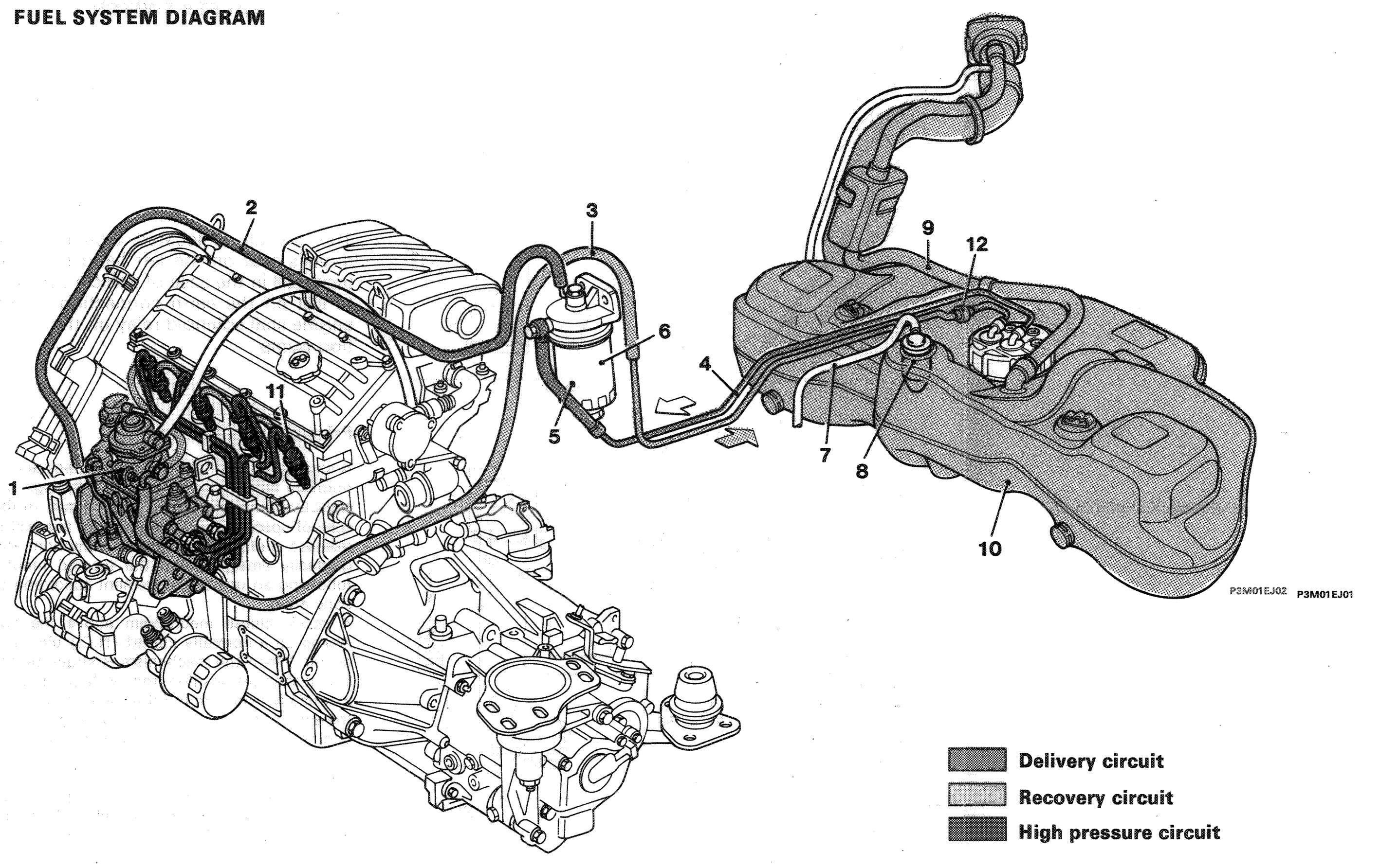
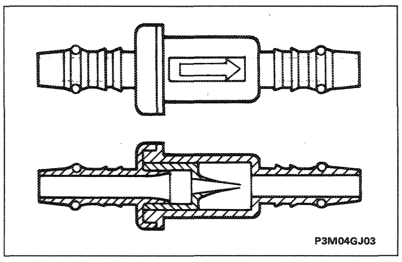
PUNTO eMANUAL

Engines

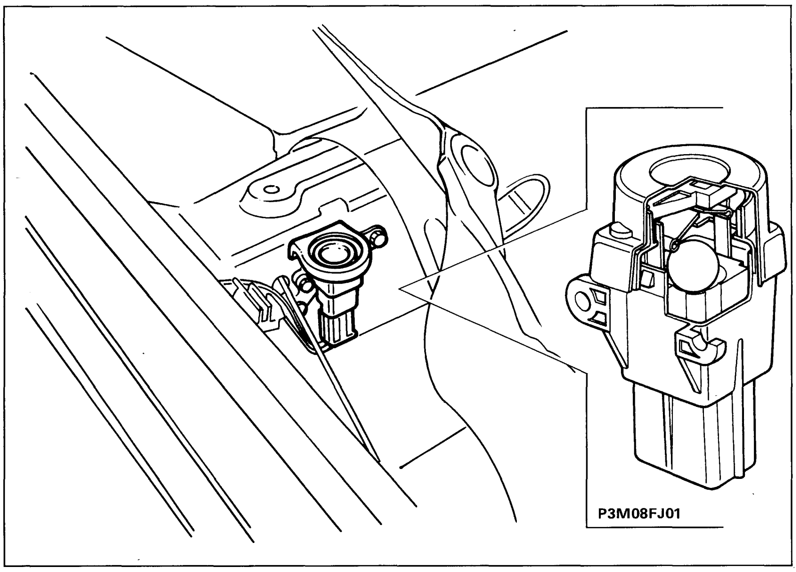
FUEL SYSTEM DIAGRAM





1. Bosch injection pump
2. Fuel delivery line from filter to injection pump
3. Excess fuel return line from injection pump to tank
4. Fuel delivery line from tank to filter
5. Fuel filter
6. Screw for draining water from fuel filter
7. Pipe for venting air from bottom of tank to top (*)
8. Ventilation safety valve with anti-roll device
9. Antiregurgitation pipe
10. Fuel tank
11. Injectors
12. One-way anti-reflux valve (*)

(*) A safety valve built into the fuel return line close to the tank. Allows fuel to return to the tank but prevents reflux in the case of accidents with pipe breakage.

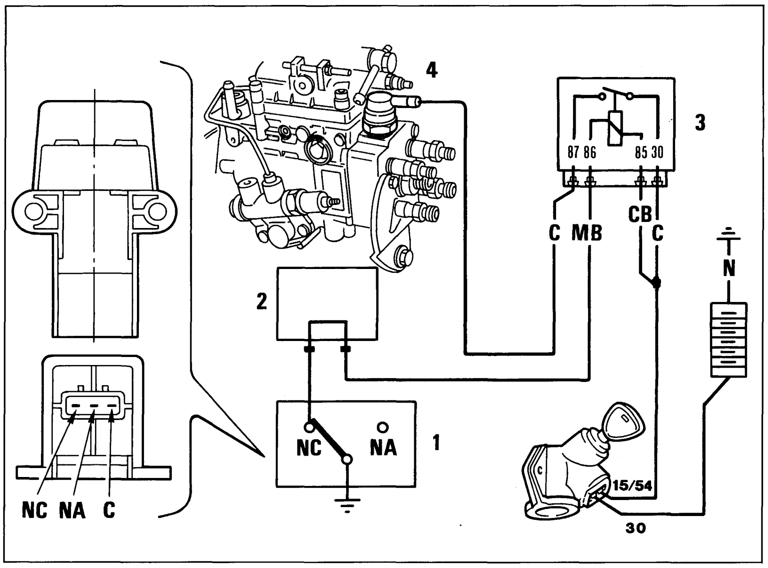


P3M05GJ01

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 of the engine stall solenoid relay on the injection pump.



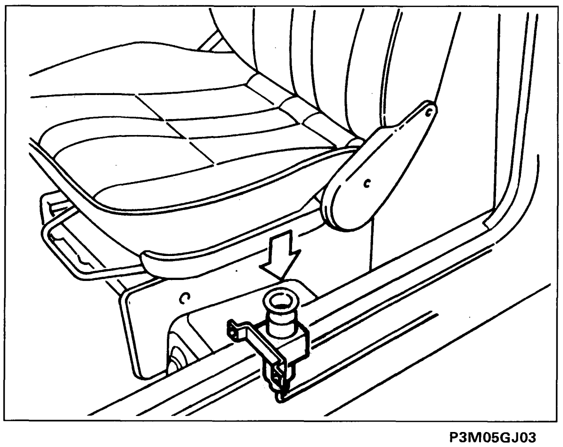
P3M02EJ01

1. Inertia switch
2. Fuse box
3. Relay
4. Engine cut out solenoid on injection pump

Principle of operation

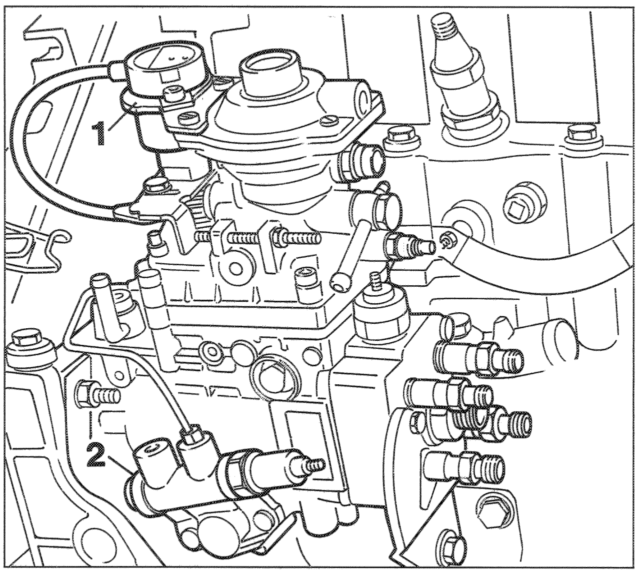
A steel ball fitted inside a tapered housing is normally held in locked position through the attractive force of an adjacent magnet. In the case of specific acceleration loads, the ball is released from the magnetic attraction and gradually emerges from the tapered mount, following an upward movement 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 earth connection of the relay supplying the engine stall solenoid on the injection pump

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).


P3M05GJ03

⚠ *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 earth connection to the exitation circuit of the relay supplying the engine stall solenoid on the injection pump.



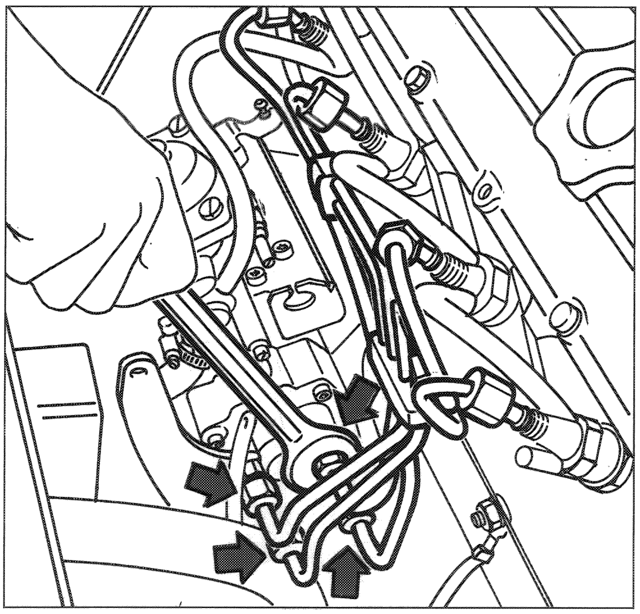
P3M03EJ01

INJECTION PUMP

VE - R - 537 (TD cat - USA 87)
VE - R - 538 (TD - EM. 08)

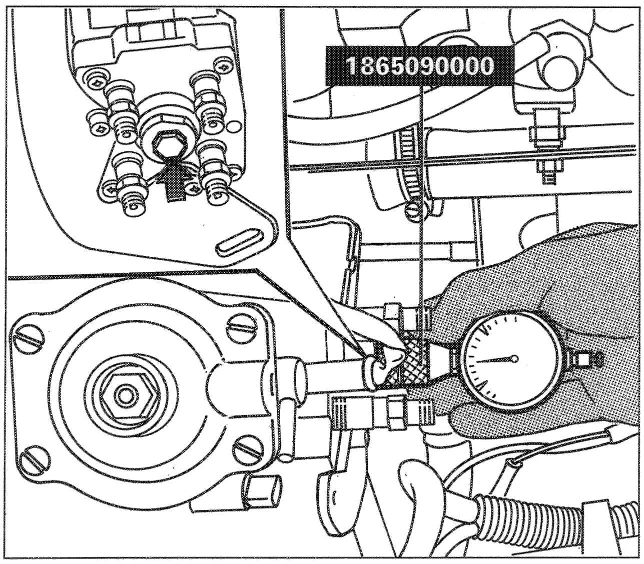
The two pumps fitted are identical; the only difference lies in the potentiometer on the EGR emission control device (USA 87).

1. Potentiometer for EGR device.
2. KSB control solenoid.


P3M03EJ02 P3M03EJ03

CHECKING IGNITION ADVANCE

Disconnect fuel delivery lines from injection pump to injectors.

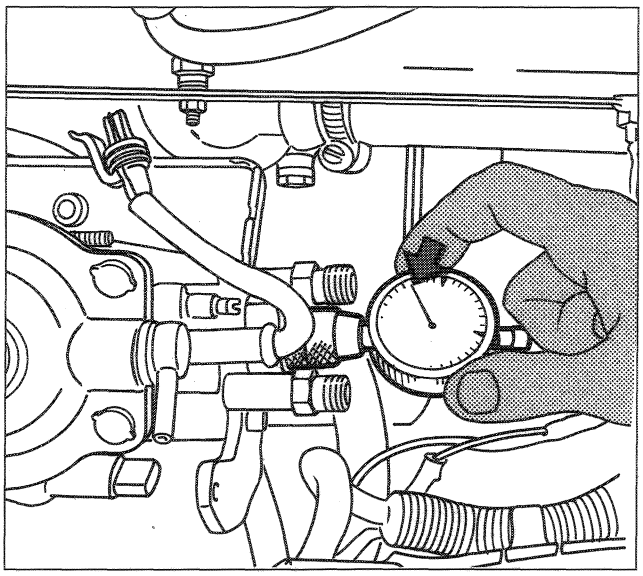


P3M03EJ04 P3M03EJ05

Fitting union 1865090000 with centesimal gauge to injection pump.

Remove plug on lockring (arrowed) and tighten tool 1865090000 with centesimal gauge into threaded seat. Position probe in contact with distributor piston crown.

10.

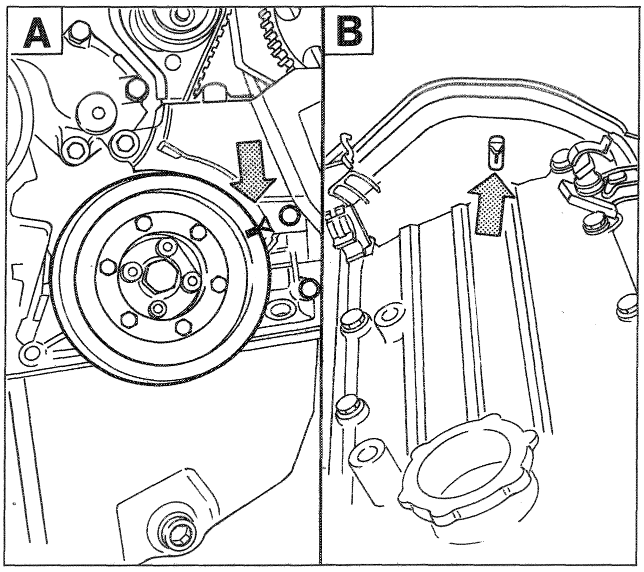


P3M04EJ01 P3M04EJ02

Zeroing gauge

Turn crankshaft against direction of rotation until pump distributor piston reaches BDC, which can be checked on gauge.

Zero the gauge in this position.

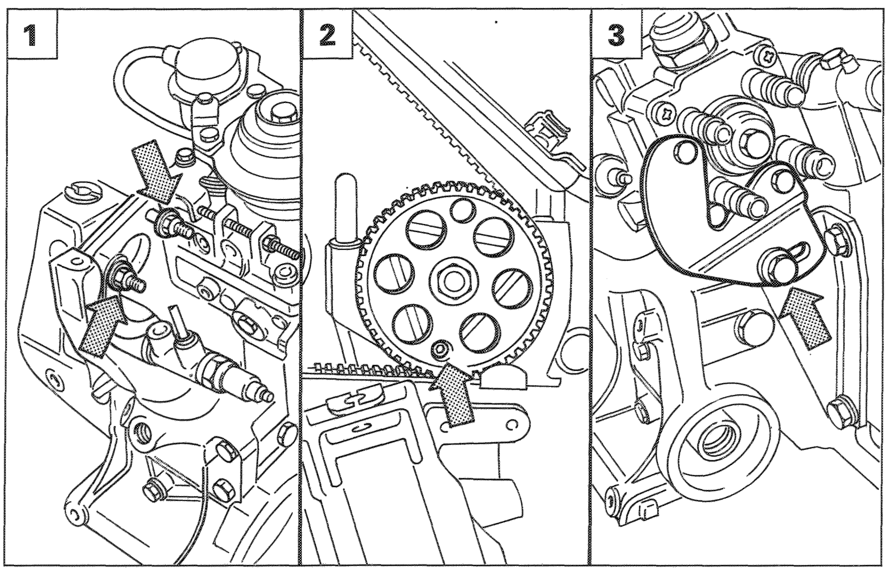


P3M04EJ03

Check pump advance

Turn crankshaft in direction of rotation until piston no. 1 is on TDC. To do this, check reference marks on crankshaft pulley (A) and camshaft pulley (B).

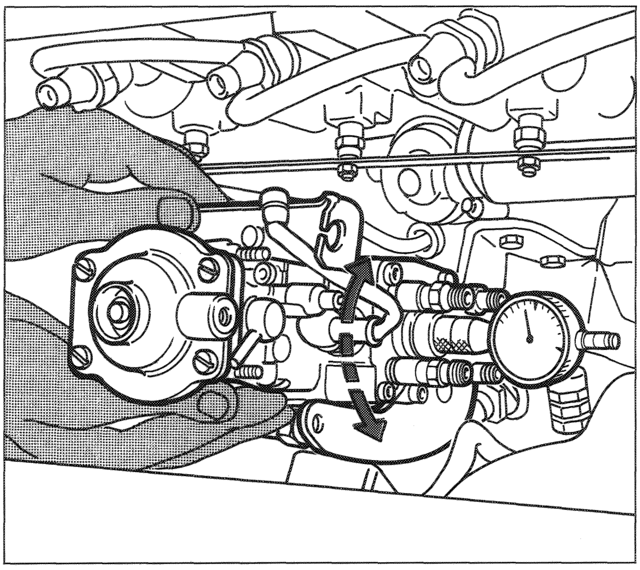
Under these conditions, pump distributor piston must have completed a stroke of **0.93 ± 0.05 mm**.



Adjusting pump advance

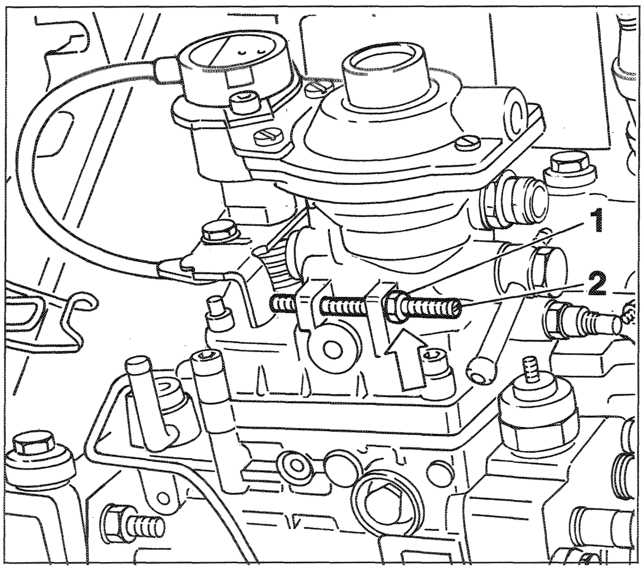
If these values are not found (0.93 ± 0.05 mm) then:

- loosen the two screws retaining pump from pump mount end (1);
- loosen the third pump retaining screw from timing end (2);
- loosen the screw retaining pump to rear mount (3);



P3M04EJ02

- Then turn pump case in its slot until set value indicated on gauge is obtained. Then tighten screws retaining pump to mount and to rear retaining bracket.



