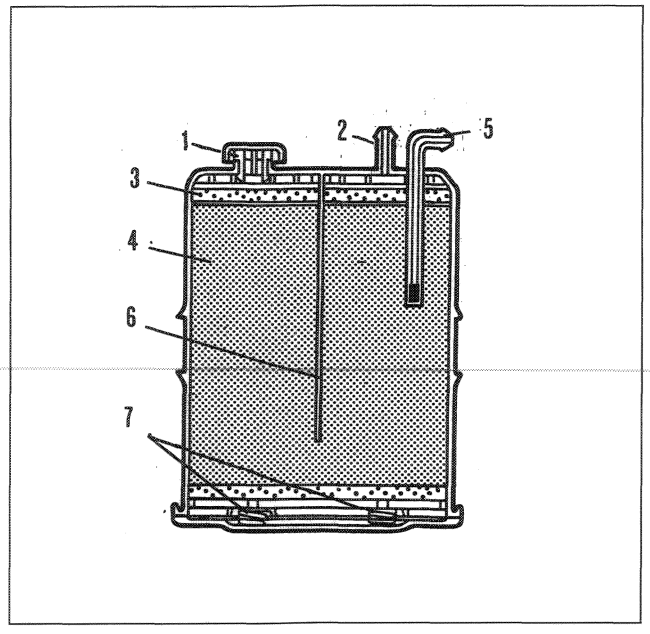


P3M31GJ02

Cross sections through multifunctional valve in working positions c) and d)

c) Valve opening for tank ventilation.

d) Valve safety closure in case of vehicle overturning.



P3M31GJ03

Active carbon trap filter

This consists of carbon granules (4) that trap fuel vapour entering intake (5).

Flushing air enters intake (1), through paper filter (3) and flows over the carbon granules to remove fuel vapours and carry them toward the outlet (2) and then on toward the cut-off valve.
Air entering through intake (5) may also be pulled back by a vacuum in the tank, when it serves to ventilate the tank.
Partition (6) ensures that the flushing air flows over all the carbon granules and promotes the release of fuel vapour toward the inlet manifold.
Two springs (7) allow the mass of granules to expand when the pressure increases.

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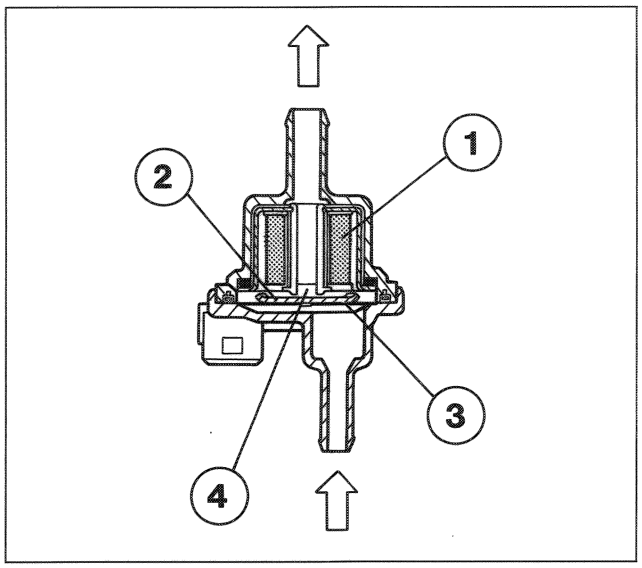


P3M34FJ01

Vapour control solenoid (Bosch)

When the key is turned to MARCIA the solenoid, normally open, is activated and closes to enable operation.
Solenoid (1), when excited, attracts plunger (2) that overcomes the load of disc spring (3) to close orifice (4) and prevent fuel vapour passing through

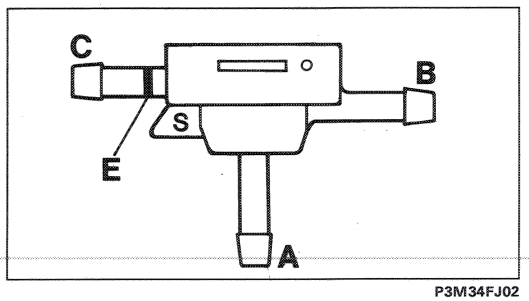
Solenoid adjusted so that the arrow on the case is turned toward the inlet manifold.

For turbo versions, the solenoid is specific as it is one-directional. If replaced, fit an equivalent solenoid.

"SIEMENS" pneumatic flushing valve
Foreword
The purpose of this valve is to allow recirculation of vapour and thus flushing of active carbon when the vapour control solenoid (Bosch) is inhibited and the inlet manifold is under pressure.

Operation
The valve is connected by pipes to three points.
Duct (A) is connected by fitting T to active carbon trap filter; duct (B) is connected to the turbocharger inlet duct; duct (C) is connected to the engine intake manifold.
The pressure set up in the inlet manifold reaches the valve through duct (C).

When this pressure exceeds a certain level when added to the vacuum set up in turn in the duct (B connected to the turbo inlet duct) it acts on membrane valve (D), to bring duct (A) into communication with duct (B).
Fuel vapours that reach the valve from duct (A) may be taken in through duct (B) from the turbocharger.



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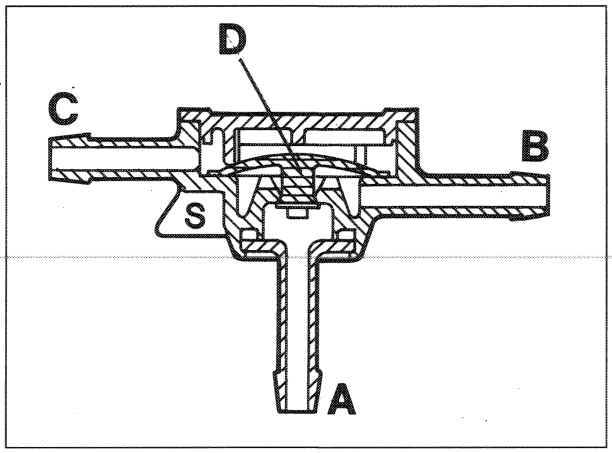


P3M34FJ03

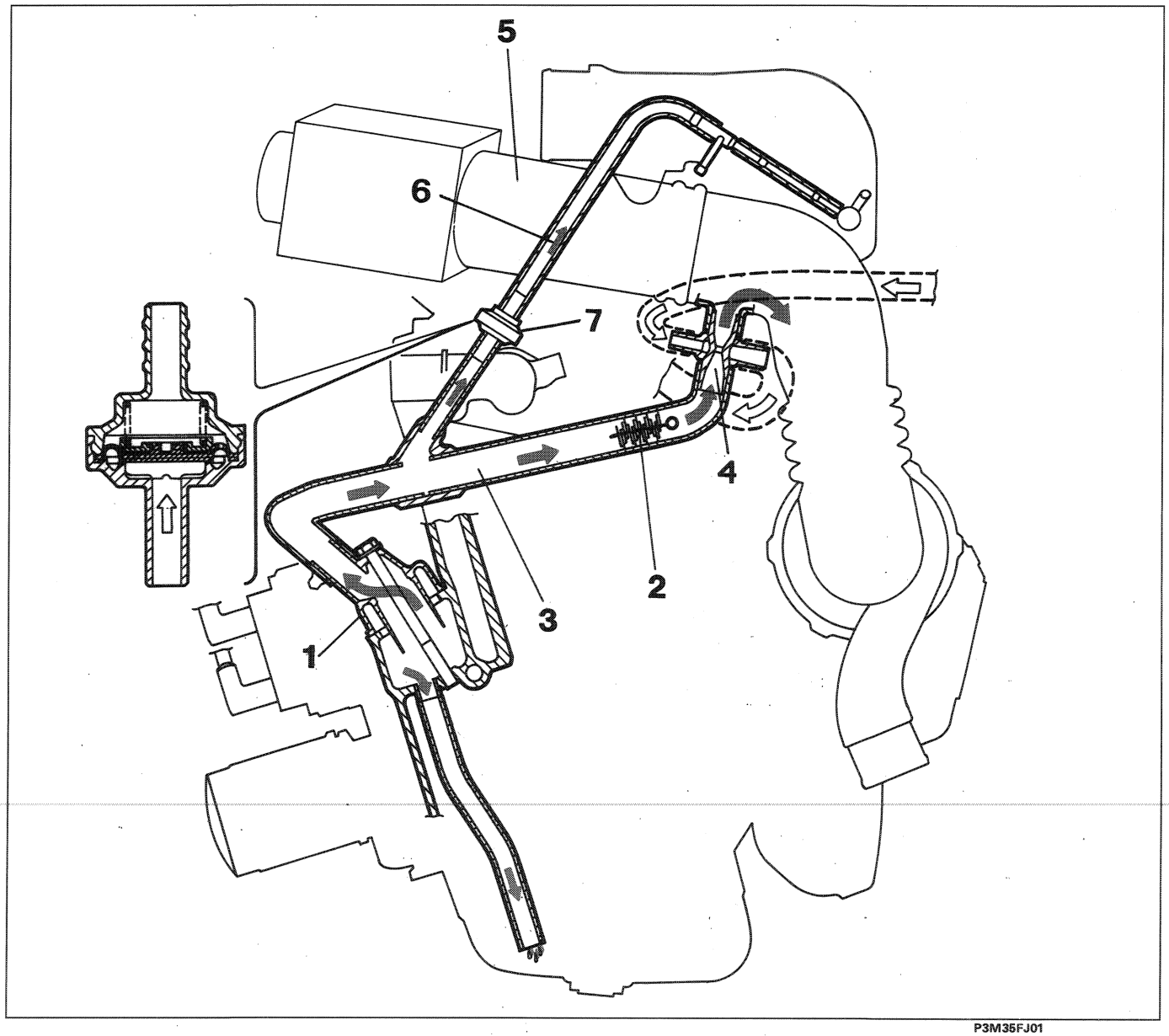
A - To three-way fitting (carbon filter)
B - To turbo inlet duct
C - To inlet manifold
D - Membrane valve
E - Yellow paint mark used as fitting reference

CRANKCASE GAS RECYCLING SYSTEM

The system controls crankcase emissions of vented gases made up of air-fuel mixtures and combusted gases that leak through the piston rings, in addition to lubricant oil vapours, by causing them to recirculate to the intake.
Vent gases flow through separator (1) where they lose part of their oil content. This returns to the sump in the form of droplets. The remaining gases reach inlet sleeve through pipe (3), which contains a flame trap (2) to prevent combustion due to the flame returning from the throttle case (5).

To resrict the vacuum in the crankcase, the gsaes flow through bush (4) with port calibrated to 3.8-4 mm, which is heated by turbine cooling water to prevent the formation of ice inside the bush.

A second pipe (6) fitted with a check valve (7) is connected to the inlet manifold downstream from the throttle valve. This ensures that when the engine is idling, the vacuum in the manifold raises the valve membrane and draws in vapour from the crankcase.
When the engine is turbocharged, the pressure in the manifold closes the valve;
this prevents the crankcase being put under pressure.
The valve consists of a plastic case containing a membrane and a calibrated spring **(the word crankcase is shown on the black part of the valve).**



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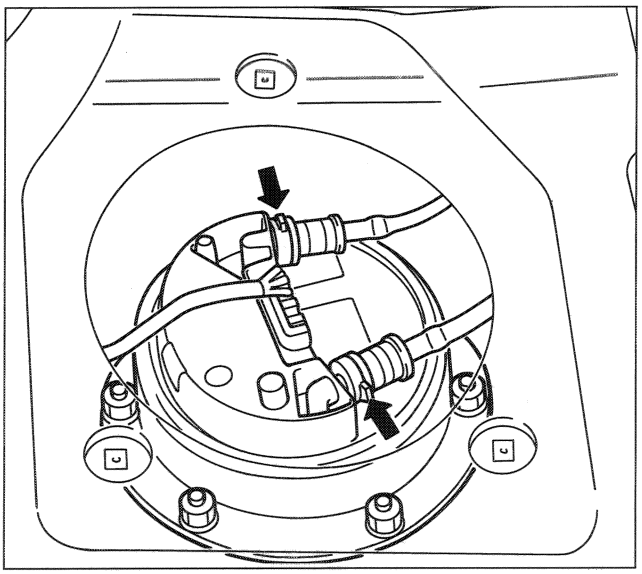
CHECKS AND ADJUSTMENTS TO BOSCH M2.7 INJECTION/IGNITION SYSTEM ADDITIONAL TO DIAGNOSIS WITH FIAT/LANCIA TESTER

OBSERVE THE FOLLOWING PRECAUTIONS WHEN WORKING ON VEHICLES WITH BOSCH INJECTION-IGNITION SYSTEMS:

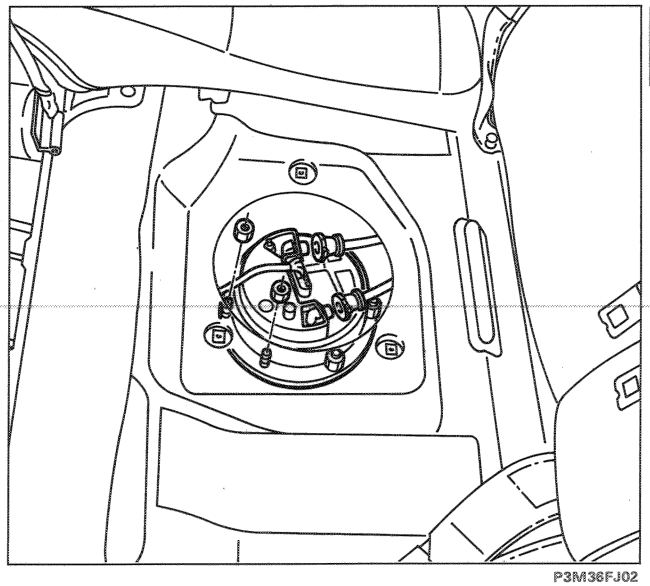
- *never start the engine when the electrical terminals are poorly connected or loose on the battery poles;*
- *never use a quick battery charger to start the engine;*
- *never disconnect the battery from the car circuit with the engine running;*
- *when charging the battery quickly, first disconnect the battery from the vehicle circuit;*
- *if the vehicle is placed in a drying oven after painting at a temperature of more than 80° C, first remove the injection/ignition ECU;*
- *never connect or disconnect the ECU multiple connector with the ignition key in MARCIA position;*
- *always disconnect battery negative lead before carrying out electrical welding on vehicle.*