CHECKING AND ADJUSTING ENGINE IDLE SPEED

Adjust idle speed with engine at service temperature, i.e. when cooling fan has come on at least twice.

Adjust idle with fan off and without other appliances activated (heated rear window, air conditioner, headlamps etc.)

If the fan comes on during adjustment, stop working until it is completely still.

Check that engine idle speed is **900±20/min**. If not, loosen locknut (1) and adjust screw (2) until correct speed is obtained, then tighten locknut.

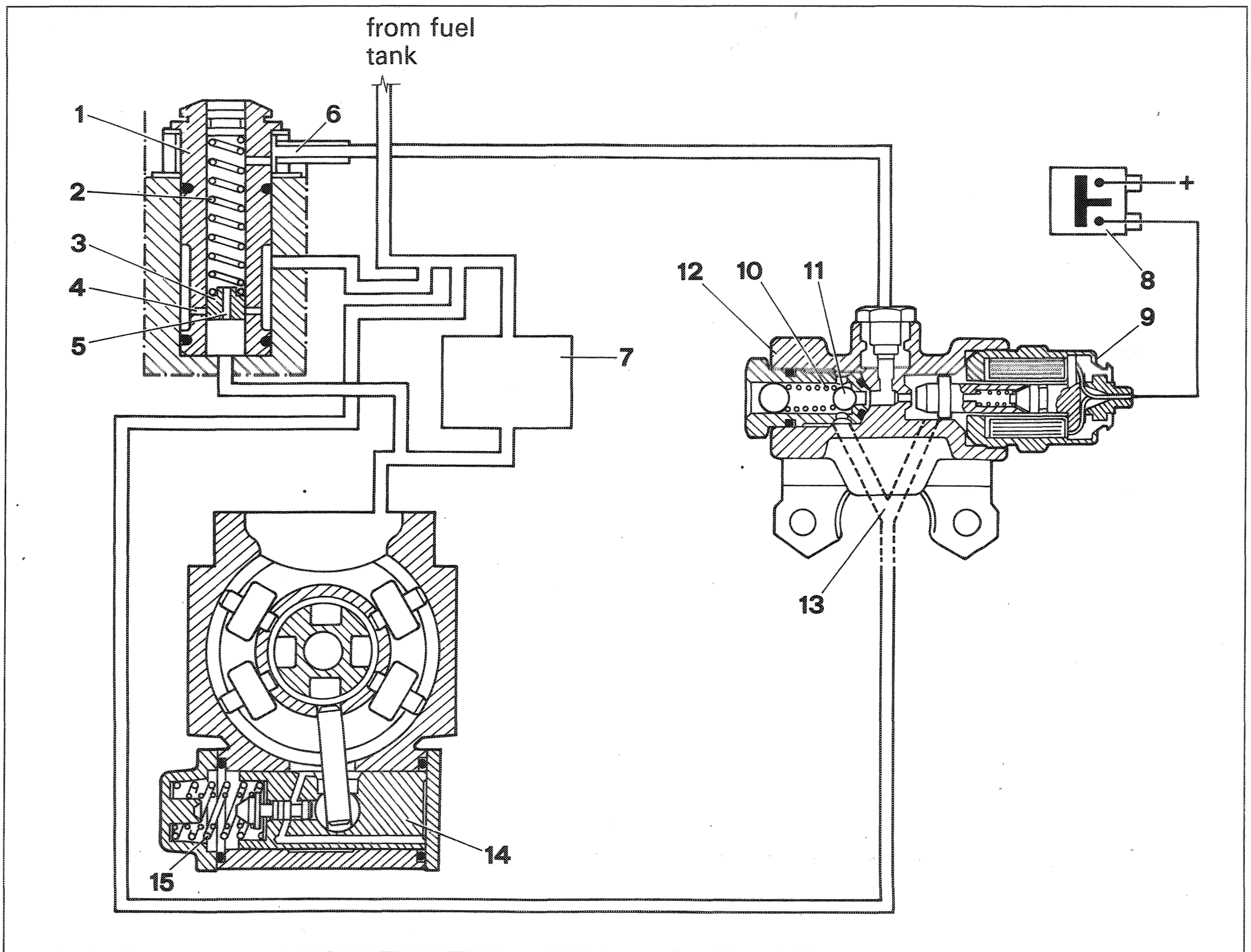
10.

AUTOMATIC COLD INJECTION ADVANCE DEVICE (KSB)

The automatic KSB device performs two functions:

1) advances the start of injection to promote even operation with engine cold;
2) improves starting.

The advance change obtained using the automatic device was previously achieved using a manual control.



P3M06EJ01

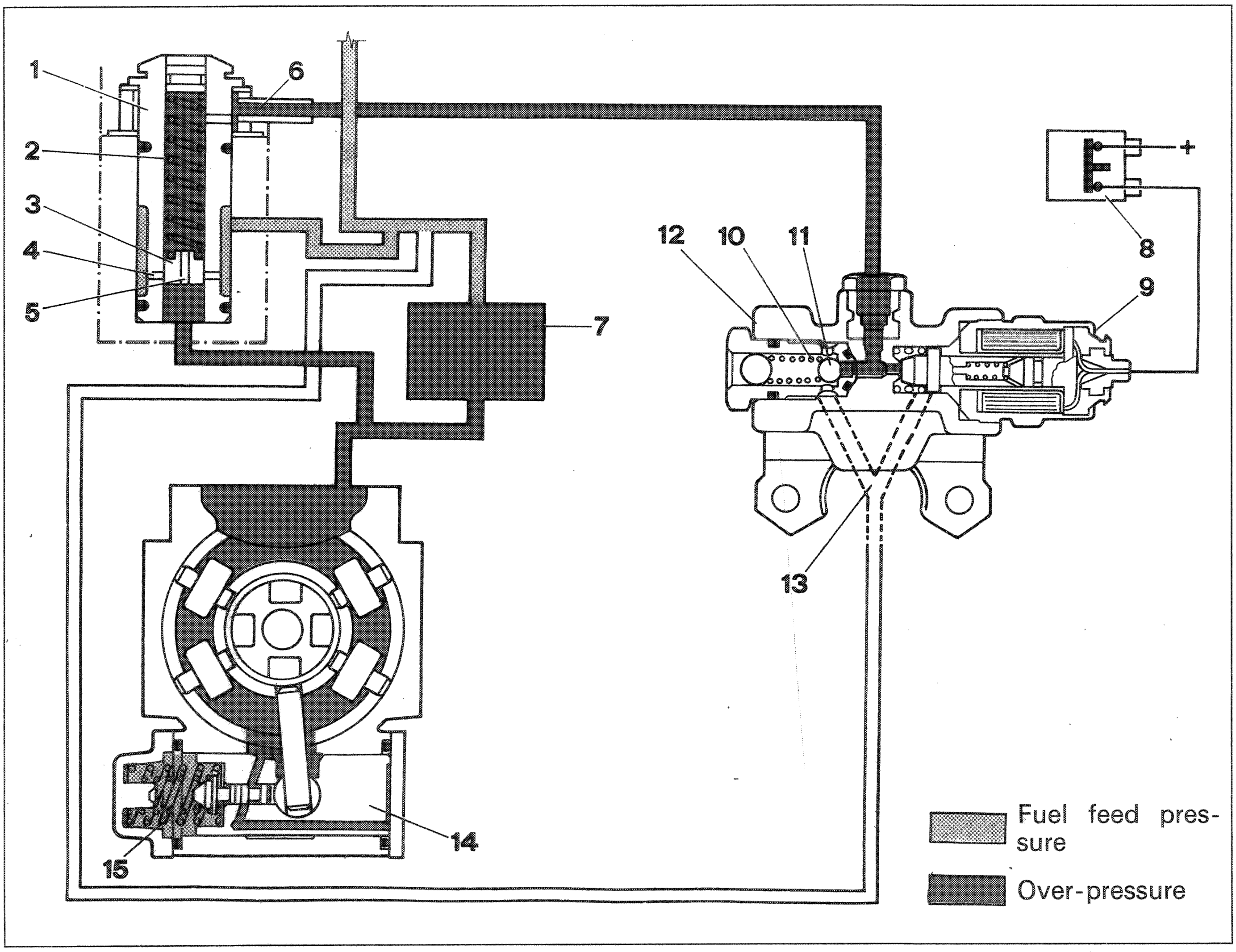
Components of automatic cold injection advance device

1. Transfer pressure regulation valve
2. Reaction spring for valve (3)
3. Piston valve
4. Exhaust ports
5. Piston calibrated hole
6. Duct connecting valve and automatic advance device
7. Transfer pump
8. Thermal switch
9. Solenoid
10. Reaction spring
11. Pressure seal ball
12. Case of automatic advance device
13. Exhaust port
14. Advance variator piston
15. Reaction spring for piston (14)

Operation

The output of the fuel pump (7) is greater than required for injection and the excess is drained through feed pressure regulation valve (1) to the pump intake to set up a pressure inside the pump case (feed pressure). Output of feed pump (7) and thus feed pressure vary according to engine rpm.

The feed pressure acts on one end of the injection advance variator (14) and pushes the reaction spring (15) to alter the beginning of injection.



P3M07EJ02 P3M07EJ01

Engine cold

With coolant temperature ≤55°C, solenoid (9) of the KSB device is activated to eliminate draining of part of the fuel through calibrated hole (5) of piston valve (3); this brings about an increase in feed pressure, i.e. advance, because the entire reflux flow must flow out through the exhaust holes.

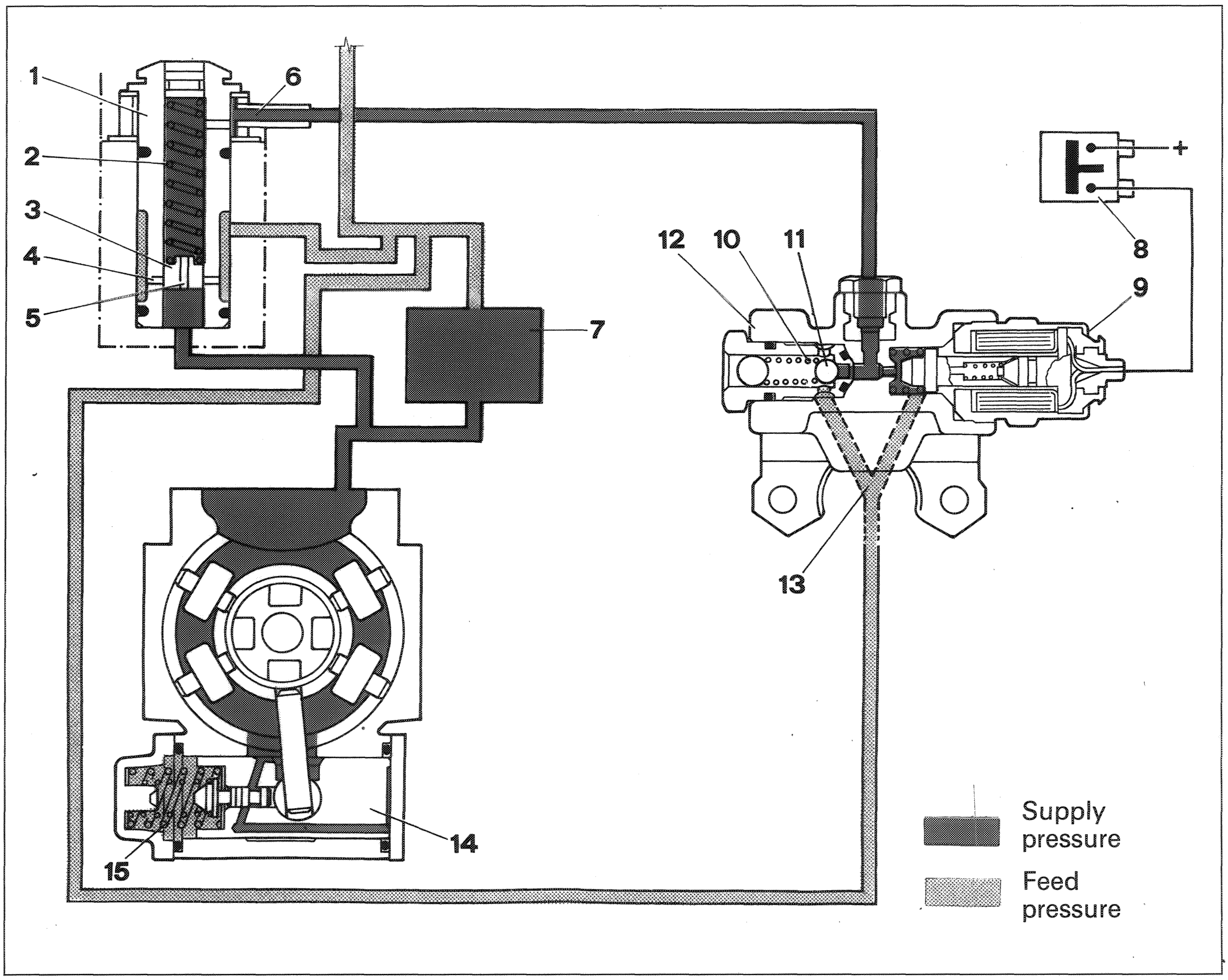
The increase in transfer pressure is experienced by piston (14) of the advance variator that overcomes the force of reaction spring (15) to alter the injection start advance (via plunger connected to roller cage).

10.

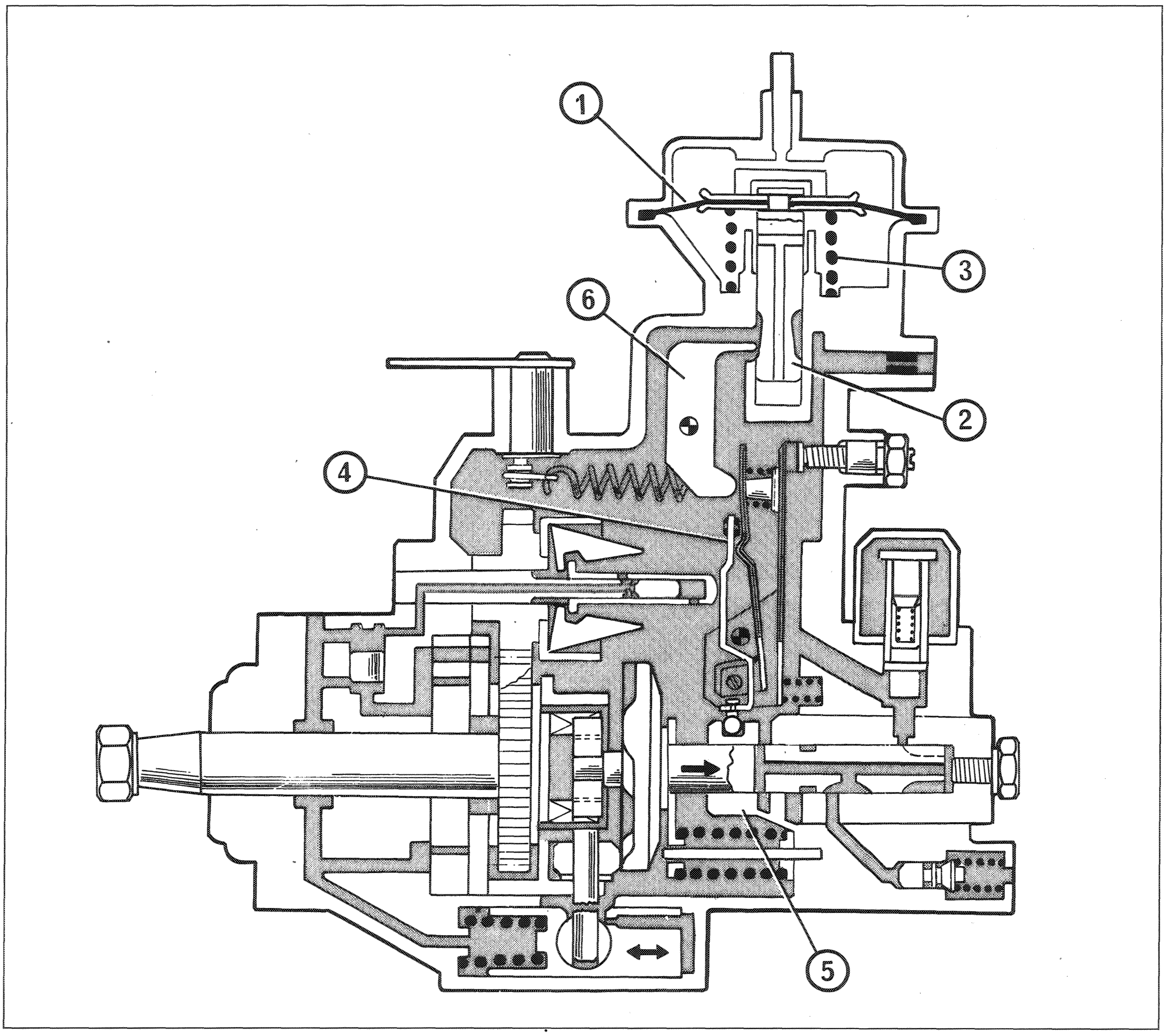
Engine warm

When coolant temperature reaches 55°C, a thermal switch (8) on the thermostat case opens to cut off supply (electrical) to solenoid (9), which due to the effect of the reaction spring (10) opens up the flow toward duct (13).

Valve opening brings about a drop in feed pressure (and extra advance of piston (14) is cancelled as a result) because part of the reflux flow is drained out of ports (4) and also calibrated port (5), that brings pressure regulation valve (1) into communication with supply channel located upstream of feed pump (7).



P3M08EJ02 P3M08EJ01



Flow limiter built into Bosch injection pump

This device adjusts the amount of fuel injected according to the pressure in the inlet manifold. This prevents an excess of fuel being introduced at low speeds when the turbocharging effect is not yet perceptible in order to prevent poor combustion, fuel waste, smokiness etc.

It consists of two chambers separated by a membrane (1): the top chamber is connected by a pipe to the inlet manifold and the pressure level contained within. The bottom chamber is subject to atmospheric pressure reinforced by a counter spring (3). Piston (2) connected to the membrane is tapered at the bottom and able to move vertically according to the pressure in the engine inlet manifold. According to the position taken up by piston (2), control pin (6) acts on regulation cursor (5) by means of linkage (4) in order to limit the amount of fuel injected by the pump if the pressure level in the manifold does not fall within turbocharging levels.