P3M36FJ01

REMOVING-REFITTING ELECTRIC FUEL PUMP

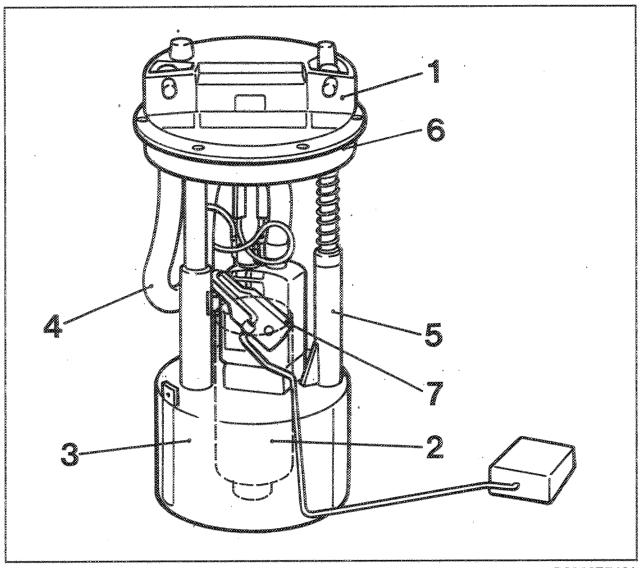
The pump is located inside the fuel tank.
In order to remove:
- raise rear seat;
- remove protective cover;
- disconnect electrical connection;
- disconnect fuel delivery and return line quick-release fittings by pressing the two tabs indicated by the arrows;



P3M36FJ02

- unscrew lock-ring connecting pump to tank.
- remove pump.

Ensure that quick-release fuel line fittings are fitted properly onto pump fittings.

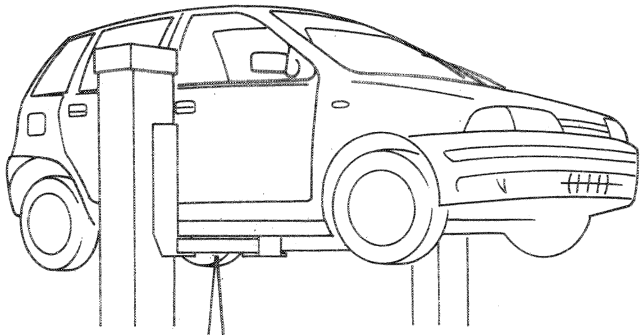


P3M37FJ01

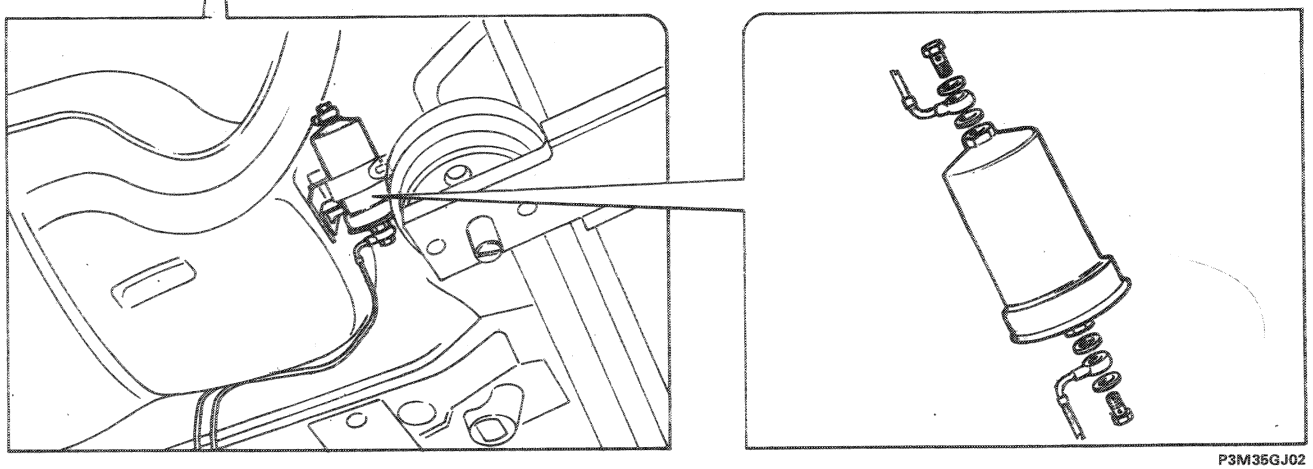
Components of fuel pump assembly

1 – Retaining plate
2 – Electric fuel pump
3 – Mesh prefilter
4 – Delivery line
5 – Return line
6 – Gasket
7 – Fuel level gauge sender unit

REMOVING-REFITTING FUEL FILTER



- Raise the vehicle and then remove the screw retaining the filter to the clip
- Unscrew fuel inlet and outlet fittings from filter
- Collect fuel emerging during the operation in a suitable container
- Clean parts thoroughly before refitting a new filter



P3M35GJ02

The fuel filter must be replaced at intervals of 30,000 km.

NOTE *The arrow stamped on the outer case indicates the fuel flow direction and therefore the correct installation direction.*
Whenever the filter is replaced, replace the seals, start the engine and check for leaks from the seals.

Fitting tightening torque: 3-3.8 da Nm.