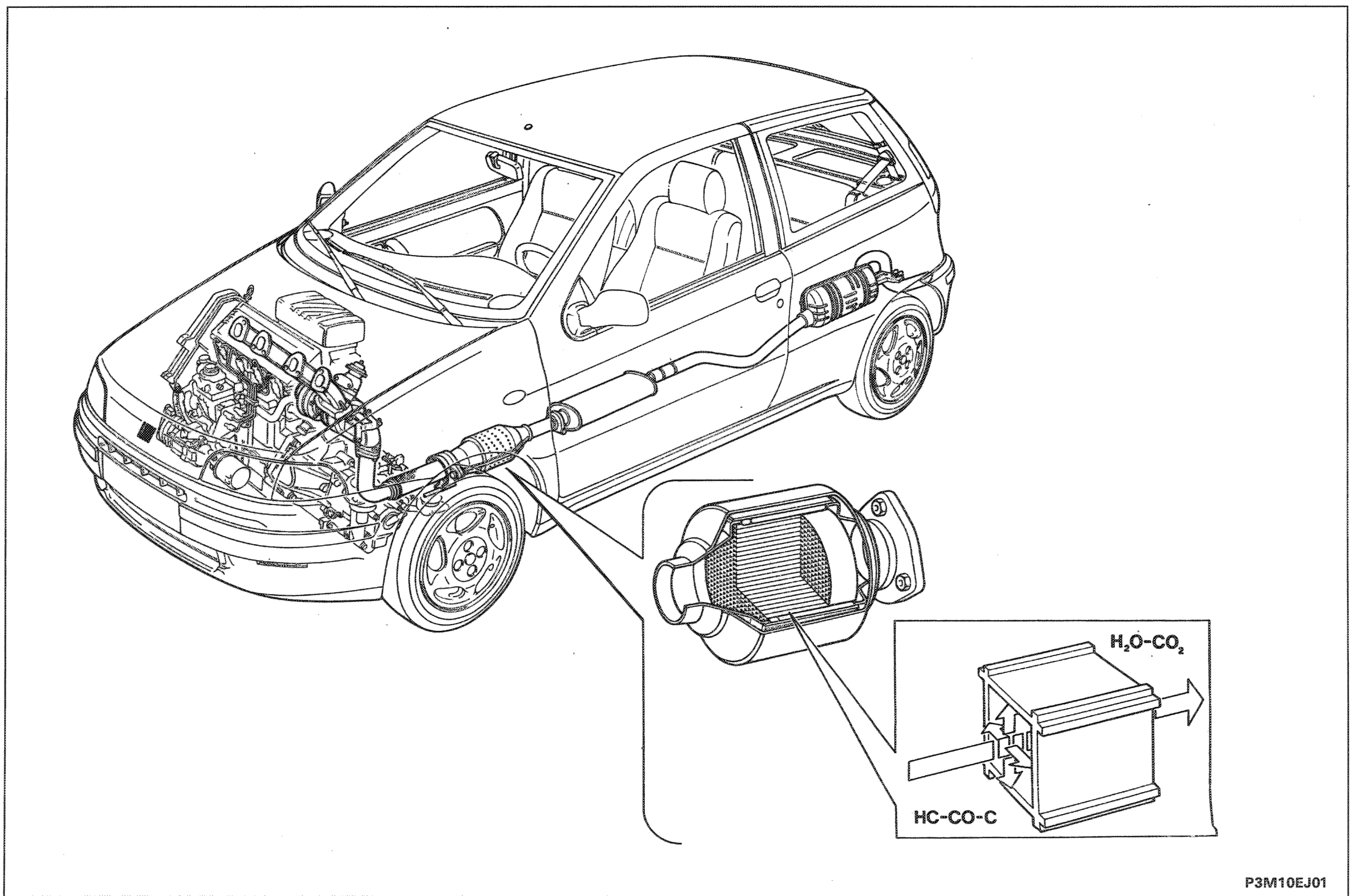
EMISSION CONTROL DEVICES - DEGUSSA OXIDIZING CONVERTER

The oxidizing catalytic converter is a simple, effective post-treatment device. It oxidizes CO, HC and particulate and converts them to carbon dioxide (CO_2) and steam (H_2O).
The barrel-shaped Degussa converter consists of a ceramic honeycomb block with its chambers impregnated with platinum, a catalyst of oxidation reactions. The total volumetric capacity is equal to 600 cm^3 with a density of 400 chambers per square inch.
Exhaust gases flowing through the chambers heat up the catalyst and trigger the conversion of pollutants to inert compounts.
The chemical oxidation of CO, HC and particulate occurs at temperatures of more than 200°C. It is not, however, advisable to exceed 350°C because at this temperature the sulphur in the diesel begins to oxidize and give rise to sulphur dioxide (SO_2) and trioxide (SO_3), responsible for acid rains.

If the catalytic converter is the correct size, temperature is kept down while achieving maximum conversion of polluting emissions and restricting the oxidation of sulphur compounds.

The catalytic converter also deals with saturated hydrocarbons and aromatic hydrocarbons in particulate, namely carbon (soot), metals, water and sulphur compounds, are eliminated in exhaust emissions.

The efficiency of reduction of individual pollutants is as follows:
- 50% for CO,
- 50% for HC,
- 35% for particulate.



Engine exhaust assembly with oxidizing catalytic converter DEGUSSA 2 fitted to vehicle

The box shows the DEGUSSA oxidizing catalytic converter and how it is fitted to the engine exhaust pipe

EXHAUST GAS RECIRCULATION SYSTEM E.G.R.

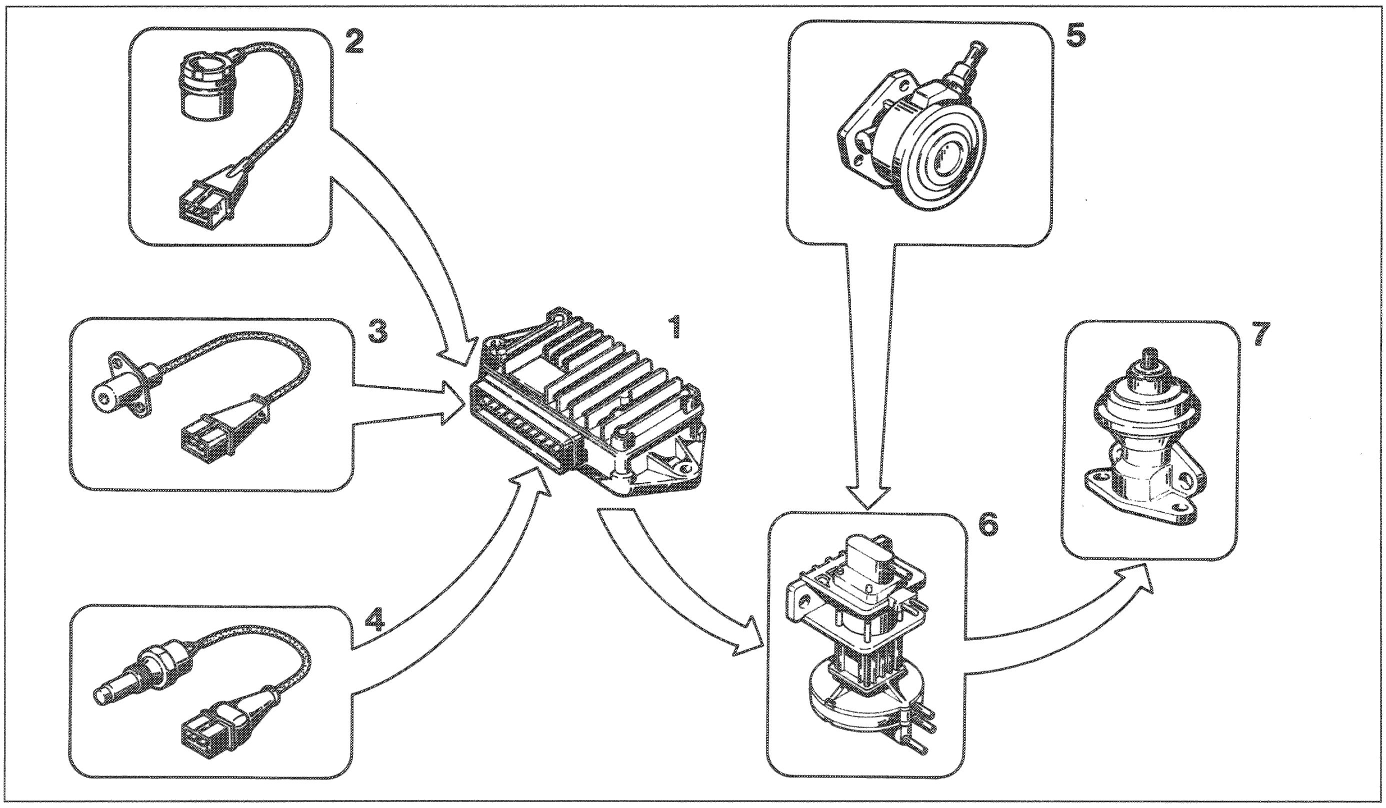
Introduction

This system permits a proportion of exhaust gases (5 - 15%) to be directed to the intake under certain engine operating conditions.
This action dilutes the fuel mixture with inert gases to lower peak temperature in the combustion chamber. This minimizes the formation of nitrogen oxides (NOx), to produce a reduction of 30 - 50% at the exhaust.
Exhaust gas recirculation is possible only at medium-low loads when the air-fuel mixture is very high and engine operation is not affected by the presence of inert gases in the place of air.

The recirculation system is controlled by an ECU (1) that receives signals from a potentiometer on accelerator lever (2) and from rpm sensor (3) and coolant sensor (4). It then sends out a command signal to the Borg Warner modulating solenoid responsible for EGR control. (6).

The solenoid, connected to the atmosphere via a filter, relays a greater or smaller vacuum from the vacuum pump of brake servo (5) to the Pierburg EGR valve (7) on the basis of the command signal received.

If the vacuum is sufficient, this valve opens to establish communication between the exhaust manifold and the inlet manifold.
The amount of recirculated gas can therefore be altered by adjusting the opening of the Pierburg EGR valve in continuous manner, consulting memory maps of opening levels on the basis of signals received.



P3M11EJ01

Components of EGR system

1. Control module Marelli MCR 102 A
2. Accelerator lever potentiometer on injection pump
3. Rpm sensor
4. Coolant temperature sensor
5. Vacuum pump for brake servo
6. Borg Warner modulator solenoid controlling EGR.
7. Pierburg EGR valve

10.

OPERATION OF EXHAUST GAS RECIRCULATION SYSTEM COMPONENTS

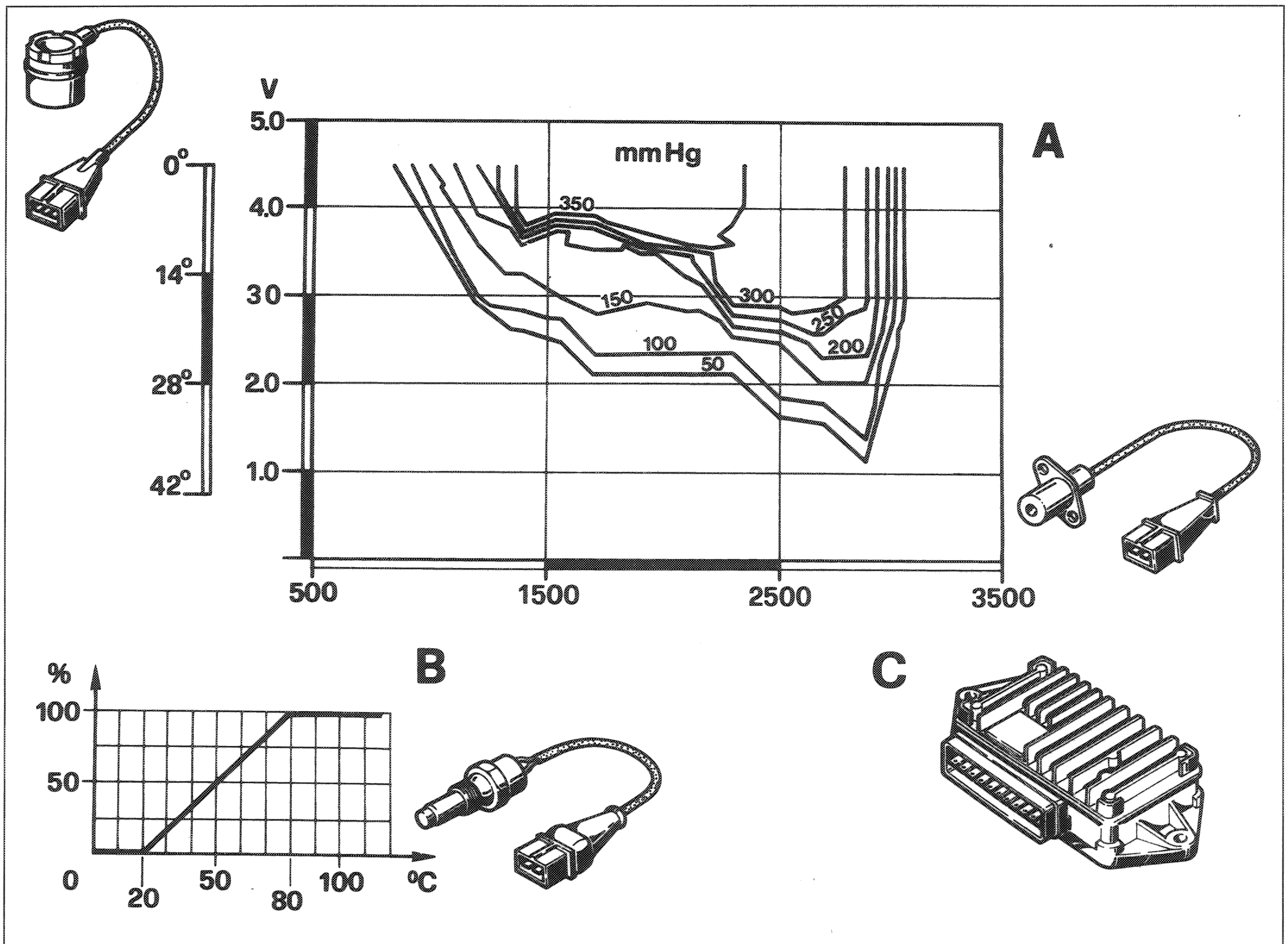
Electronic control unit Marelli MCR 102 A

The exhaust gas recirculation system control module used on this module is identified by the code Marelli MCR 102 A.
This digital microprocessor unit receives data on engine service conditions that are sent in by the three engine load sensors (injection pump accelerator lever position sensor, rpm sensor and coolant sensor).

On the basis of these signals, ECU (C) is able to govern the modulator solenoid using a square wave signal on the basis of its internal EGR maps.
The mapping is represented on the accelerator lever angular position/engine rpm plane and uses EGR valve control solenoid values in mmHg as level curve parameters (A).

A temperature correction is made at a later stage, again by the control module. This correction (B) corresponds to a zeroing of intensity values for temperatures less than 20°C, and a reduction ranging linearly from 100% to 0% for temperatures from 20°C to 80°C. For coolant temperatures in excess of 80°C, no solenoid control current corrections are made.

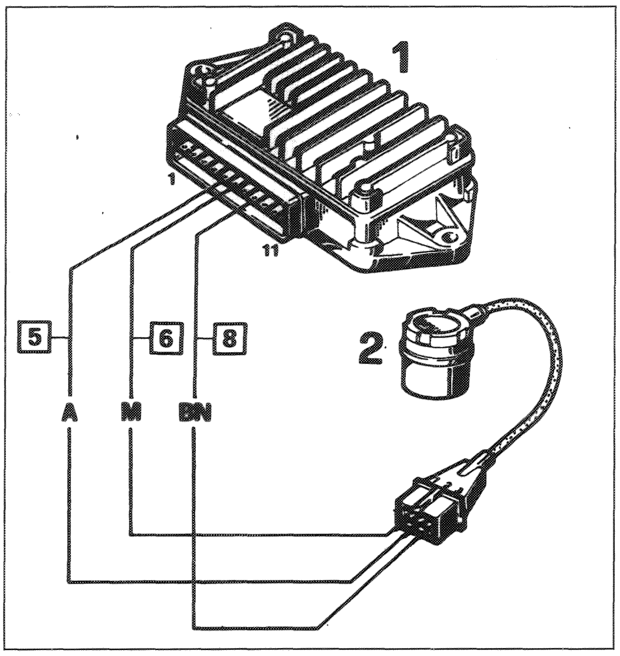
The control module also includes a connector for the Fiat-Lancia Tester serial output. During maintenance, this can be used to detect any operating faults.



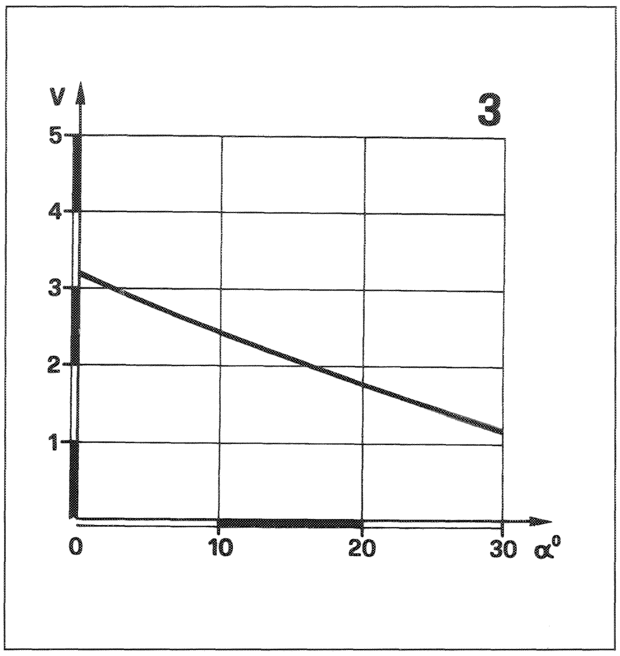
P3M12EJ01

Accelerator lever potentiometer on injection pump

Potentiometer (2) fitted to the injection pump measures accelerator lever angular position and informs ECU (1) about engine load.
Lever rotation alters potentiometer internal resistance. For a constant power supply of 3.7 ± 0.2 V supplied by the ECU, therefore, an output voltage ranging from 3.1 V when idling, to 1 - 1/4 V upon maximum load (3) is obtained.
This voltage represents a significant engine operating data item and is used by the ECU to control opening of the EGR Pierburg valve.



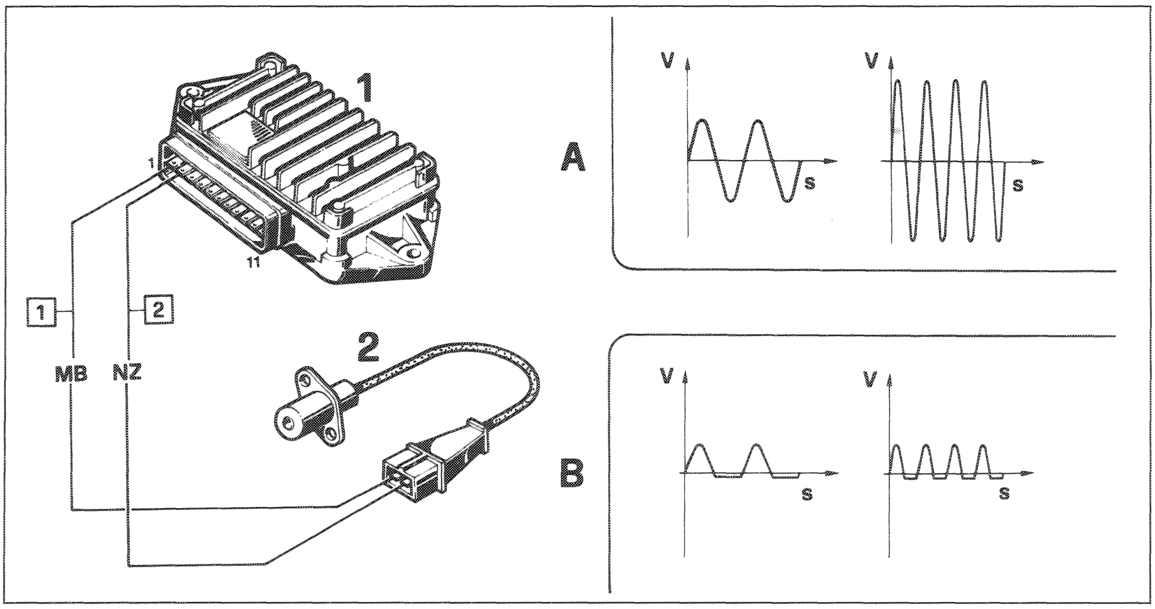
P3M13EJ01



P3M13EJ02

Rpm sensor

The angular speed sensor (2) fitted to the gearbox bell housing by the flywheel ring gear is a passive electromagnetic recorder with a gap of 0.25 - 1.3 mm between the top of the ring gear teeth and the winding.
Each time a tooth of the ring gear passes it, the sensor produces a sinusoidal wave form voltage signal that varies in amplitude and frequency according to engine rpm (case A).
ECU (1) stabilizes positive half-wave amplitude and cuts out the negative half-wave (case B).