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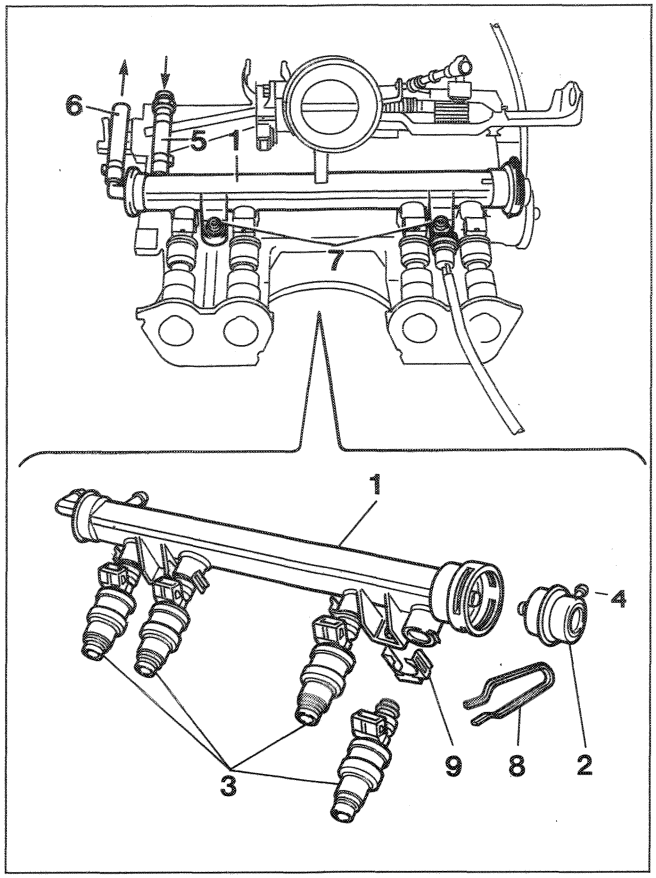


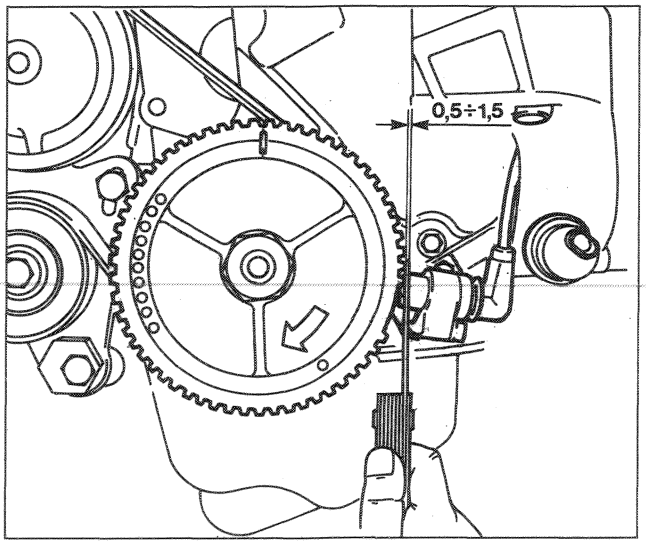
1. Fuel manifold
2. Fuel pressure regulator
3. Injectors
4. Vacuum socket from engine inlet manifold
5. Fuel inlet pipe from pump
6. Fuel return lines to tank
7. Screws retaining fuel manifold and injectors
8. Pressure regulator clip on fuel manifold
9. Injector clip on fuel manifold

REMOVING-REFITTING FUEL MANIFOLD WITH INJECTORS AND PRESSURE REGULATOR

- Disconnect fuel inlet pipe (5) from fitting
- Loosen clip from return pipe and disconnect hose from rigid pipe
- Disconnect electrical connectors from injectors
- Unscrew both retaining screws (7).
- Remove injector manifold assembly
- To remove the injectors from the fuel manifold, remove clip (9).

Fuel manifold: Never wash fuel manifold by immersing in detergents; this operation should only be carried out externally using a brush. Otherwise the o rings may be damaged.

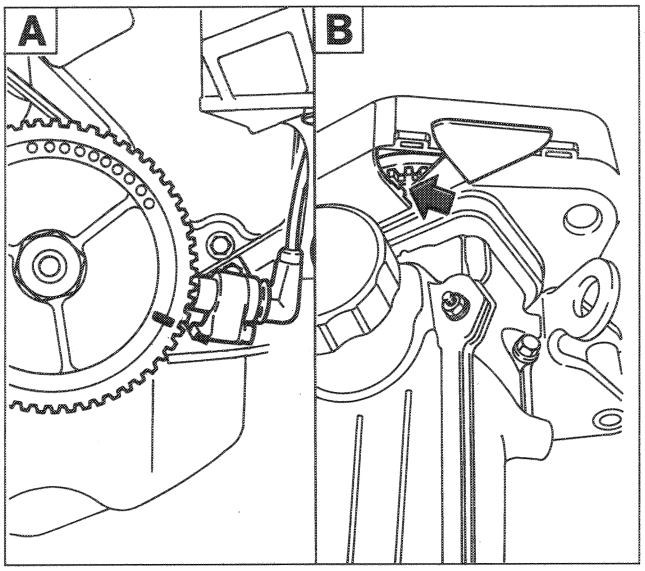
NOTE *Lubricate injector and pressure regulator o-rings with pure vaseline (in minimum amounts in order not to affect working area) before installation.*



CHECKS ON RPM SENSOR

Angular position cannot be adjusted because the sensor is fitted using a rigid support and machining tolerances are designed to ensure correct positioning.

The gap can be checked and should be between 0.5 and 1.5 mm.
If not as specified, incorrect machining tolerences must be the cause.



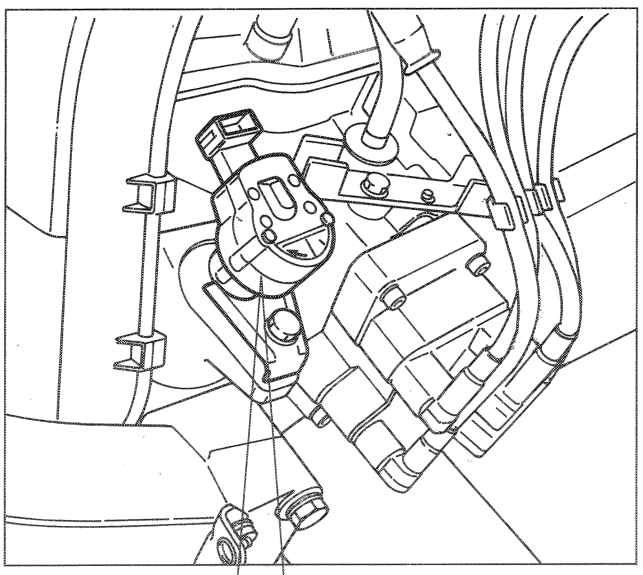
P3M39FJ01 P3M39FJ02

ADJUSTING INJECTION TIMING SENSOR

Position injection timing sensor with piston pair 1-4 on TDC, with cylinder 4 in combustion phase.

Align TDC marks on crankshaft pulley and rpm sensor mount (Fig. A).