P3M13EJ03

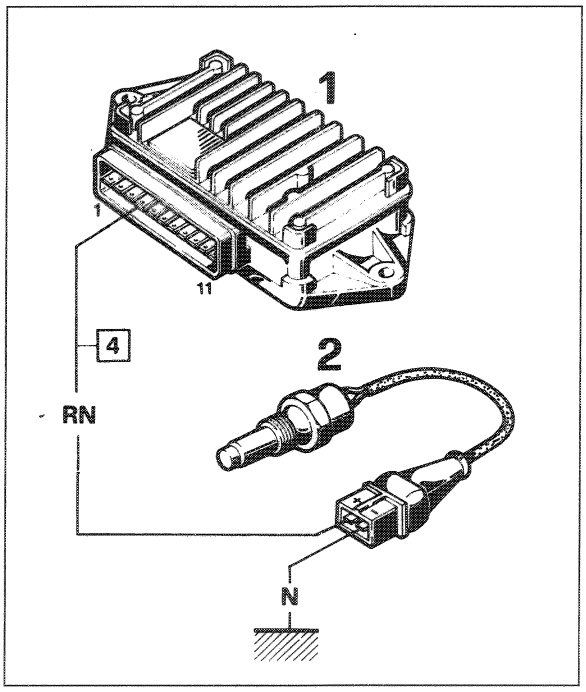
10.

Coolant temperature sensor

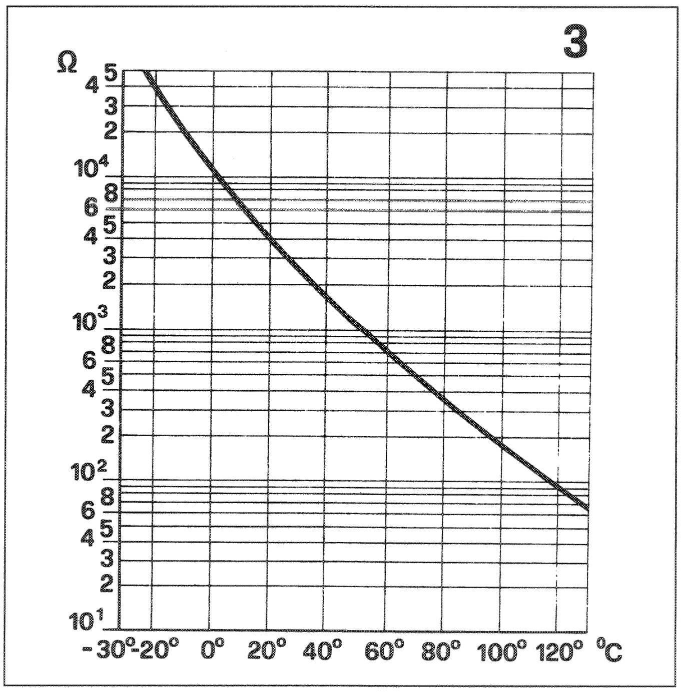
The sensor is fitted to the thermostat case with the sensitive part in contact with the coolant. It consists of an NTC (Negative Temperature Coefficient) resistance that alters its resistance value in proportion to temperature, as shown in the diagram (3).
ECU (1) supplies NTC sensor (2) according to the resistance value, and measures coolant temperature on the basis of temperature changes proportional to the intensity of the current flowing through the sensor in order to correct modulator solenoid commands.

This prevents the engine taking in an excessive amount of exhaust gas before optimal service temperature has been achieved, or when very severe weather conditions prevent this occurring.

This sensor therefore ensures safe engine operation during the stage following start-up by preventing a drop in the intake oxygen load. This ensure the best possible conditions for combustion while the engine is warming up.



P3M14EJ01



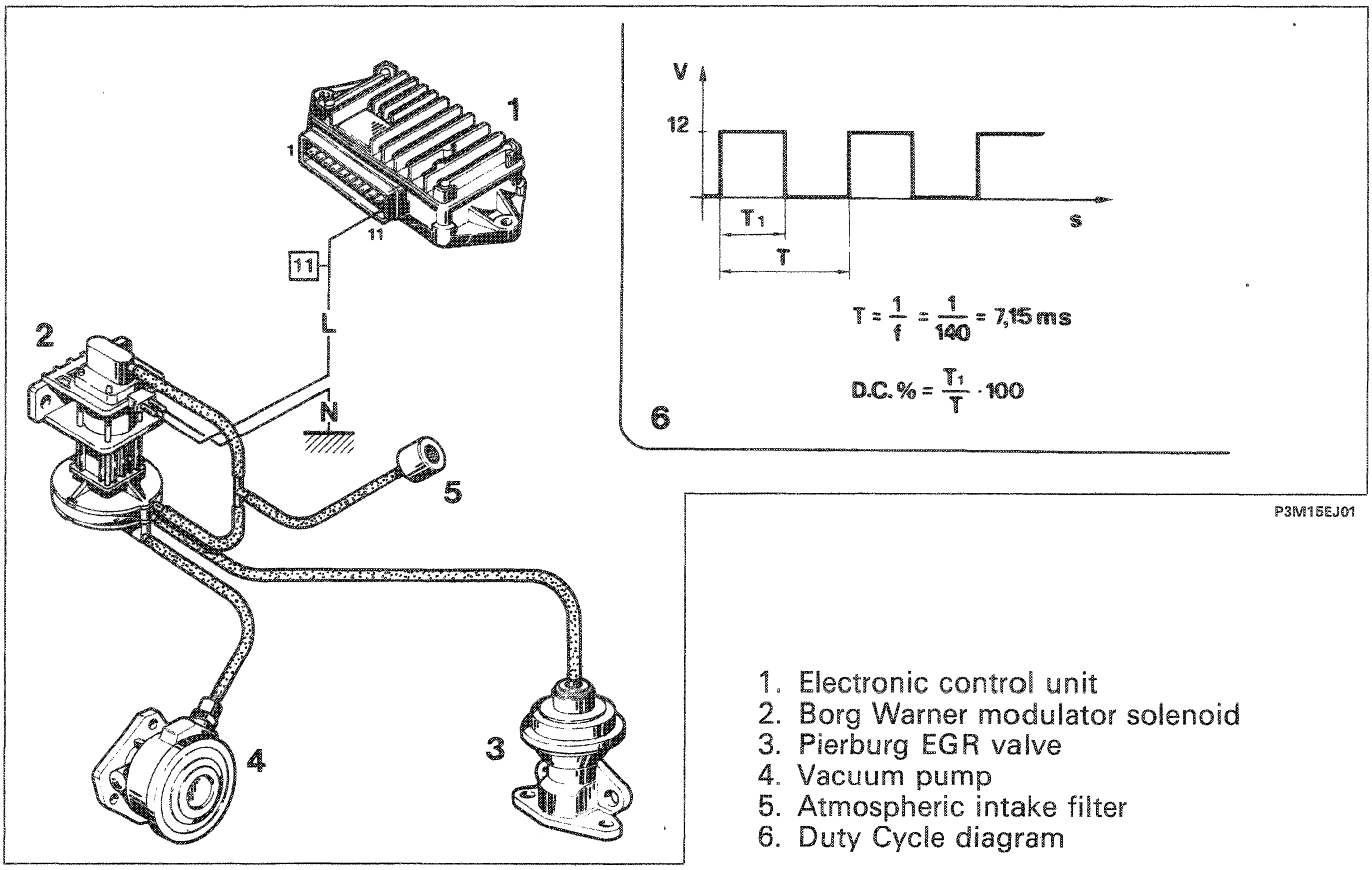
P3M14EJ02

Borg Warner modulator solenoid

The Borg Warner solenoid (2) is fitted in the rear part of the engine bay, in a vertical position on the flame bulkhead that separates engine from passenger compartment.
It is connected to the EGR pneumatic system with a vacuum connection from the brake servo vacuum pump (4), with an output to be connected to Pierburg EGR valve (3) and two atmospheric pressure points that take in air from a filter (5).
The solenoid is governed directly by ECU (1) with a square wave signal with frequency 140 Hz, voltage 12 V and variable Duty-Cycle (diagram 6) that gives rise to a current from 0 to about 800 mA, when a maximum voltage level is transmitted to the Pierburg valve.

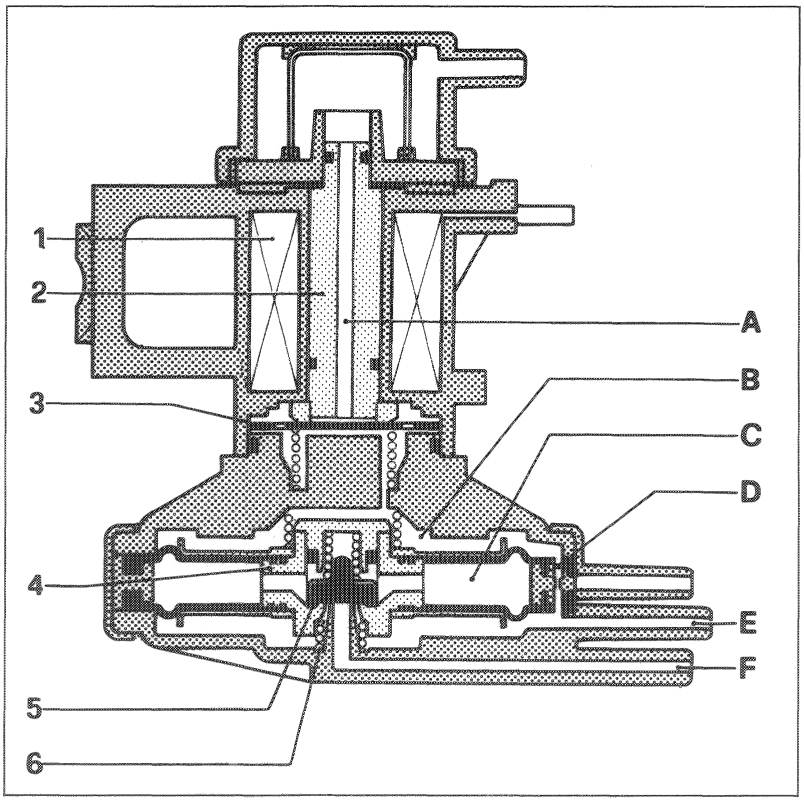
The term Duty-Cycle denotes the ratio between time when signal is 12 V and total cycle period (1/140 s).

It should be noted that modulated voltage does not depend on the input vacuum level but only on the Duty-Cycle of the electrical control signal.



P3M15EJ01

1. Electronic control unit
2. Borg Warner modulator solenoid
3. Pierburg EGR valve
4. Vacuum pump
5. Atmospheric intake filter
6. Duty Cycle diagram



P3M15EJ02

Cross section through Borg Warner modulator solenoid

1. Electromagnetic coil
2. Magnetic core
3. Mobile modulation plate
4. Mobile unit
5. Shunt valve
6. Counter spring

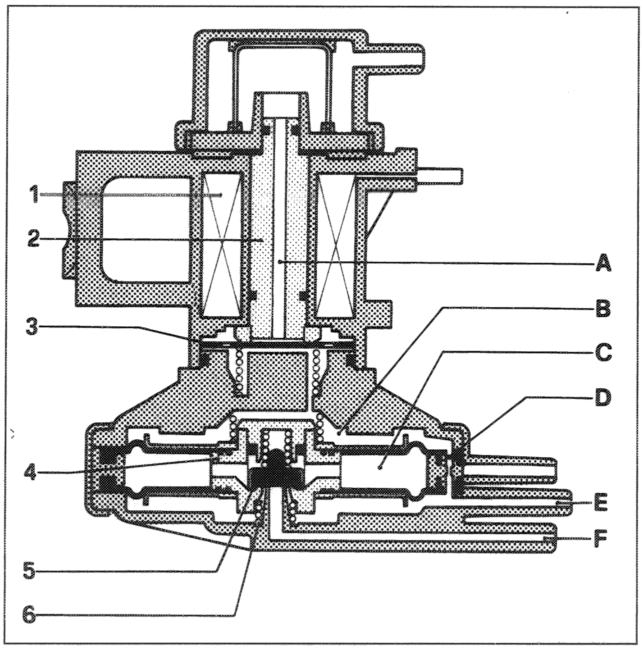
A. Atmospheric pressure intake duct
B. Top modulated pressure chamber
C. Atmospheric pressure chamber and duct
D. Chamber B and E compensation port
E. Lower chamber and EGR connection duct.
F. Vacuum intake from vacuum pump

OPERATION

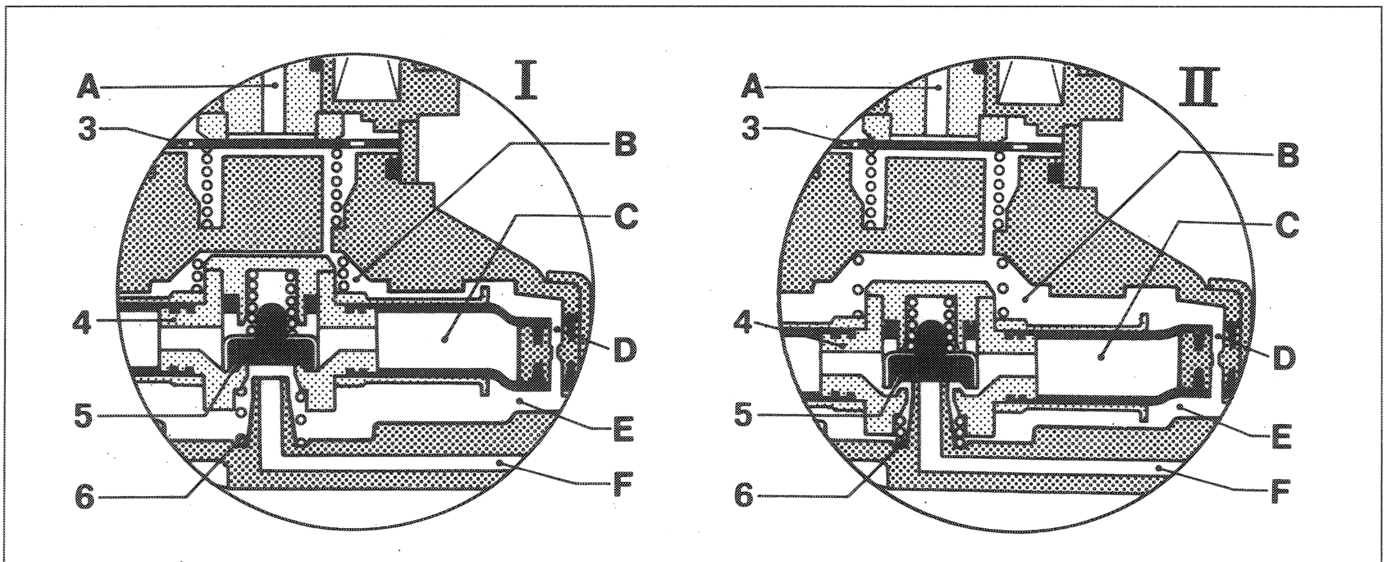
Maintenance position

The vacuum reaches chamber E from duct F (case I), since the force of spring (6) acts on mobile unit (4) and shunt valve (5) to open up the passage.
The vacuum passes through compensation port D to chamber B and the lower surfaces of the plate plunger (3).
Once the forces acting on plate (3) are balanced, the atmospheric pressure in duct A enters chamber B to move the mobile unit down (case II). The plunger of valve (5) then closes duct F and brings chamber E into communiction with chamber C at atmospheric pressure to reduce the vacuum in duct E.

The reduced vacuum level or increase in absolute pressure in chamber E causes mobile unit (4) to lift (case I) to close passage C-E and restore valve (5) to ideal conditions (E in communication with F), to repeat the cycle.



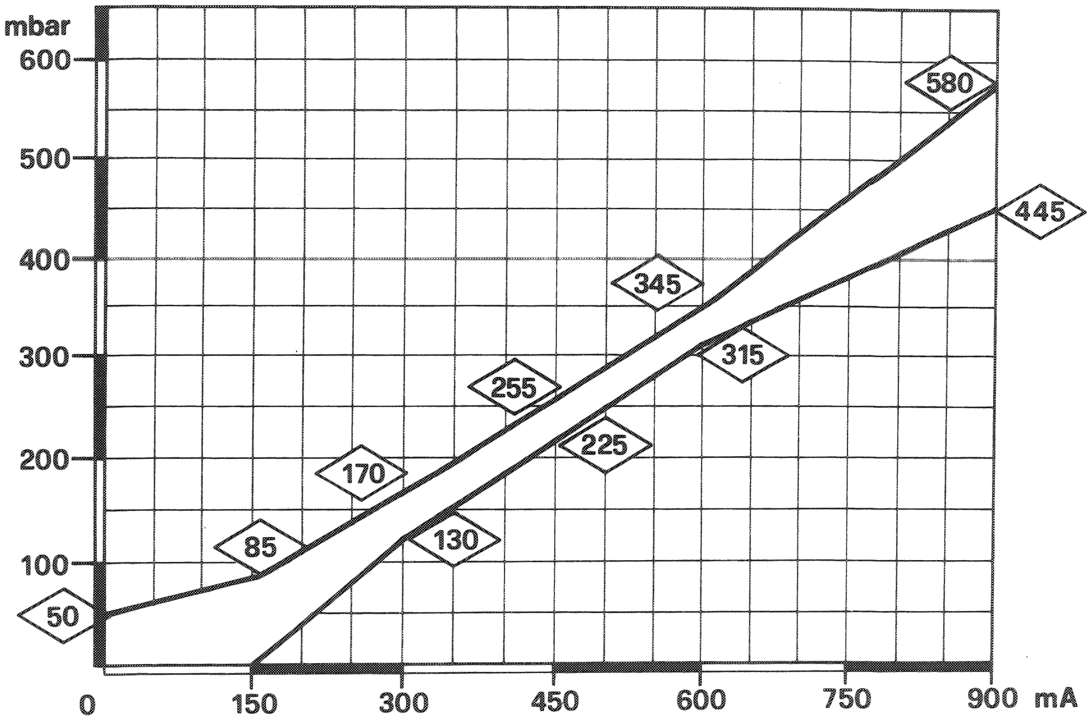
P3M16EJ01



P3M16EJ02

Regulation stage

When engine service conditions alter, the ECU sends a different Duty Cycle signal to the Borg Warner solenoid.
As the Duty-Cycle increases, the average current increases and also the force of attraction on plunger plate (3).
Under these new conditions, chamber B is brought into communication with duct A at a higher vacuum level to overcome the electromagnetic force of the coil.
The cycles repeat themselves to maintain a vacuum in chamber E as a function of the Duty-Cycle alone.
The vacuum that controls and modulates the opening section of E.G.R. valve therefore depends solely on the signal sent from the ECU.