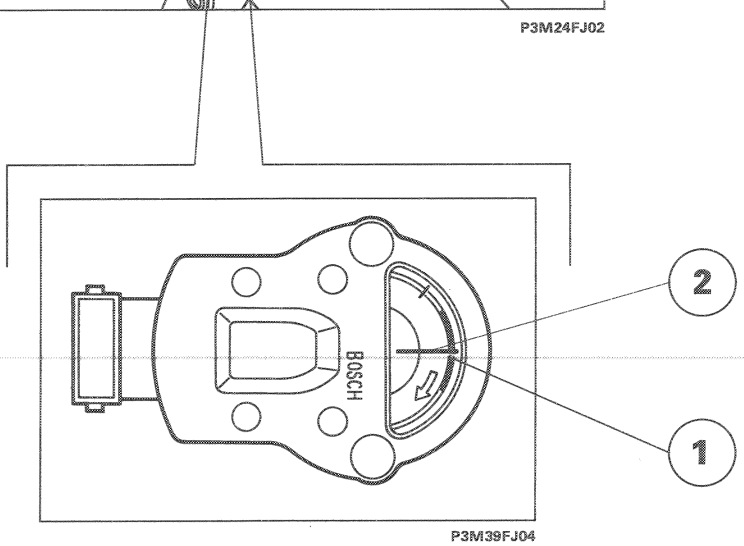
Check that the timing adjustment sign appears in the window on the timing belt guard cover (Fig. B). In this position cylinder (4) is in combustion phase. If not, turn crankshaft through another turn.



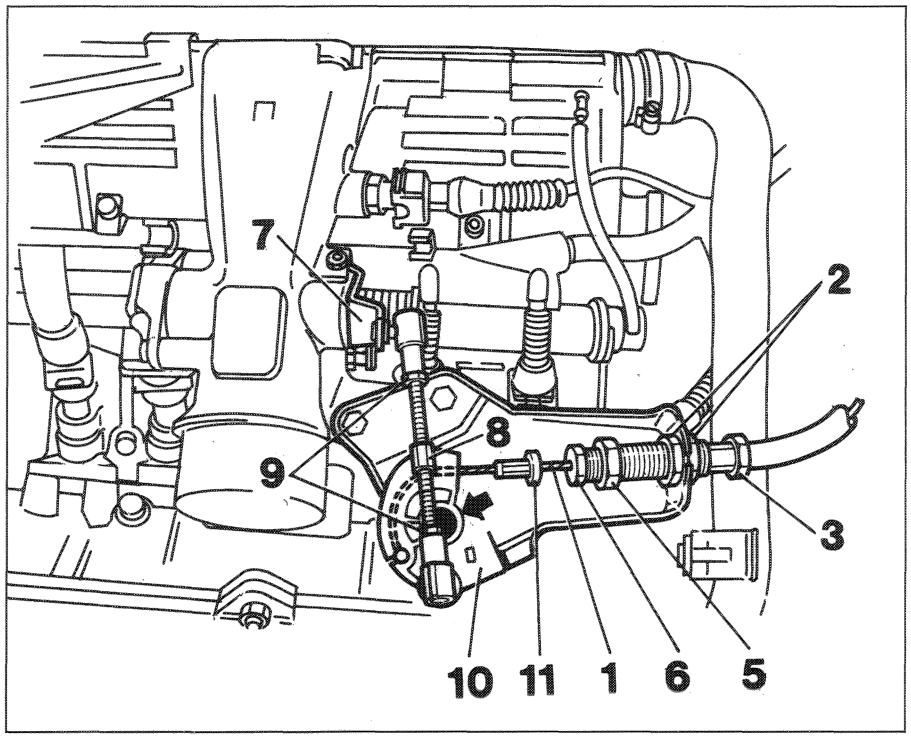
P3M24FJ02

With the sensor removed, before fitting in seat, turn the shaft to align roughly reference mark (1) on rotor ring and highlighted with blue paint, with reference notch (2) on the sensor cover slot. Fit sensor in its seat, taking care when positioning electrical connector terminal. If necessary, align reference notches again by turning sensor case.

Tighten sensor in seat.



P3M39FJ04



P3M40FJ01

ADJUSTING ACCELERATOR CONTROL CABLE

Before adjusting the throttle cable, lubricate the arrowed pin. "TUTELA MRM2" grease is recommended

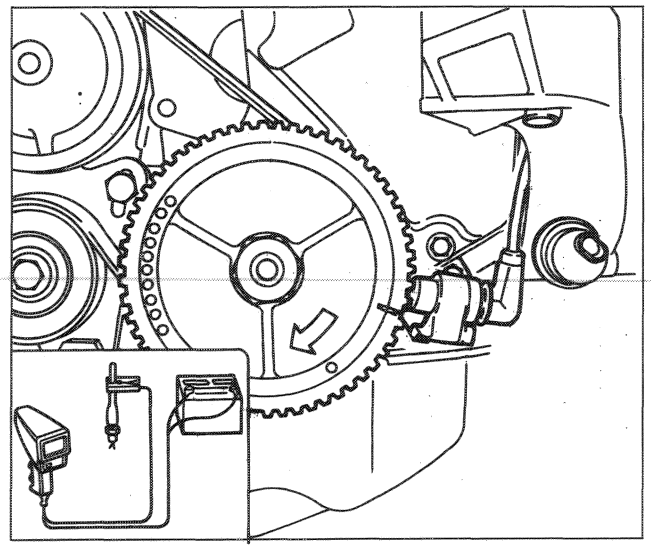
Proceed as follows to adjust the accelerator cable:

With link (8) disconnected from head of throttle control elever (7), pulley (10) is in abutment position.

Under these conditions, accelerator cable (1) must not be too tight or too loose so that accelerator pedal has no free travel.
Otherwise, loosen locknuts (2) and adjust hexagon (3).
Connect link (8) in head of lever (7) removed previously. The link seat should be aligned with the head.
Otherwise loosen locknuts (9) and adjust link (8), tighten locknuts.

Once adjustment is complete, press accelerator pedal to the floor and check that when throttle is fully open bush (11) fitted to the accelerator cable abuts with bush (6). Otherwise loosen locknut (5) and adjust bush (6), tighten locknut.

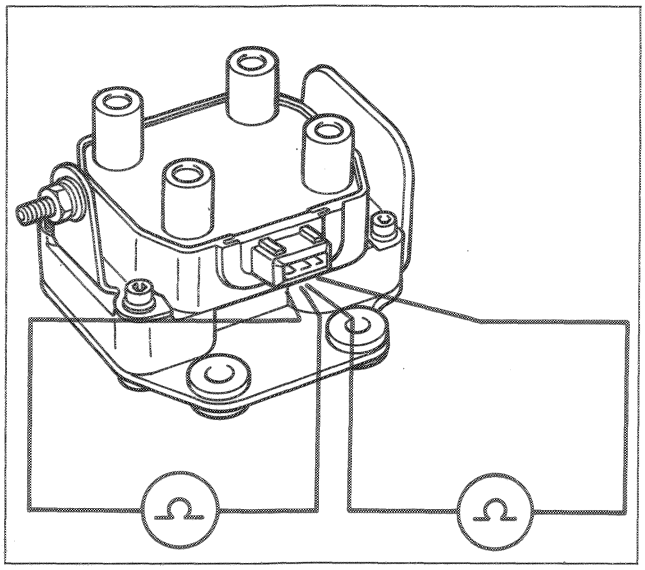
APPROXIMATE CHECK ON IDLING IGNITION ADVANCE WITH STROBOSCOPIC LAMP



Connect inductive clip stroboscopic lamp with graduated scale.