P3M17EJ01

Pierburg EGR valve

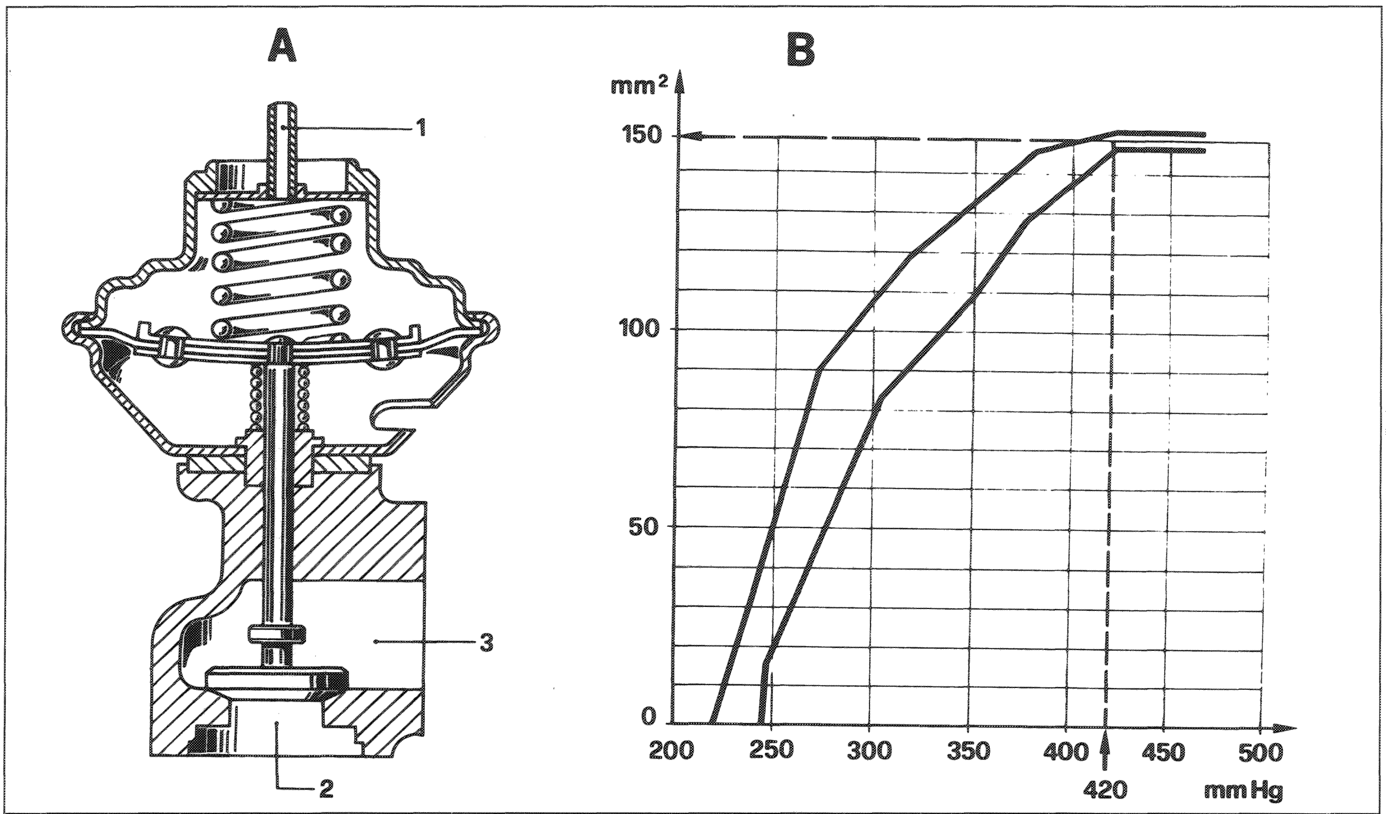
This valve is governed by a vacuum generated by the brake servo vacuum pump and modulated by the Borg Warner modulator solenoid.
The EGR valve is governed as follows:

- if, as a result of the signal from the ECU, the modulator solenoid puts duct (1) under a vacuum, membrane (2) lifts together with associated plunger (3) to open up the flow of gas according to the pressure in duct (1). This then allows a certain quantity of exhaust gas to recirculate to the intake manifold;

- if not excited, the solenoid brings duct (1) into contact with the atmosphere to bring about the closure of plunger (3). This prevents the recirculation of exhaust gas in order to ensure efficient engine operation when cold, idling and under medium-high load conditions.

10.

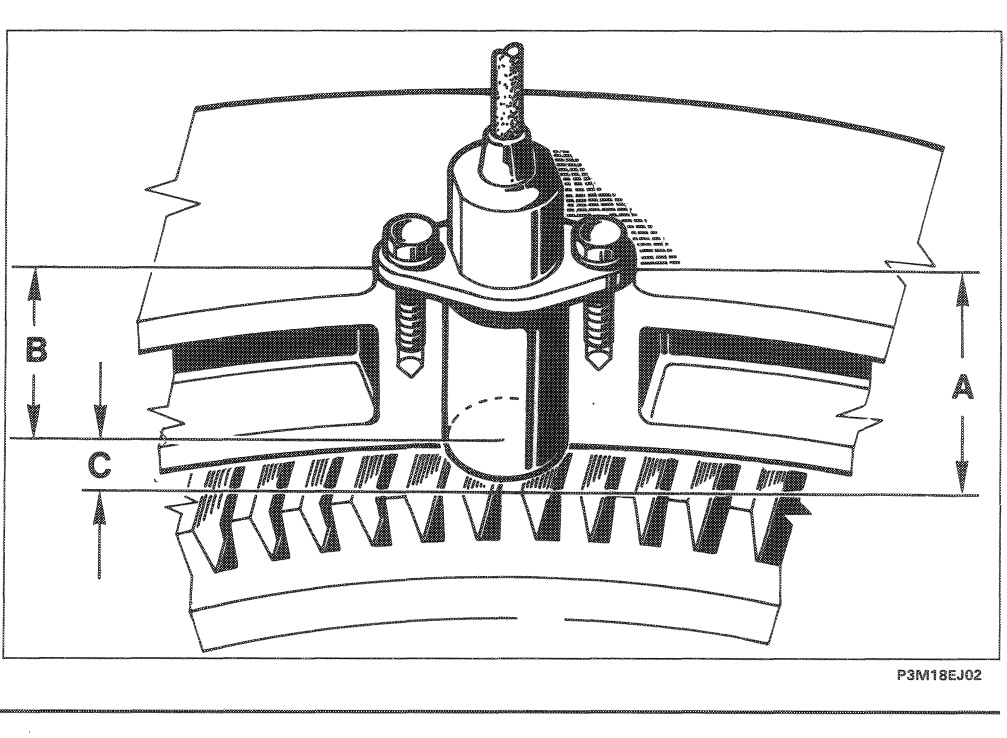
The exhaust gas passage cross section is a function of the modulated vacuum level, that reaches duct (1), as described roughly on diagram (B). The vacuum levels are shown in mmHg on this rough graph Full 150 mm opening of the EGR valve is obtained at vacuum levels in excess of 420 mmHg.



P3M18EJ01

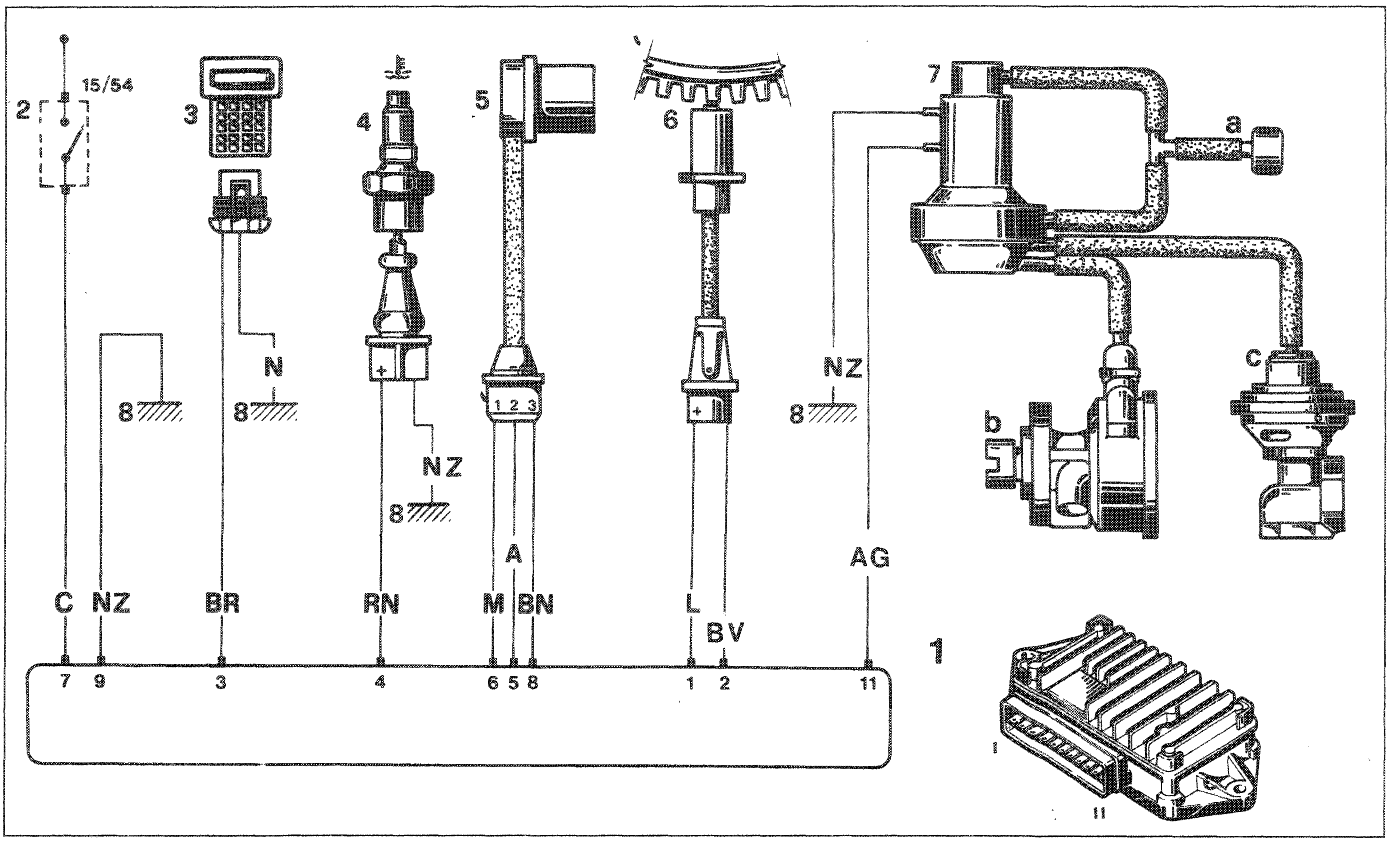
Checking rpm sensor gap

1. Remove the sensor from its seat on the gearbox bell housing.
2. Use a gauge to measure the gap A (distance between sensor seat and tip of flywheel ring gear teeth).
3. Measure gap B on sensor.
4. Gap C, determined by A - B must be between 0.25 - 1.3 mm.
5. The resistance value of the sensor coil must be equivalent to 680 ± 100 Ω.



P3M18EJ02

Diagram of electro-pneumatic system



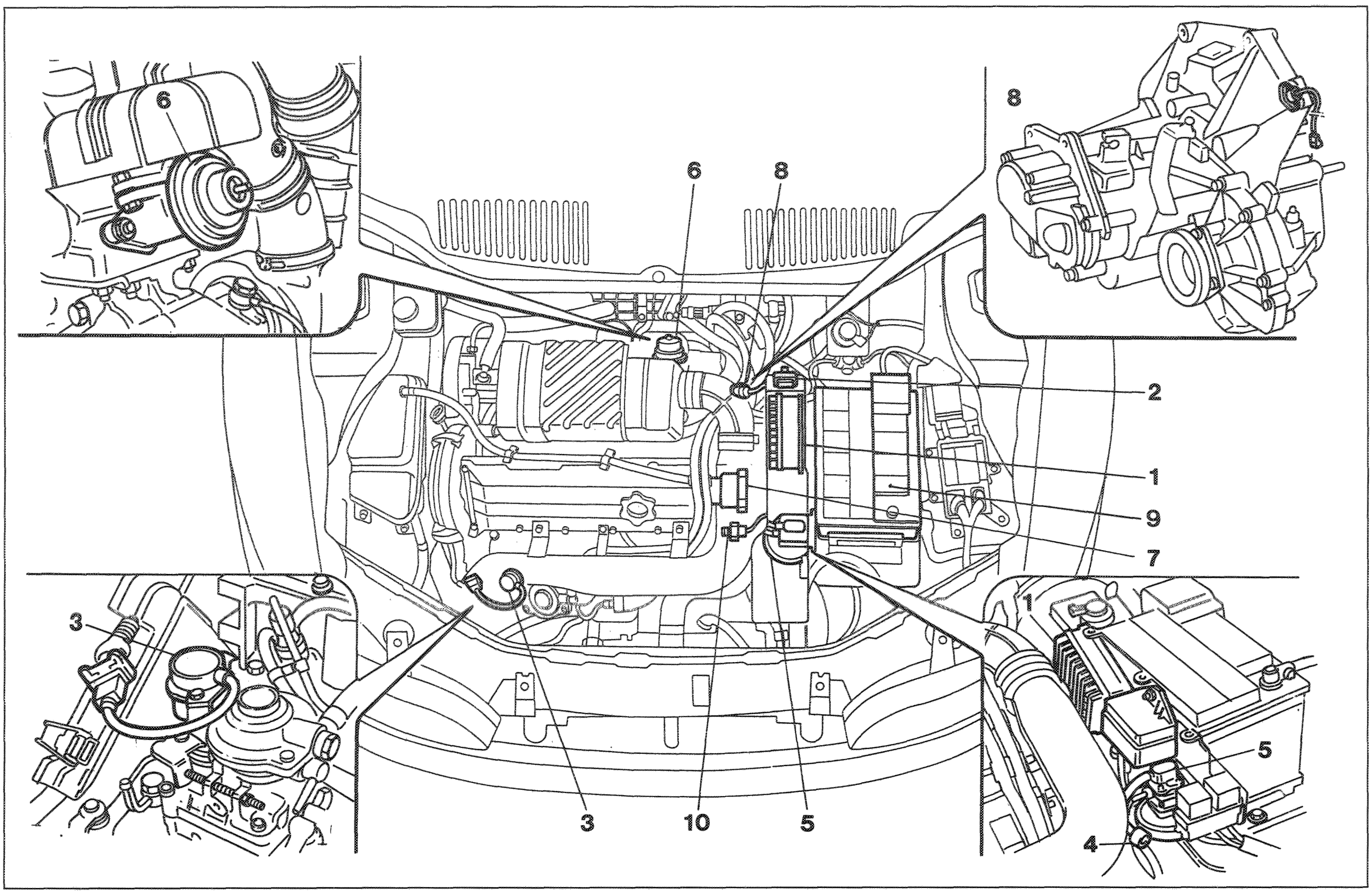
P3M19EJ01

1. Control unit Marelli MCR 102 A
2. Ignition switch
3. Diagnostic socket for FIAT-LANCIA Tester
4. Coolant temperature sensor
5. Accelerator lever potentiometer
6. Engine rpm sensor
7. Borg Warner modulator solenoid
8. Earth plate

a. Atmospheric intake filter for Borg Warner modulator solenoid
b. Vacuum pump for brake servo
c. Pierburg EGR valve

0.

LOCATION OF EGR SYSTEM COMPONENTS ON VEHICLE



P3M20EJ01

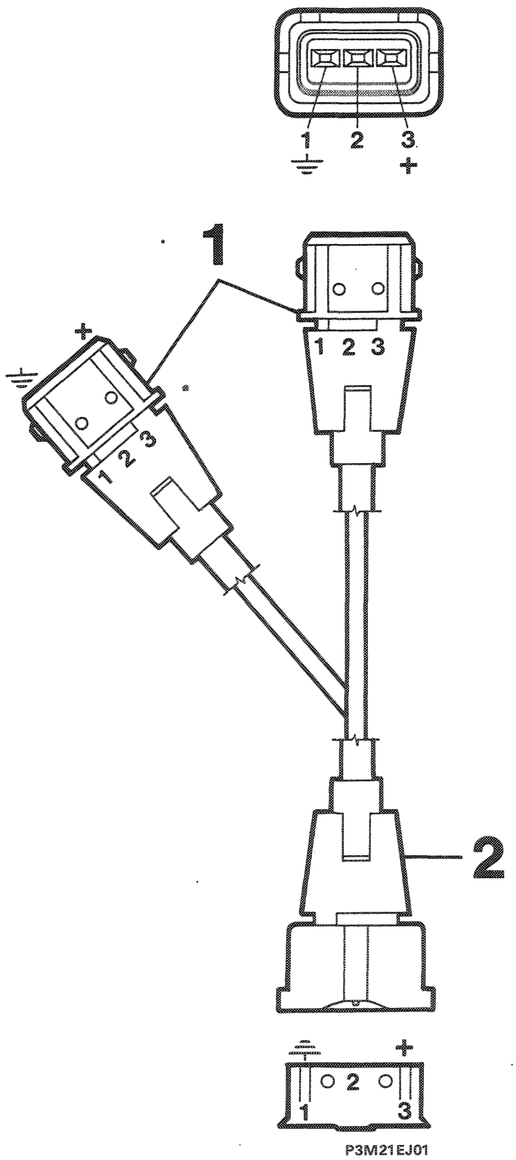
1. Control unit Marelli MCR 100 A
2. Diagnostic socket for FIAT-LANCIA Tester
3. Accelerator lever potentiometer
4. Atmospheric intake filter for Borg Warner modulator solenoid
5. Borg Warner modulator solenoid
6. Pierburg EGR valve
7. Vacuum pump for brake servo
8. Engine rpm sensor
9. Battery
10. Coolant temperature sensor

DIAGNOSES AND CHECKS ON EGR EMISSION CONTROL SYSTEM

A complete electronic diagnosis can be carried out on the EGR system using a Fiat/Lancia Tester with memory module M11-B and adaptor ADT 101A. For workshops not equipped with the Tester, the procedure for checking and adjusting the potentiometer responsible for modulating the signal to the ECU for EGR system control is described using a digital voltmeter with centesimal resolution.

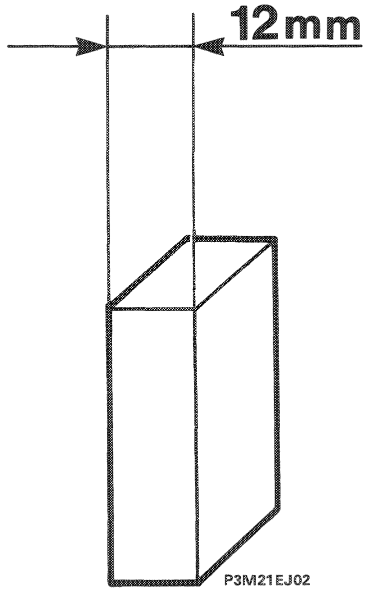
Foreword

The operations described below should be carried out on the vehicle after making a braid (unless one is available) to be connected between the connectors of ECU-potentiometer connection lead for parallel recording of the voltage to the potentiometer terminals, and a gauge for checking the 12 mm shim to be inserted between the tab on the rpm variator and the stop screw (see details on following pages). Specifications for building the two parts are described below.



Connection braid

1. Bosch minitimer connector
   N° 1254487003
   Cap N° 1280703022
   Contacts N° 1280703022
2. Bosch minitimer connector
   N° 1284485112
   Cap N° 1280703022
   Contacts N° 1/23341/44

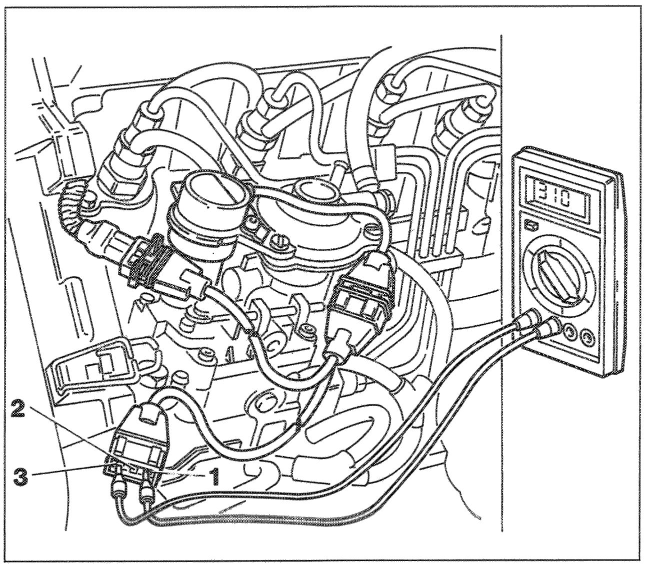


Feeler gauge

10.

Checking and adjusting potentiometer position on injection pump

The operations below should be carried out on the vehicle after checking that idle speed is correct (900 ± 20/min). Also check that battery voltage is about 12.50 V (with engine off).

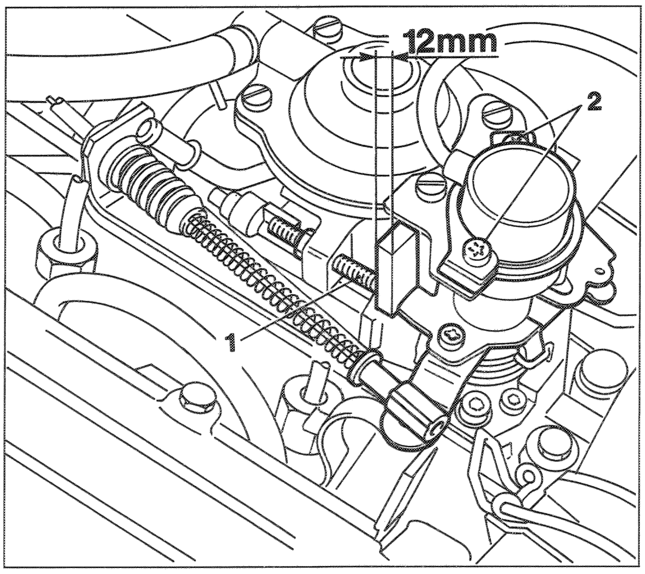


1. Insert braid for measuring voltage in parallel between connectors of ECU-potentiometer connection cable.

2. Supply the ECU by turning on panel. Using a digital voltmeter (with centesimal resolution) measure the supply voltage by connecting + to terminal 3 and – (earth) to terminal 1, when reading should be 3.70 ± 0.2 V.

If it is not, check and eliminate any false contacts, wiring breaks and short circuits to earth.

If voltage value is still incorrect, replace ECU.



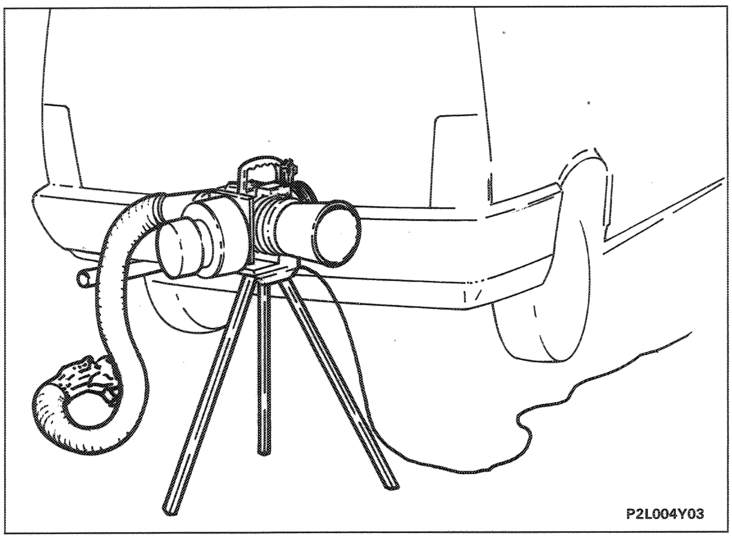
3. Position 12 mm feeler gauge between tab on rpm variator lever and stop screw (1).

   Then measure modulated voltage output from potentiometer, by connecting voltmeter to + of terminal 2 and – (earth) to terminal 1, when reading should be 2.4 ± 0.05 V.

If voltage reading is not as specified, position potentiometer correctly:

- loosen the two screws (2) retaining potentiometer to support bracket;
- turn potentiometer angularly in one direction or another until the exact output voltage is obtained (2.4 ± 0.05 V);
- tighten the two potentiometer retaining screws;
- after tightening, check modulated voltage value at potentiometer outlet.

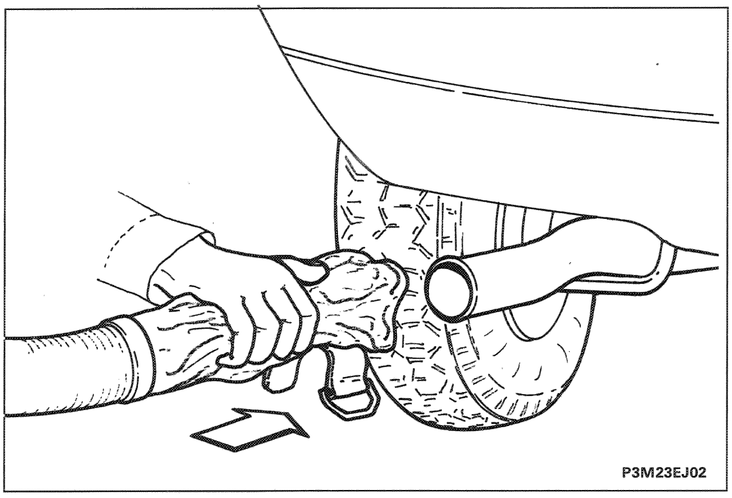
- After checking/positioning potentiometer, remove 12 mm gauge and let rpm variator lever come into contact with the idle stop screw.
  Under these conditions, measure modulated potentiometer voltage output, which should be 1.1 ± 0.2 V.
- If the test result is positive, carry out a further check. This involves turning the rpm variator lever slowly from MINIMUM to MAXIMUM and measuring output voltage at the same time on the voltmeter 1.1 ± 0.2 V (MIN position) at 3.50 ± 0.2 V (MAX position).


P2L004Y03

CHECKING EXHAUST SMOKE USING OPACIMETER

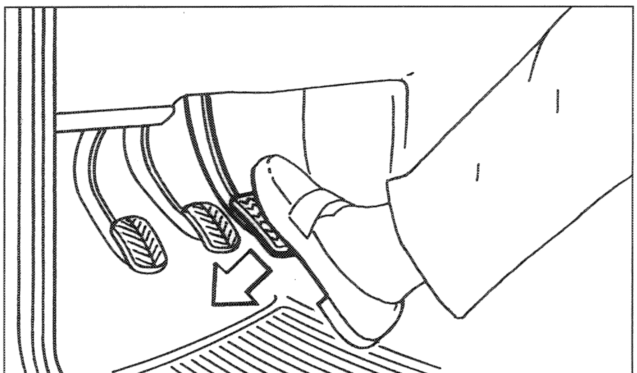
Start up vehicle engine and allow to warm up to service temperature (radiator cooling fan comes on twice).

Position opacimeter measurement unit firmly near the vehicle exhaust pipe (place opacimeter fume exhaust down wind)


P3M23EJ02

Connect hose of measurement unit to vehicle exhaust pipe.

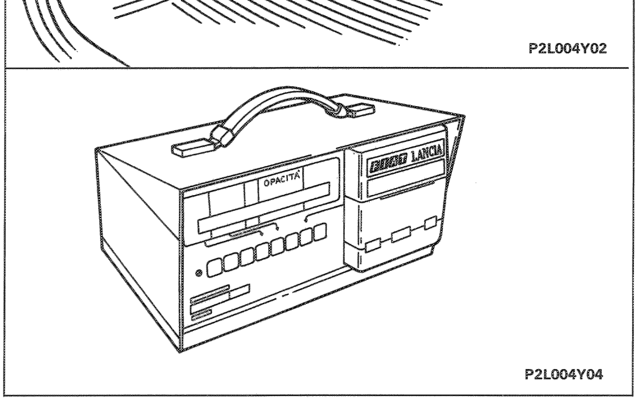
Connect and adjust equipment as instructed by the Manufacturer.


P2L004Y02

Pump accelerator pedal three times quickly to the floor until rpm limiter threshold speed is reached.

Carry out measurements over five successive full accelerator pedal pumps.
Note maximum values achieved.
Take the arithmetic mean of the three closest readings to obtain the test result.

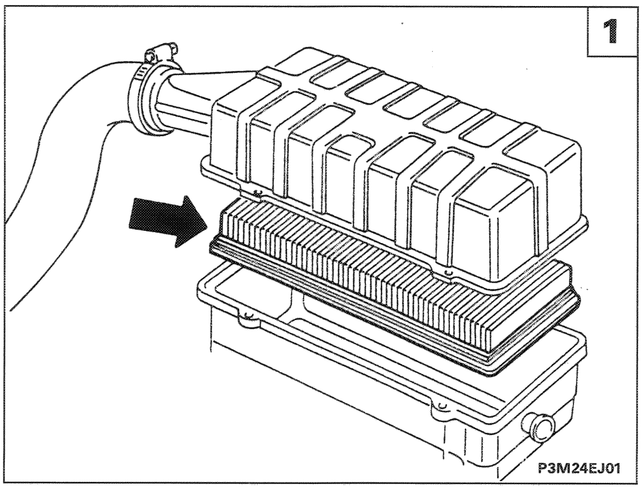
If more than one set of three readings is suitable, choose the one with the highest mean.



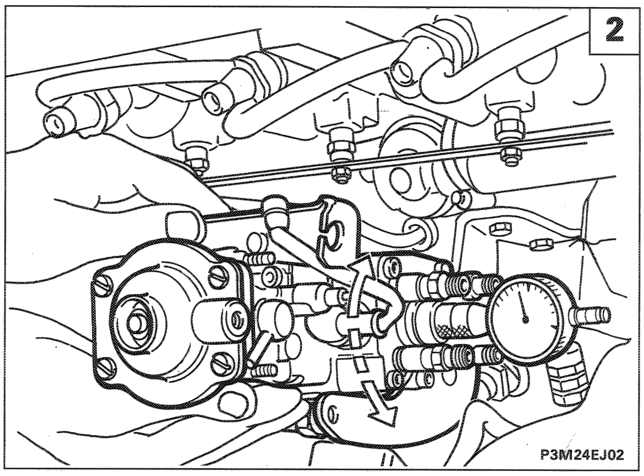
P2L004Y04

If exhaust smoke level exceeds 70%, carry out the tests desribed overleaf.

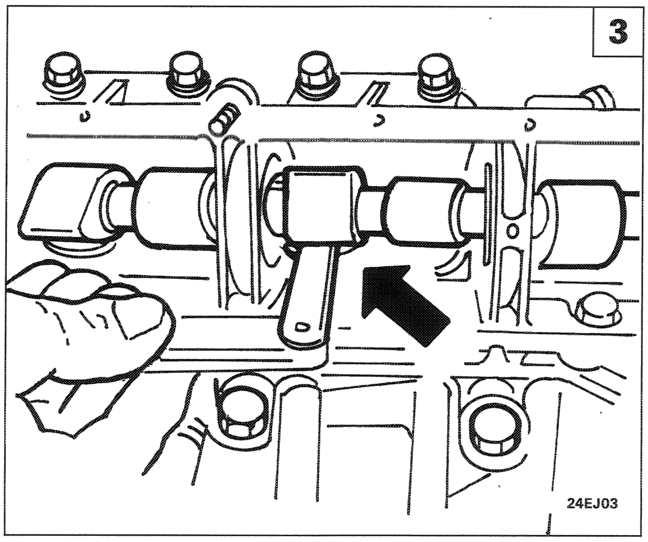
10.



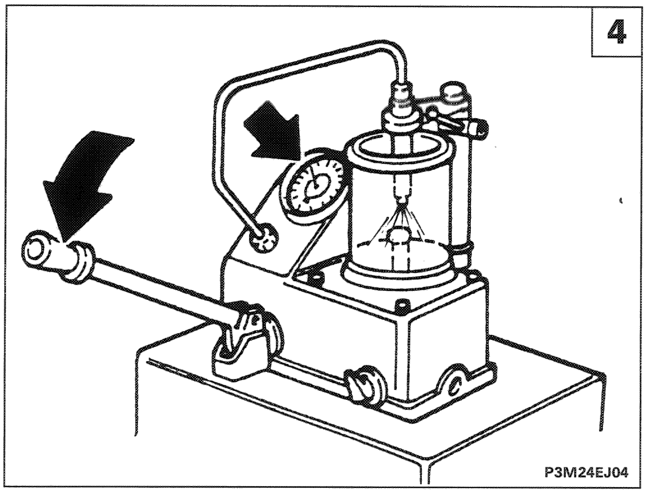
Check air cleaner condition



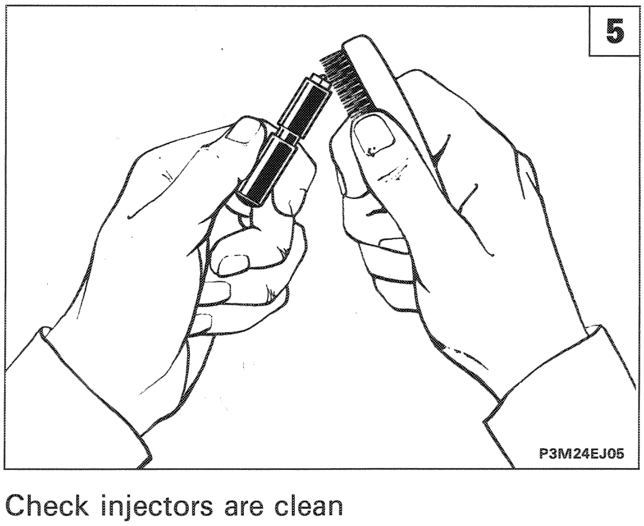
Check injection pump timing and/or output



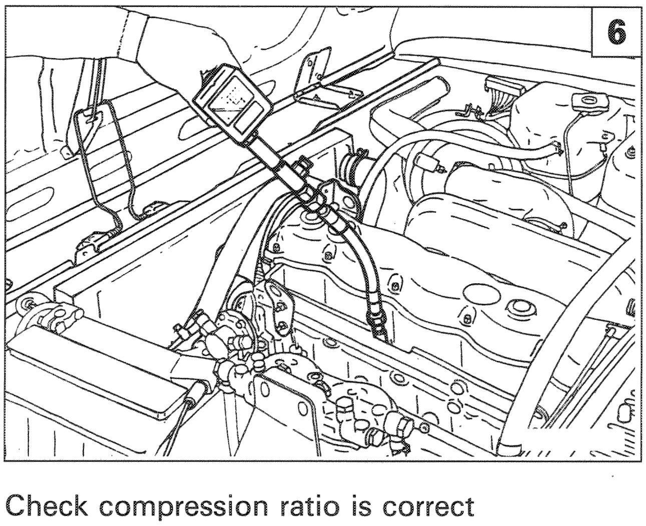
Check valve clearance and/or timing



Check injector setting



Check injectors are clean



Check compression ratio is correct

The numbers at the top of each illustration indicate the progressive order of operations.

EEC STAGE 2 FUEL SYSTEM (CF2)

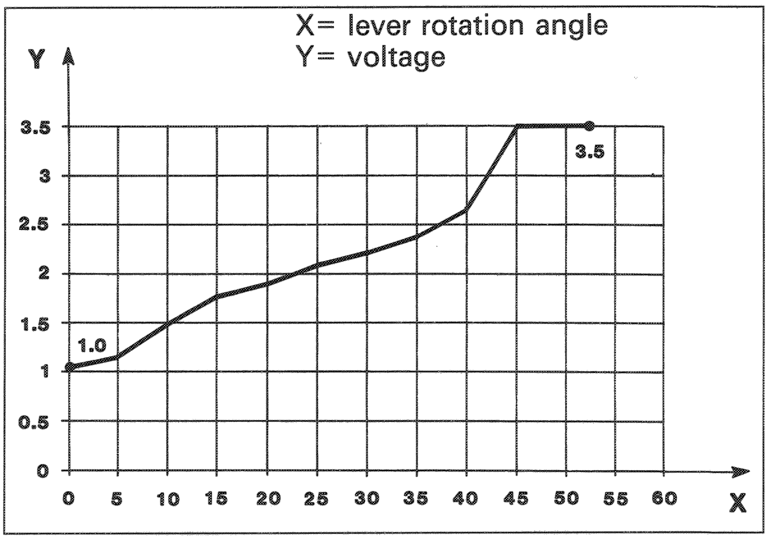
The rational, well laid-out design of the fuel and emission control systems fitted to the 1698 TD CAT version of the Punto had already achieved optimal results.
Despite this, certain slight improvements have nevertheless been made; particularly to the exhaust gas recirculation system (E.G.R.).
A microprocessor in the control module (coded MARELLI MCR102.B) contains mapped settings for the new E.G.R. valve, which enable it to control the modulator valve.
This system allows a proportion of exhaust gases (5-15%) to be directed to the intake under certain engine service conditions, i.e. with medium-low loads, when the air-fuel ratio is very high and engine operation is not impaired by the presence of inert gas in place of air. In this way we are able to achieve the objectives laid down by new regulations under directive 94/12/CE (EEC STAGE 2) as the following table shows.
Ordinary engine maintenance does not involve any action to control the above values because levels automatically fall within specified tolerance ranges provided instructions given in this section of the Manual are observed.

	HC+NOX	CO	PART
Stg. 1	0.87 gr/Km	2.10	0.124 gr/Km
Stg. 2	0.70 gr/Km	1.00	0.080 gr/Km

Comparison of emission levels

Accelerator lever potentiometer on injection pump

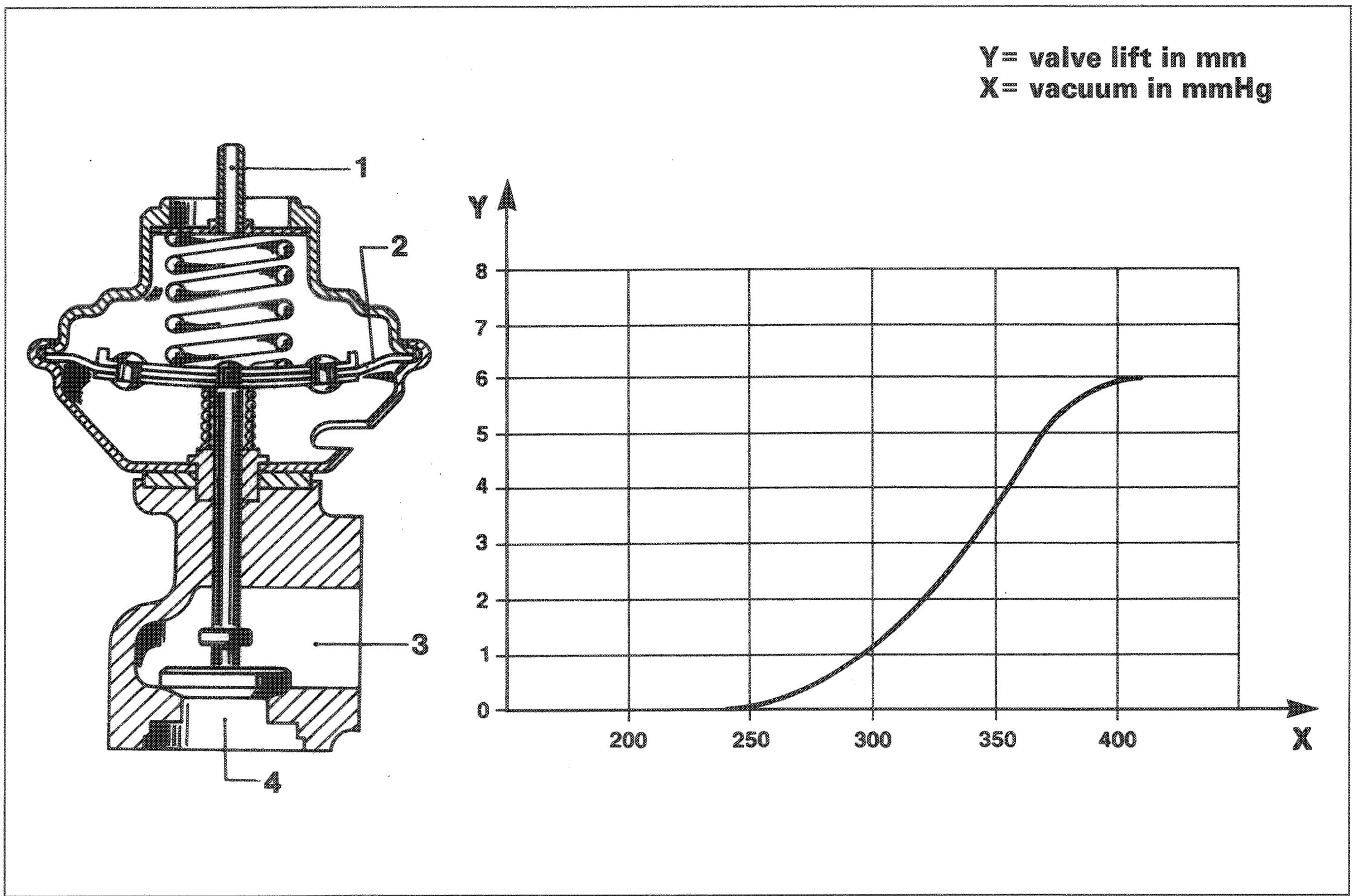
Potentiometer electrical output signal is another factor governed by the control module that is important for effective engine operation. The following table shows variable voltages obtained at the outputs. Because lever rotation alters internal potentiometer resist, a constant output of 3.7±0.2V from the control unit will therefore give rise to output voltages ranging from 1-1.00V with engine under minimum load; 3.50-3.55V with engine under maximum load.
Continue to check and adjust the potentiometer as described on page 22.



P3M25EJ01

E.G.R. VALVE.