To check the ignition advance angles at different engine speeds, use a Fiat/ Lancia Tester.

Idling engine advance (850±50/min)
6°



P3M41FJ01

BOSCH IGNITION COIL 0.221.503.407

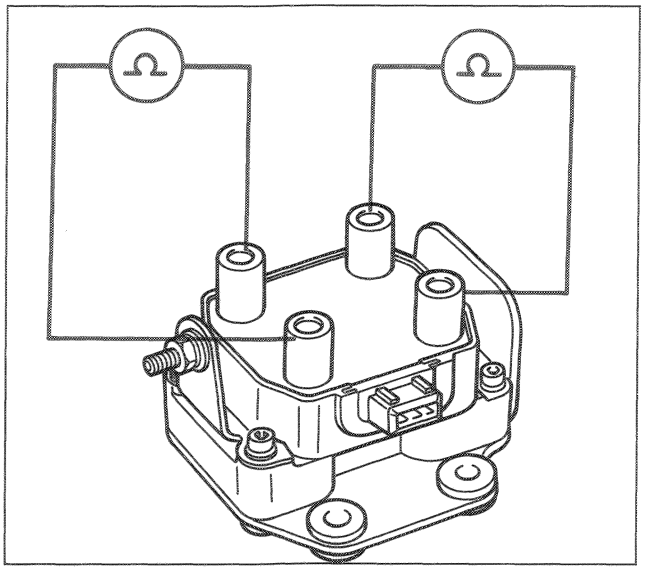
Checking resistance of ignition coil primary winding

Check resistance of primary winding using a digital multimeter.

Bring probes of a multimeter into contact with the positive terminal (central terminal) and negative terminals respecively (outer terminals).

The value of the two resistances must be between 0.450 Ω and 0.550 Ω at 22 - 25°C

P3M41FJ02



P3M41FJ03

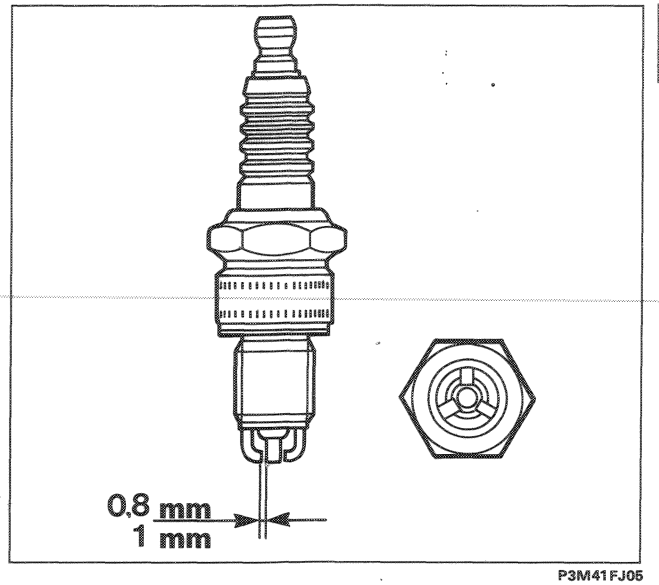
Checking resistance of ignition coil secondary windings

Check resistance of secondary winding using a digital multimeter.

Bring multimeter probes into contact with the two high tension output terminals respectively 1-4 and 2-3.

The resistance reading must be between 12,000 Ω and 14,600 Ω at 22 - 25°C.

P3M41FJ04



P3M41FJ05

SPARK PLUGS

CHAMPION - RC7BYC4

FIAT / LANCIA - 7GBYSR4

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CHECKING IDLE SPEED

If idle speed is not 850±50/min, because injection-ignition ECU is self-regulating, ***the adjustment cannot be carried out.*** *The position of the accelerator linkage must therefore be checked and then the fault detected by means of full diagnosis using a Fiat/Lancia Tester.*

CHECKING LEVELS OF POLLUTING EMISSIONS

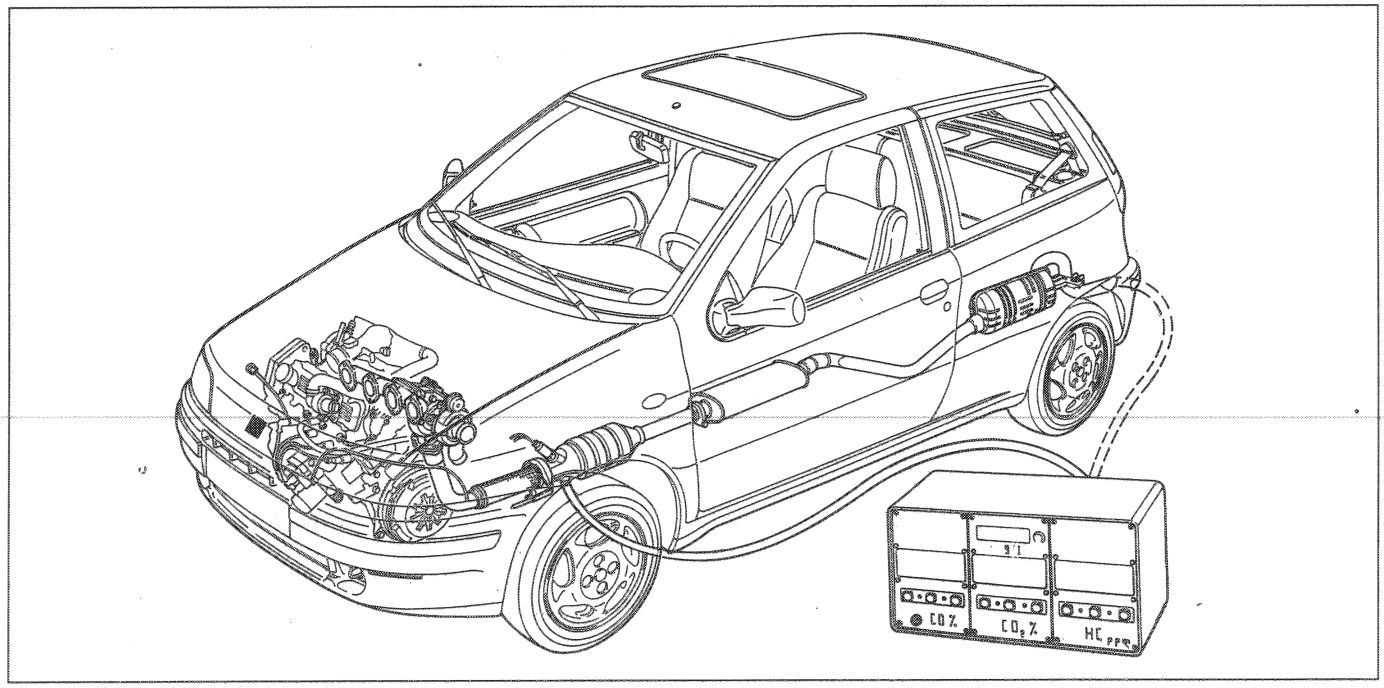
Foreword

The Motronic system self-adaptive function continually controls idle speed and CO level so that any external regulations are unnecessary (adjustment screws are no longer fitted). A check on the exhaust emissions upstream and downstream from the catalytic converter can nevertheless provide useful information on injection-ignition system operation, engine parameters and the catalytic converter