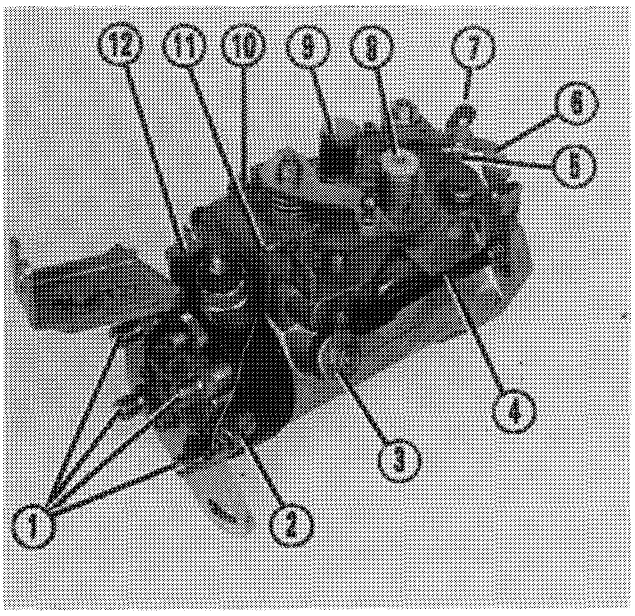
Noxious exhaust emission levels have been further reduced by adopting a new Pierburg EGR valve with exhaust duct diameter reduced from 16 mm to 10 mm. This helps meter exhaust gas flow more effectively and modulate valve opening.
If the vacuum is sufficient, this valve opens to bring the exhaust manifold into communication with the inlet manifold. Recirculated gas quantity can be altered by regulating opening of the Pierburg EGR valve continuously by adopting opening levels mapped on the basis of signal input.
The E.G.R. valve opens fully (6 mm) with vacuum levels greater than 420 mmHg.



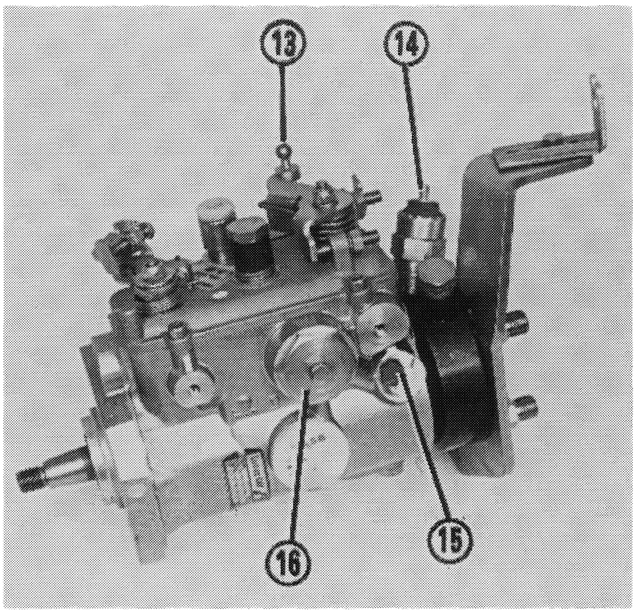
P3M26EJ01

NOTE *The E.G.R. valve differs from the previous version applied to the USA '87 system in its diameter (4) (shown in figure), which is reduced from 16 mm to 10 mm.*

INJECTION SYSTEM WITH LUCAS FT 08-CAV-ROTODIESEL PUMP



P3M01IJ01

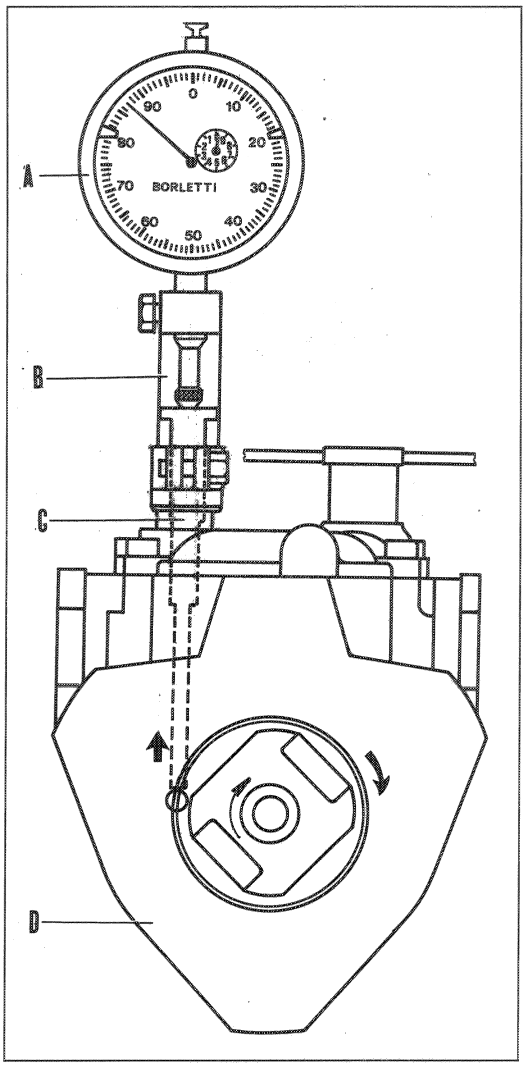


P3M01IJ02

1. Delivery line fittings (with delivery valves incorporated)
2. Transfer pressure valve (*)
3. Advance valve for choke (manual control)
4. Choke advance valve control rod
5. Idle adjustment screw
6. Fast idle control lever
7. Stop lever for fuel cut-off
8. Fitting for adjusting pump timing on engine
9. Fitting for diesel return line to tank
10. Anti-stall adjustment screw
11. Maximum speed adjustment screw
12. Fitting for diesel delivery line from tank
13. Accelerator control lever
14. Solenoid for engine arrest
15. Enrichment flow cut-out or supplement valve
16. Automatic advance device

(*) This valve performs the following functions:
   a. Creates transfer pressure generated by vane pump
   b. Controls transfer pressure on the basis of engine rpm
   c. Allows pump to fill with diesel during start-up (priming)

10.



P3M02IJ01

ADJUSTING PUMP TIMING ON VEHICLE

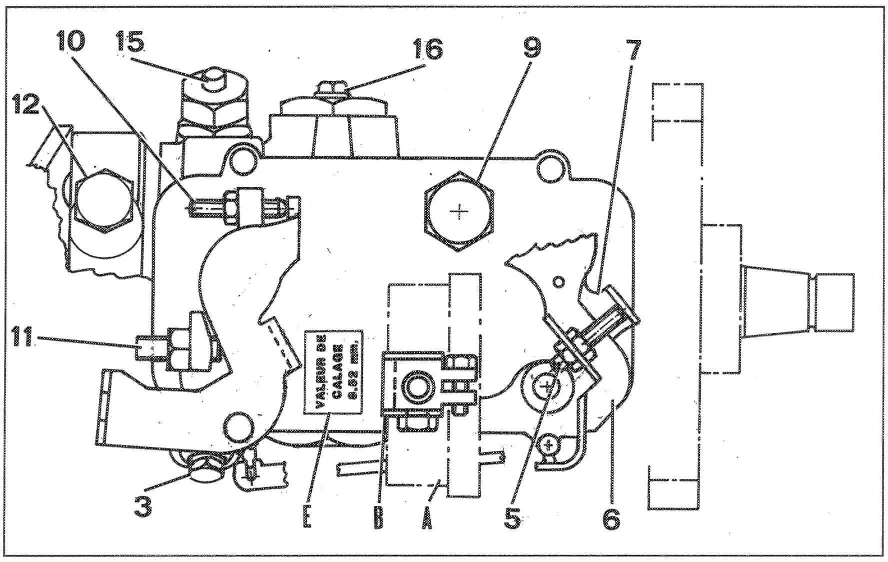
Fitting pump and checking advance on engine

Tools required: n° 1865091000 comprising probe stylus (C), mount (B) and centesimal dial gauge (A).
*Pump must also bear label (E) glued to the top. Above this is the installation gap in mm preceded by wording in French (*valeur de calage*).*

Fitting injection pump

- Move crankshaft to a position close to TDC.
- Fit injection pump (D) to its mount, aligning pump gear ridge with grooves inside pump drive shaft. Do not tighten nuts fastening pump to mount.
- Remove plastic cap from top pump cover
- Turn crankshaft against direction of rotation through about 20°.
- Tighten tool (B), with probe (C) and centesimal gauge (A), into threaded socket.

NOTE *Probe (C) fits into a seat on the pump and not against the pump distributor or rotor.*



P3M02IJ02

The gap between the pump seat and the position of a distributor (rotor) dowel allows pump to be adjusted correctly in relation to the engine when the stylus touches the dowel as the pump is turned. The installation gap is indicated on label (E) on each pump.

5. Idle adjustment screw
7. Idle and fuel cut-off control lever
10. Anti-stall adjustment screw
11. Maximum speed adjustment screw

- Fasten dial gauge (A) to push-rod (C), making sure that dial gauge is fitted with a preload of 10 - 15 mm, then zero.
- Turn pump in its slots and move top of pump away from cylinder assembly (maximum delay).
- Turn crankshaft in its direction of rotation until piston no. 1 is moved exactly to TDC.

Never turn crankshaft against direction of rotation, otherwise tool or pump could become damaged.

- Read gap off dial gauge, then turn pump slowly in slots until dial gauge shows exact installation gap shown on pump label (e.g. 8.52 mm).
  Now tighten pump retaining screws fully.

FINAL CHECK

- Turn the crankshaft in its direction of rotation through several revolutions (at least 2) until piston no. 1 is exactly at TDC: the dial gauge reading must correspond to gap printed on pump label.
  Otherwise, repeat procedure described previously with greater precision.

ADJUSTMENTS WITH PUMP FITTED TO VEHICLE

Before adjusting pump, engine must be at service temperature, i.e. radiator cooling fan must have come on at least twice.

Anti-stall speed adjustment

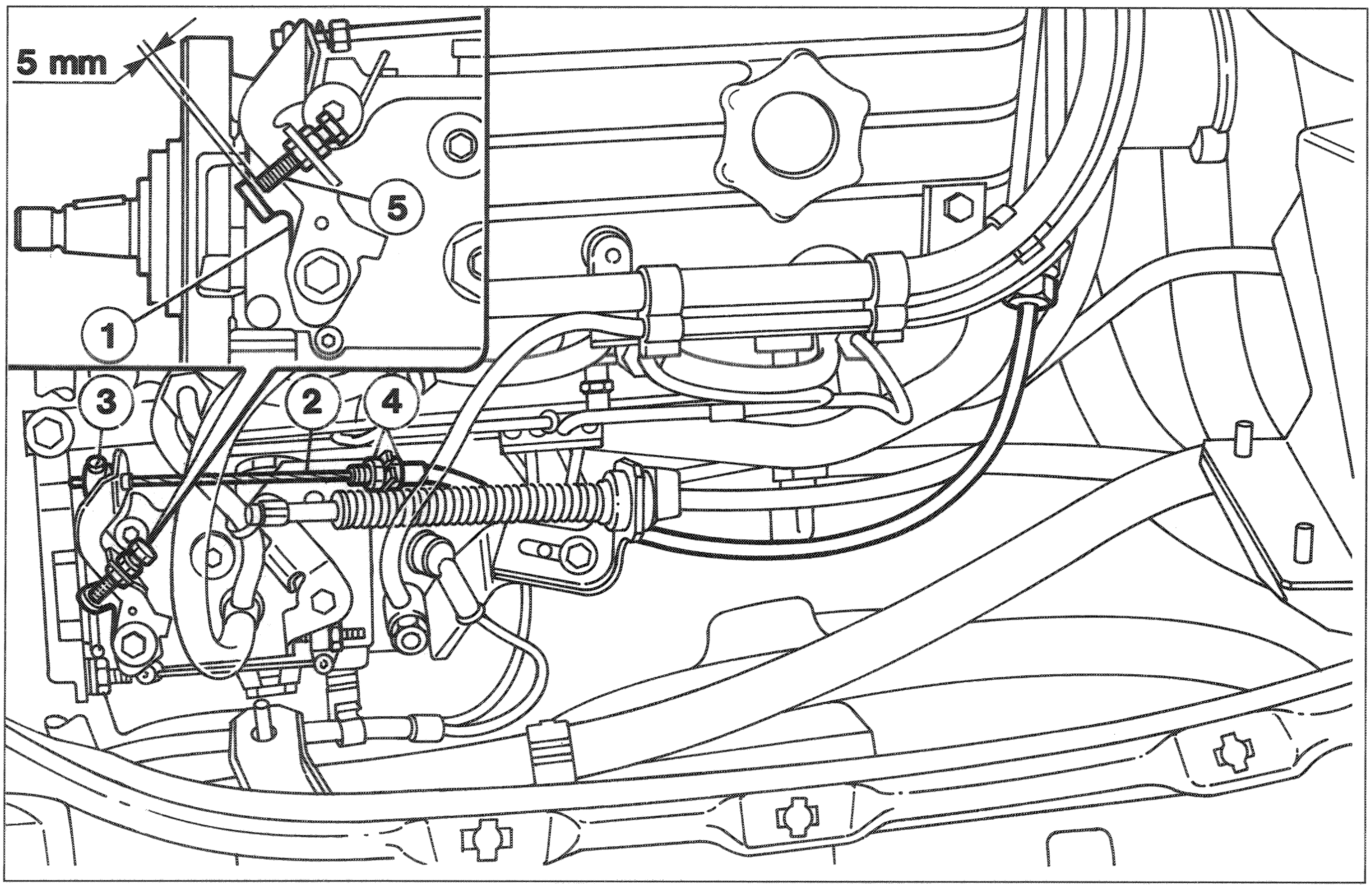
1. Interpose a spacer measuring exactly 2 mm between anti-stall adjustment screw (10) (see figure on previous page) and accelerator control lever.
2. Turn on engine and adjust speed to 1600±100 min, using a 3 mm socket wrench to turn anti-stall adjustment screw (10).
3. Remove 2 mm spacer.
4. Adjust idle speed to 810±20/min by means of idle adjustment screw (5) after loosening locknut. After adjustment, tighten idle adjustment screw locknut.
5. Move idle control and fuel cut-off lever (7) by hand (see figure on previous page) toward cut-off position by 0.5 - 1 mm. The engine should tend to stall or at least speed should drop. If this does not occur, repeat the previous adjustments described at points 1 - 2 - 3 - 4 to obtain a new engine speed that still lies between 800-1000/min: then repeat test until a positive result is obtained.

10.

CHECKING ANTI-STALL SCREW SETTING

Accelerate engine to maximum speed, then release accelerator completely: speed should drop steadily to idle level without fluctuations or judder. Otherwise adjust anti-stall screw as follows:

- if deceleration is too slow (deceleration time from maximum to minimum with no load should be 3-4 seconds), adjust anti-stall adjustment screw (10) (see figure on page 2),
- if deceleration is too fast, tighten anti-stall adjustment screw (10) to achieve required deceleration.



P3M04IJ01

CHECKING AND ADJUSTING AUTOMATIC FAST IDLE DEVICE

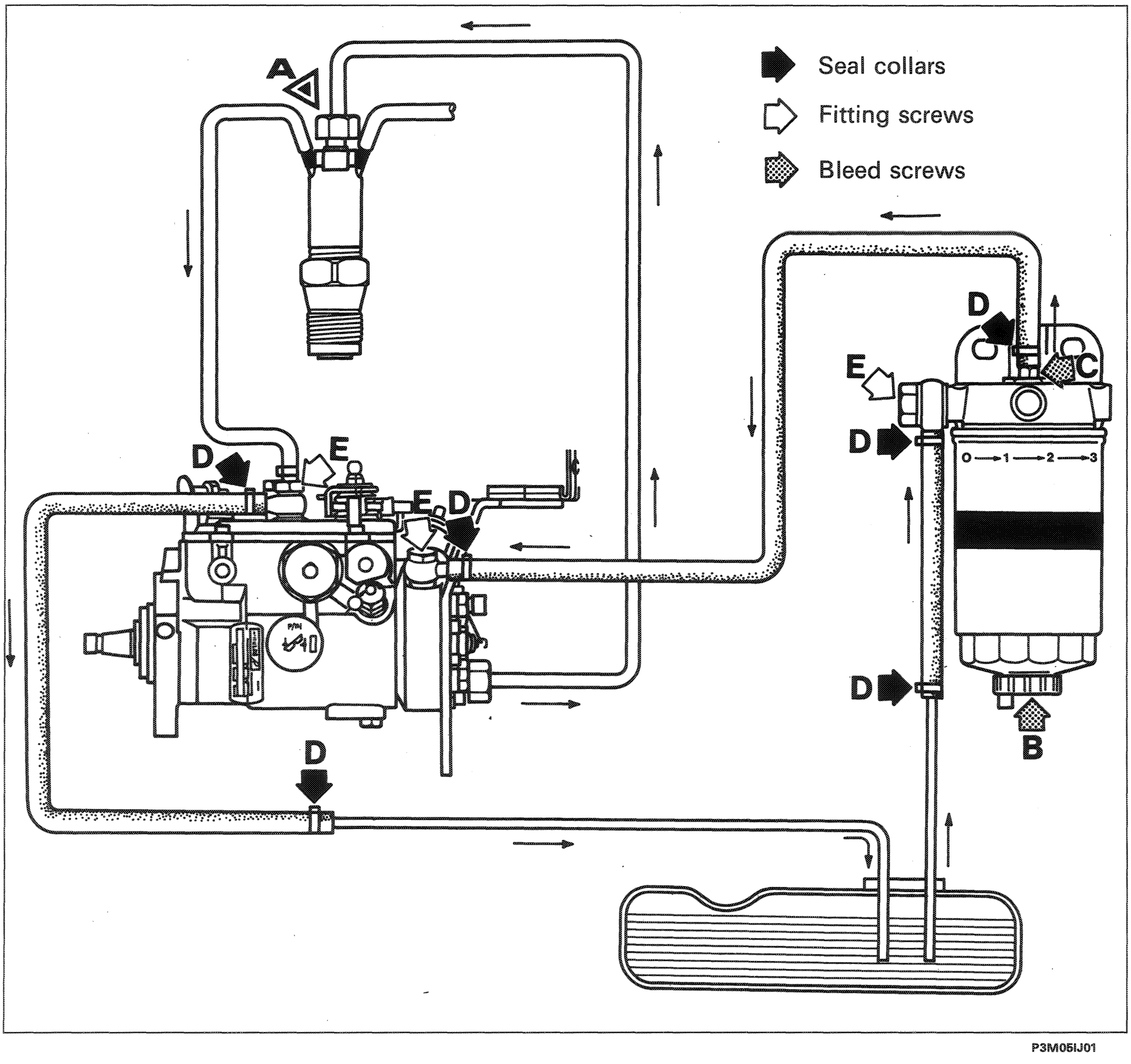
With engine cold, automatic fast idle speed should be 1050 rpm with a gap of 5 mm between end of lever (1) and adjustment screw (5). If gap is not 5 mm, correct by adjusting nut and lock-nut (4). If a 5 mm gap cannot be obtained even following adjustment, adjust bush (3) anchoring cable (2) to automatic fast idle lever (1).

NOTE *When resetting the system, move lever to the end of its travel. Device will then settle in normal position when coolant temperature reaches 60 °C.*

BLEEDING PUMP HYDRAULIC CIRCUIT

If engine stalls due to lack of fuel or if fuel low pressure lines have been disconnected or fuel filter has been changed, proceed as follows to facilitate pump self-priming:
- unscrew fittings fastening delivery lines to injectors (A);
- start engine and run until fluid emerges from open injector fittings;
- keep engine running and tighten injector fittings.

If engine will not start, check all fuel inlet pipe union points (D) and also fittings (E). Replace seal washers to eliminate the possibility of air leaks.



P3M05IJ01

NOTE *Only use LUCAS diesel case/filter and lines to avoid faults in system.*

Adjusting engine top speed

Move accelerator control lever fully to end of its stroke; if top speed of 5150±50/min is exceeded, tighten top speed adjustment screw until engine rpm is as specified. Then tighten locknut of screw (11) and apply seal.