Checking idling CO and HC levels upstream of catalytic converter

To check the levels of carbon monoxide (CO) and uncombusted hydrocarbons (HC) upstream of the converter, proceed as follows:

1. Unscrew the plug or nut located on the exhaust pipe upstream of the converter and tighten the tool in its place.
2. Connect the probe of a specially calibrated CO-tester in its place.
3. Start up the engine and allow to warm up.
4. Check that the rpm is as specified.
5. Check that idling CO level is as specified (see table); otherwise check:
   - Lambda probe operation, using a Fiat/Lancia Tester;
   - for air leaks in the area around the Lambda probe seat;
   - the injection system **(particularly the condition of the spark plugs).**
6. Check, under the same conditions, that HC level is lower than 500 p.p.m.
7. If these level are not as specified, adjust the engine and check the following in particular:
   - ignition advance angle
   - valve clearance
   - timing
   - engine compression



P3M42FJ01

Summary table showing emission level tolerances

	CO (%)	HC (p.p.m.)	CO_2 (%)
Upstream of converter	0,4 - 1	⩽600	⩾ 12
Downstream of converter	⩽0.35	⩽90	⩾ 13

Checking CO and HC levels at exhaust

Measure carbon monoxide (CO) and uncombusted hydrocarbon (HC) at the exhasut by inserting the probe of a calibrated tester into the end of the exhaust pipe by at least 30 cm as indicated in the figure.

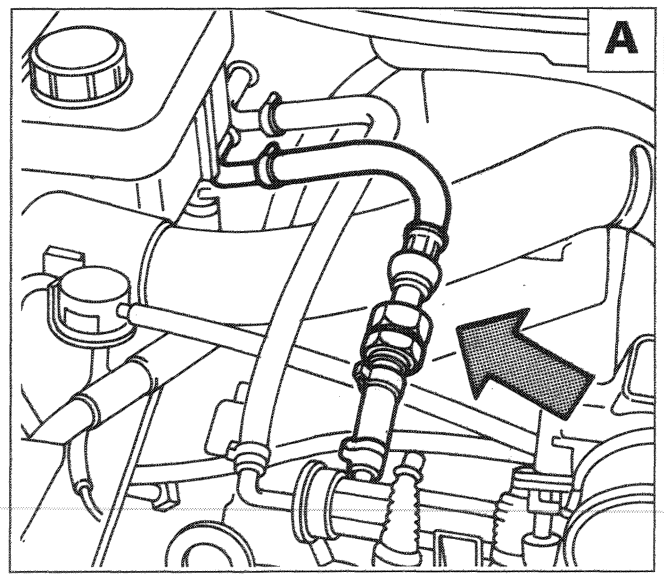
If the shape of the exhaust tail pipe will not allow the probe to be fitted fully, add an extension pipe and ensure the joint area is well sealed.

1. Check that idling CO and HC levels are as specified (see table).
2. If the HC level is not as specified whereas level measured upstream of converter is correct, engine parameters should be considered correct and the cause of the anomaly must lie in reduced converter efficiency.

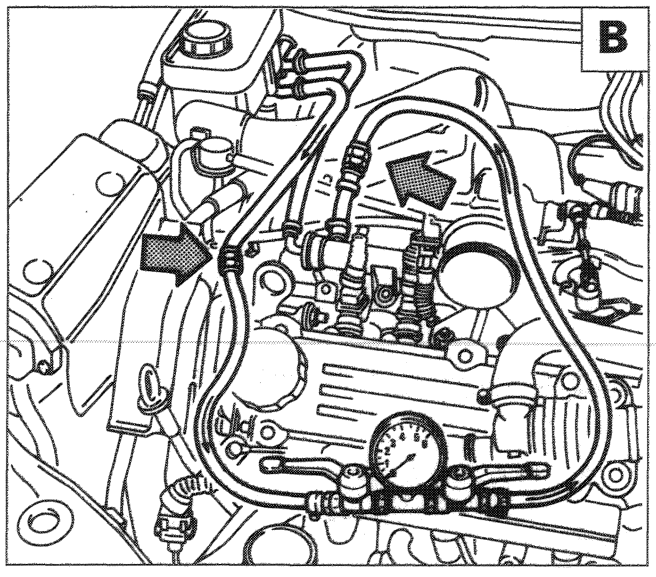
TESTING FUEL FEED CIRCUIT PRESSURE

Check 1: check fuel regulation pressure as follows:

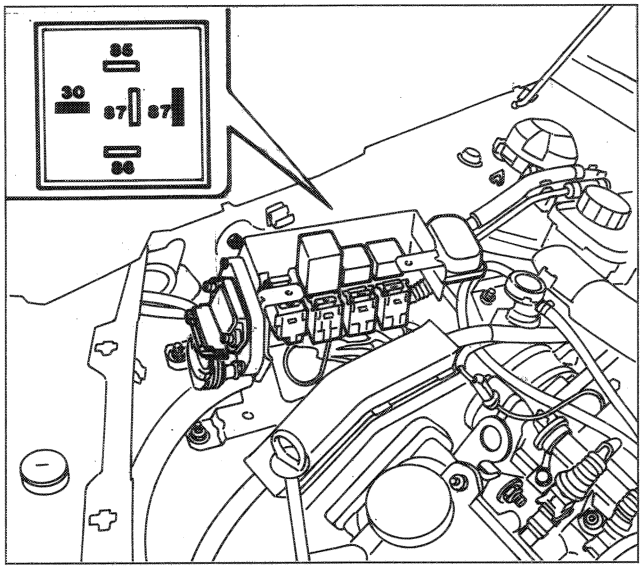
- Disconnect the pipe (arrowed in figure A) from the filter from the injector fuel manifold supply end.
- Interpose pressure gauge 1895890000 between the disconnected pipe end and the injector fuel manifold as shown in figure B.



P3M43FJ01



P3M43FJ02

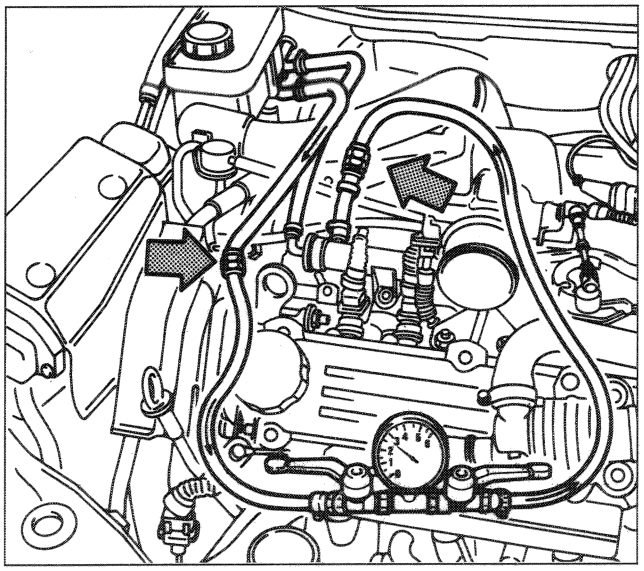


P3M44FJ01

- Operate pump with engine off.

Remove the pump control relay: connect terminals 30 and 87 of the relay carrier block using a lead with a 10A fuse fitted (see figure alongisde).

Take great care when connecting terminals 30 and 87 because an incorrect connection between terminals (30 and 85) could damage the ECU irremediably.



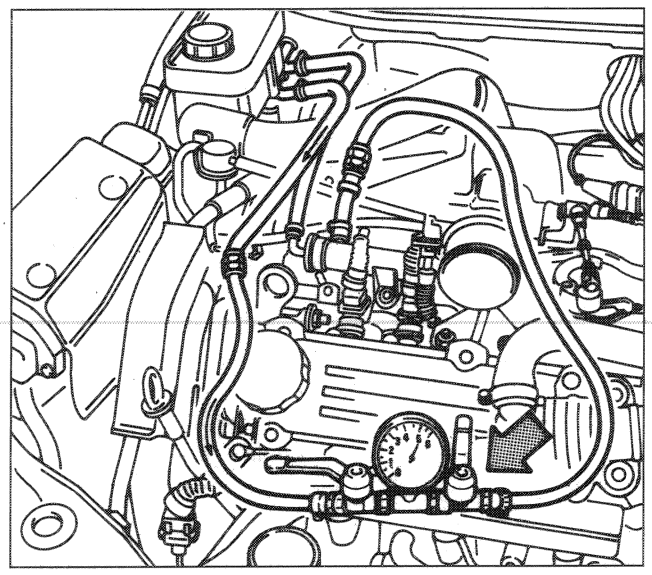
P3M44FJ02

- The pressure reading on the gauge should stabilize at 3 ± 0.2 bar under these test conditions.
  If pressure is insufficient, carry out the next test.

Check 2

Checking maximum pump supply pressure (or pump efficiency)

Carry out this test only if absolutely necessary

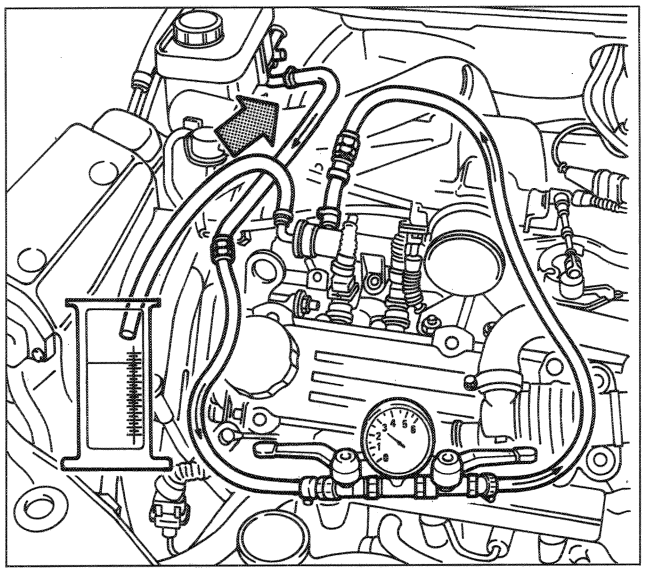


P3M44FJ03

Same connections as in previous test.

- Close fuel cock control lever (arrowed) (downstream from pressure gauge).

- operate the pump with the engine off as described. The pressure should reach 6 bar but not exceed 7.5 bar (pump pressure relief valve setting). Once this pressure level has been reached, cut off the supply to the pump by removing the bridge from the relay carrier block in order to avoid damage to the pressure regulator internal membrane. Otherwise replace the pump because it is defective.



P3M45FJ01

If pressure reading exceeds 3 bars in the 1st test (see previous page), proceed as follows:

- disconnect fuel return pipe (at point indicated by the arrow) and place in a container suitable for collecting the fuel.

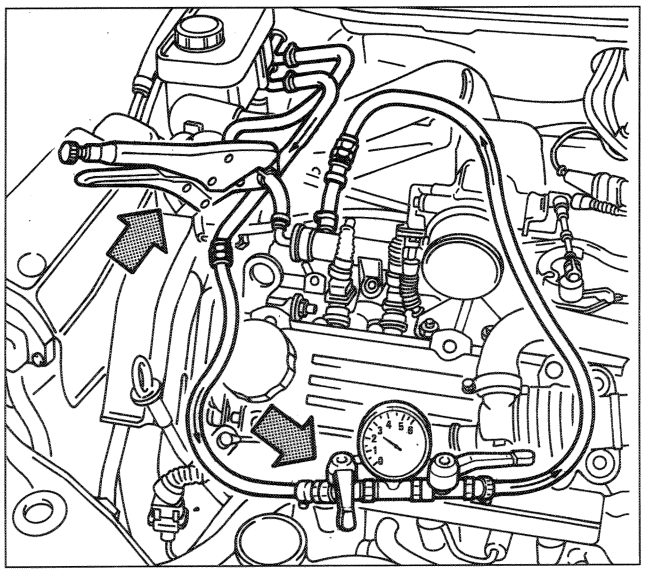
- operate the pump with the engine off, as described on the previous page, then read the presure level off the pressure gauge:

  a) if it reaches 3 bars, check fuel return line to tank because it is blocked or kinked;

  b) if it exceeds 3 bars, replace the pressure regulator because it is defective.

check 3
Checking pneumatic part of pressure regulator

- Remove electric lead and refit pump relay after replacing fuel return pipe to tank. Run engine at idle speed: pressure gauge reading should be 2.5 bar. If not, the air connection hose to the regulator manifold is defective or the regulator itself is defective and should be replaced.



P3MFJ4502

Checking injector seal

To check for drips from the injectors, connect as described in first test (regulation pressure check) and operate pump with engine off. Once regulation pressure is reached, close fuel cock control lever (arrowed) (upstream of the pressure gauge) and simultaneously compress fuel return line to tank; use pliers for this purpose and avoid damage to the pipe

This operation is necessary to tell the difference between an actual injector leak and an imperfect seal in the fuel pressure regulator reflux valve

Then:
- turn off the pump;
- see whether the pressure remains constant for about 60 seconds once it stabilizes (i.e. drops slightly).

If not, one or more of the injectors or a fitting must be leaking.
- In this case, disconnect the fuel manifold from the inlet manifold while maintaining the connection to the pressure gauge.
- Repeat the previous test, leaving the pressure gauge cock open.
- After supplying the pump with the engine off, look to see whether any of the injectors or connection sections are dripping.

Replace any dripping injectors and/or repair the defective seal in the leaking joint.

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