Bleeding water from diesel

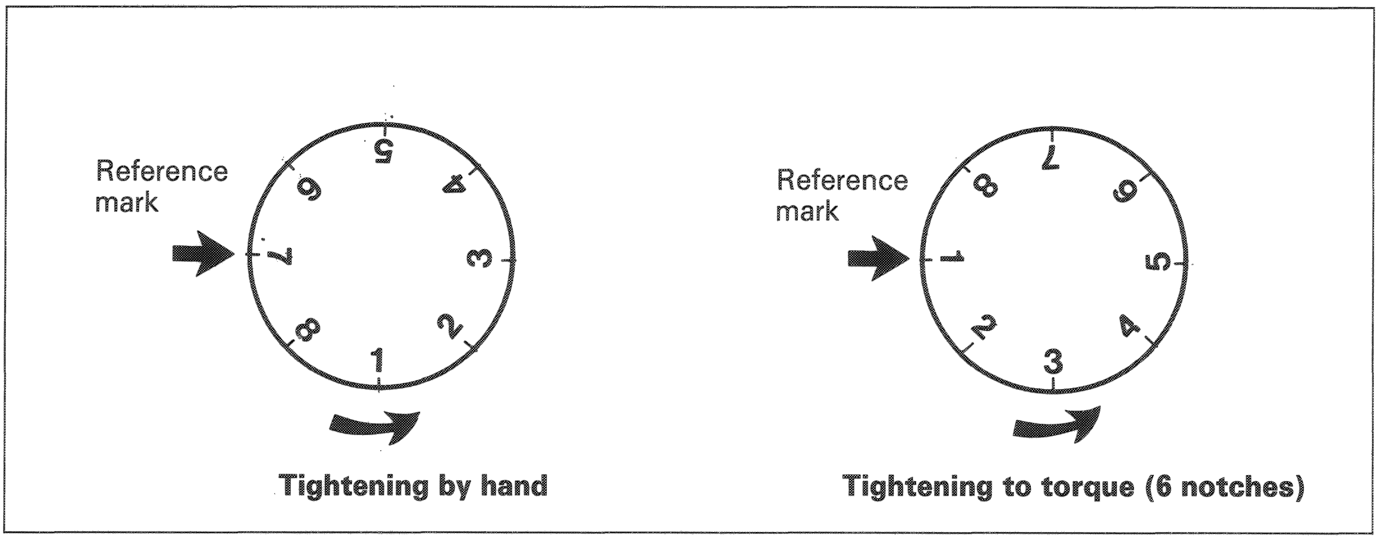
Each time the oil is changed, bleed off the water from the fuel filter as follows:
- unscrew water bleed screw (B) under filter,
- unscrew air bleed screw (C) above the filter.

Let water and fuel emerge until no more water is present, then tighten water bleed screw (B) and air bleed screw (C).

Replacing cartridge fuel filter

Change diesel filter every 15,000 km. Proceed as follows to change:
- lubricate rubber cartridge seal,
- fill filter cartridge with diesel (in order to reduce self-bleeding period),
- tighten cartridge until it touches the mount,
- tighten cartridge by 3/4 turn (to obtain torque of 1.3 - 1.6 daNm).

This is achieved using numbered notches engraved on the cartridge. For example when the cartridge is moved into contact with the mount, make a mark on the mount against one of the notches engraved on the filter. Then tighten filter through 6 further notches after the reference notch.



P3M06IJ01

FAULT DIAGNOSIS

Introduction

The main differences experienced when working on a Diesel engine, compared to a petrol engine, are as follows:

1) The diesel fuel system is driven by an injection pump and also comprises:
   - a tank and two fuel feed and return lines;
   - a fuel filter (with hand pump for bleeding fuel system);
   - injectors with inlet pipes;
   - preheating device for starting engine when cold;
   - an engine arrest device.

The injection pump is the most reliable part of the fuel system due to very low component wear and low likelihood of incorrect adjustment.
Engine failure should not immediately be attributed to the injection pump but more probably to one of the other fuel system components.

2) The combustion process within a Diesel spontaneous fuel self-ignition engine produces very high temperatures. Coupled with the fact that the fuel inevitably contains traces of sulphur, this determines:
   - greater tendency than petrol engines to produce sparks and thus greater wear on moving parts, particularly those close to the combustion chamber;
   - greater tendency of piston rings to become bonded in their seats.

It is very important to change the fuel filter every 15,000 km.
Use only specified lubricant oil grade and change engine oil every 15,000 km. (**) If vehicle is used under heavy conditions (mainly town driving, continuous mountain driving, towing of trailers or caravans, routes through dusty areas) change oil every 10,000 km.
Make sure injectors are always efficient in order not to increase production of uncombusted products during engine operation.

3) The combustion process in spontaneous self-ignition diesel engines also gives rise to higher engine noise levels (*) with the production of combustion knock clearly discernible from outside.
   Although this phenomenon has been greatly reduced in present-day engines with prechambers, it is still present, particularly at low speed, but tends to diminish at medium-high speeds.

   NOTE *If the injection pump is advanced only slightly in relation to correct timing setting, combustion knock is considerably accentuated.*

4) An indirect injection Diesel engine needs a prechamber preheating device (rapid glow plugs and ECU) to facilitate fuel self-ignition when the engine is cold and hence engine start-up.
   A special solenoid is used to turn off the engine (which occurs when the fuel supply to the injection pump ceases). This opens up fuel flow in the injection pump when the ignition key is in MARCIA position and turns it off when the ignition key is turned to STOP.

(*) Engine running noise: this is due to an excessive fuel pressure gradient, i.e. the ratio between pressure developed by combustion and corresponding crankshaft angles of rotation.

(**) Adopt SELENIA oil. If VS oils are used, change every 10,000 km and every 7,500 km in the case of heavy use.

10.

DIAGNOSING FAULTS IN DIESEL FUEL SYSTEM

This fault diagnosis table is applicable only if the engine is efficient and the electrical equipment has been properly checked.

ANOMALY	CAUSE	REMEDY
When warm, the engine will not start or starts with difficulty	Tank empty, ventilate blocked tank	Fill tank, check tank ventilation
	Water in fuel	Drain water from filter, clean filter and bleed air
	Air in fuel system	Bleed air and eliminate system air leaks
	Injection order does not correspond to combustion order	Fit pipes from pump to injectors in correct order
	Engine arrest solenoid short-circuited	Check electrical leads and/or replace solenoid
	Fittings loose, leaks from lines, pipes broken	Tighten fittings and eliminate leaks
	Injectors defective or excessively dirty	Clean injectors, check and/or replace
	Incorrect injection pump timing	Reset injection pump timing and adjust advance
	Incorrect injection pump setting	Check injection pump setting at test bench
When cold, engine does not start or starts with difficulty	Tank empty, ventilate blocked tank	Fill tank, check tank ventilation
	Water in fuel	Drain water from filter, clean and bleed
	Air in fuel system	Bleed air and eliminate leaks in sytem
	Heavy paraffin build-up in fuel filter	Change filter and use winter-type fuel
	Injection order does not correspond to combustion order	Fit injection pipes from pump to injector in the correct order
	Engine arrest solenoid short-circuited	Check electrical leads and/or replace solenoid
	Fittings loose, leaks from pipes, pipes broken	Tighten fittings and eliminate leaks
	Pre-heating circuit defective	Check glow plugs and ECU
	Injectors defective or excessively dirty	Clean injectors, check and/or replace
	Incorrect injection pump timing	Restore correct injection pump timing and adjust advance
	Incorrect injection pump setting	Check injection pump timing at bench

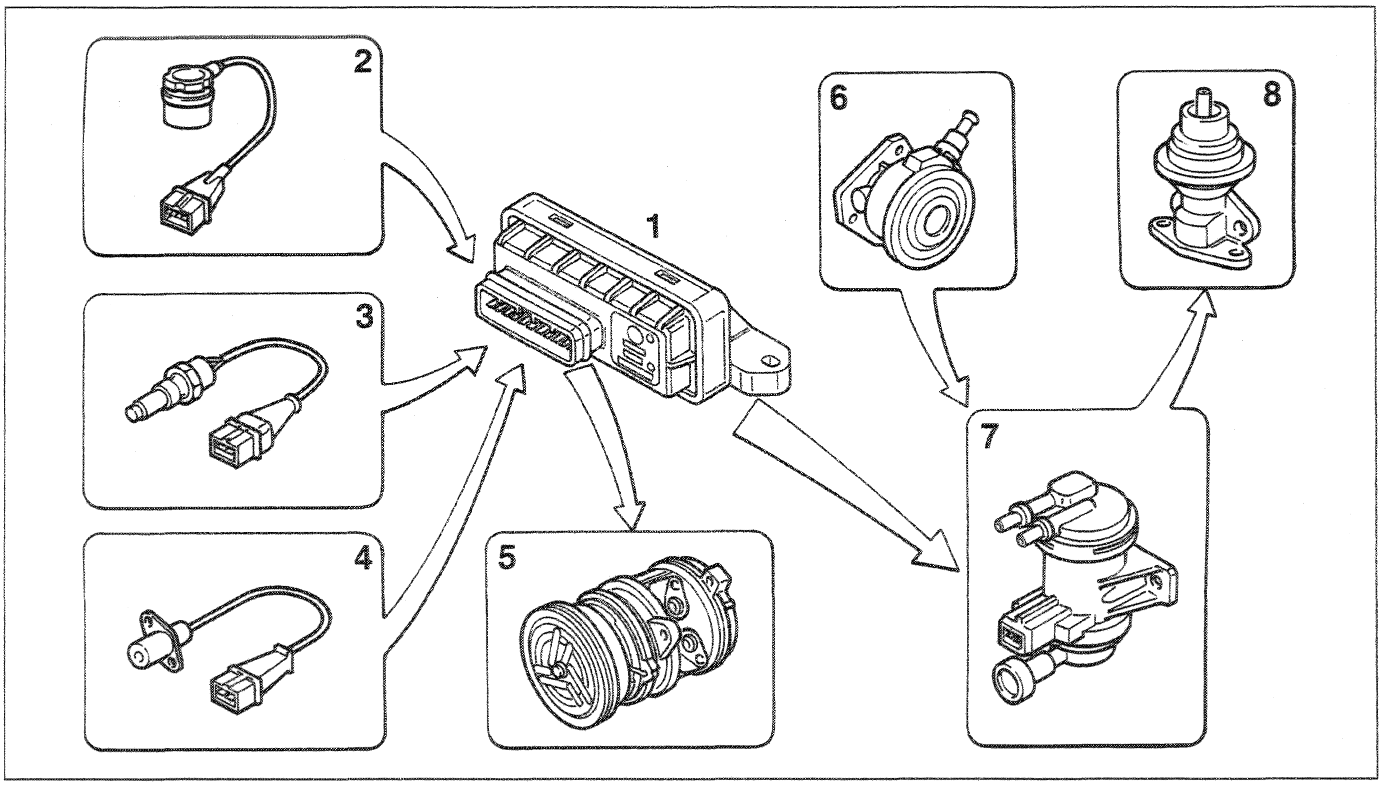
ANOMALY	CAUSE	REMEDY
Engine misses when idling	Fuel outlet and inlet fittings on injection pump exchanged	Fit fittings correctly
	Incorrect injection pump setting	Check injection pump setting at test bench
Uneven idling with engine warm	Injection order does not correspond to combustion order	Fit pipes from pump to injectors in correct order
	Air in fuel system	Bleed and eliminate air leaks into system
	Fittings loose, leaks from pipes, pipes broken	Tighten fittings and eliminate leaks
	Injectors defective or excessively dirty	Clean injectors, check and/or replace
	Incorrect injection pump setting	Check injection pump setting at test bench
Engine runs irregularly or misses	Tank ventilation defective	Check tank ventilation
	Fuel delivery and return lines on injection pump changed over	Fit fittings correctly
	Air in fuel system	Bleed and eliminate air leaks into system
	Fuel filter blocked	Replace filter
	Fittings loose, leaks from pipes, pipes broken	Tighten fittings and eliminate leaks
	Fuel and injection lines blocked or restricted	Check lines: repair or replace
	Water in fuel	Drain water from filter
	Incorrect injection pump timing	Restore correct injection pump timing on test bench
	Injectors defective or excessively dirty	Clean injectors, check and/or replace
	Incorrect injection pump setting	Check injection pump setting at test bench

ANOMALY	CAUSE	REMEDY
Engine not efficient (road performance unsatisfactory)	Tank ventilation defective	Check tank ventilation
	Injection order does not correspond to combustion order	Fit pipes from pump to injectors in correct order
	Fuel delivery and return lines on injection pump changed over	Fit fittings correctly
	Air in fuel system	Bleed and eliminate air leaks into system
	Fuel filter blocked	Replace filter
	Fittings loose, leaks from pipes, pipes broken	Tighten fittings and eliminate leaks
	Fuel and injection lines blocked or restricted	Check lines, repair or replace
	Air cleaner blocked	Replace filter element
	Engine does not reach maximum speed specified	Adjust top speed by means of screw on injection pump
	Injectors defective	Check and/or replace injectors
	Incorrect injection pump timing (delayed)	Restore correct injection pump timing and adjust advance
	Incorrect injection pump setting	Check injection pump setting at test bench
Excessive fuel consumption	Injection order does not correspond to combustion order	Fit injection pump lines in correct order
	Fittings loose, leaks from pipes, pipes broken	Tighten fittings and eliminate leaks
	Idle speed too high	Adjust idle speed by means of screw on injection pump
	Incorrect injection pump timing	Restore correct injection pump timing and adjust advance
	Incorrect injection pump setting	Check injection pump setting at test bench
Engine will not stop	Engine arrest solenoid short-circuited	Check electrical leads and/or replace solenoid

ANOMALY	CAUSE	REMEDY
Black smoke at exhaust	Injection order does not correspond to combustion order	Fit lines from pump to injectors in correct order
	Air cleaner blocked	Replace filter element
	Injectors defective	Check and/or replace injectors
	Incorrect injection pump timing	Restore correct injection pump timing and adjust advance
	Incorrect injection pump setting	Check injection pump setting at test bench
White smoke at exhaust	Tank ventilation defective	Check tank ventilation
	Fuel delivery and return fittings on injection pump changed over	Fit fittings correctly
	Air in fuel system	Bleed and eliminate air leaks into system
	Fuel filter blocked	Replace filter
	Fuel and injection lines blocked or restricted	Check lines, repair or replace
	Injectors defective	Check and/or replace injectors
	Incorrect injection pump timing (delayed)	Restore correct injection pump timing and adjust advance
	Incorrect injection pump setting	Check injection pump setting at test bench
Engine does not reach maximum rpm	Air in fuel system	Bleed and eliminate air leaks into system
	Injectors defective	Check and/or replace injectors
	Incorrect injection pump timing (delayed)	Restore correct injection pump timing and adjust advance
Excessive engine noise	Injectors defective	Check and/or replace injectors
	Incorrect injection pump timing (advance)	Restore correct injection pump timing and adjust advance

E.G.R. (Exhaust Gas Recirculation) BURNT GAS RECIRCULATION SYSTEM

Introduction The function of this system is to allow, under particular conditions of engine operation, the introduction of some of the exhaust gases into the inlet duct.
In this way the fuel mixture is diluted with inert gases, reducing the temperature peak in the combustion chamber, limiting the formation of nitrogen oxides (NOx).
The recirculation of some of the burnt gases is permitted only at medium-low loads, when the air-fuel ratio ratio is very high and engine operation is not impaired by the presence of inert gases in the fuel mixture.
The burnt gas recirculation system is controlled by an electronic control module (1) which receives as inputs signals from the potentiometer (2) located on the fuel injection pump throttle lever, the coolant temperature sensor (3) and the rpm sensor (4), and supplies as an output a signal to exclude the compressor electromagnetic coupling (only for versions with air conditioning) and to activate the E.G.R. control (7).
The modulating solenoid, which must be fitted in a vertical position, is connected not only to the control module, but also via pipes to the vacuum pump and the E.G.R. valve and to the atmosphere via a filter.
In accordance with the control signal received from the electronic module, the modulating solenoid sends more or less vacuum, provided by the brake servo vacuum pump (6), to the E.G.R. valve (8).
If the vacuum is sufficient, this valve opens, placing the exhaust manifold in communication with the inlet manifold, allowing the exhaust gases to pass.
The electronic module can therefore vary the quantity of burnt gases recirculated by continuously regulating the opening of the E.G.R. valve, working out the mapping of the degree of opening in accordance with the signals received from the sensors.



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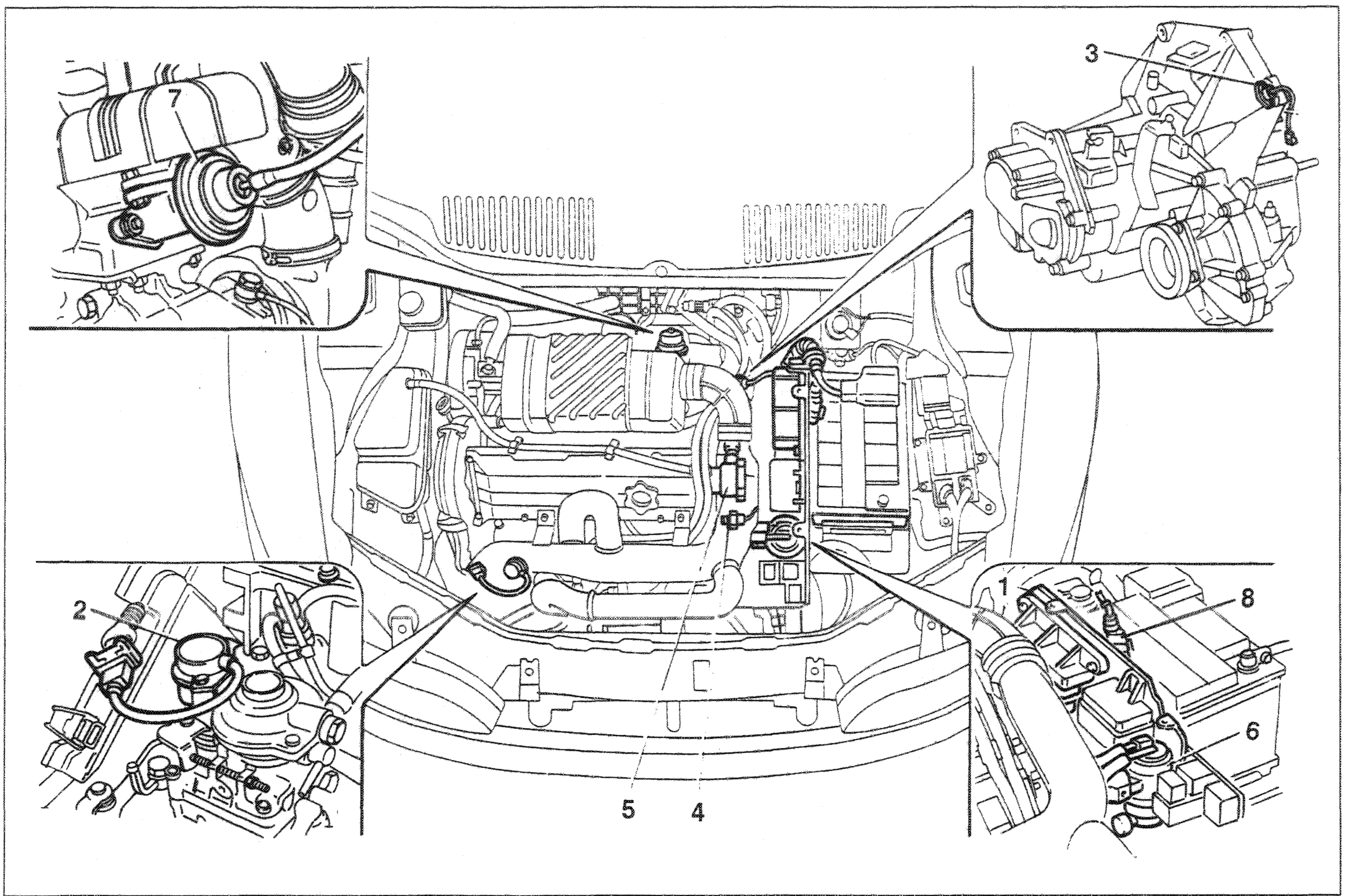
Components of the E.G.R. system

1. E.G.R. solenoid electronic control module;
2. Throttle lever potentiometer on fuel injection pump;
3. Engine coolant temperature sensor;
4. Rpm sensor;
5. Air conditioning compressor electromagnetic coupling;
6. Brake servo vacuum pump;
7. E.G.R. control modulating solenoid;
8. E.G.R. valve

10.

LOCATION ON CAR OF E.G.R. SYSTEM COMPONENTS



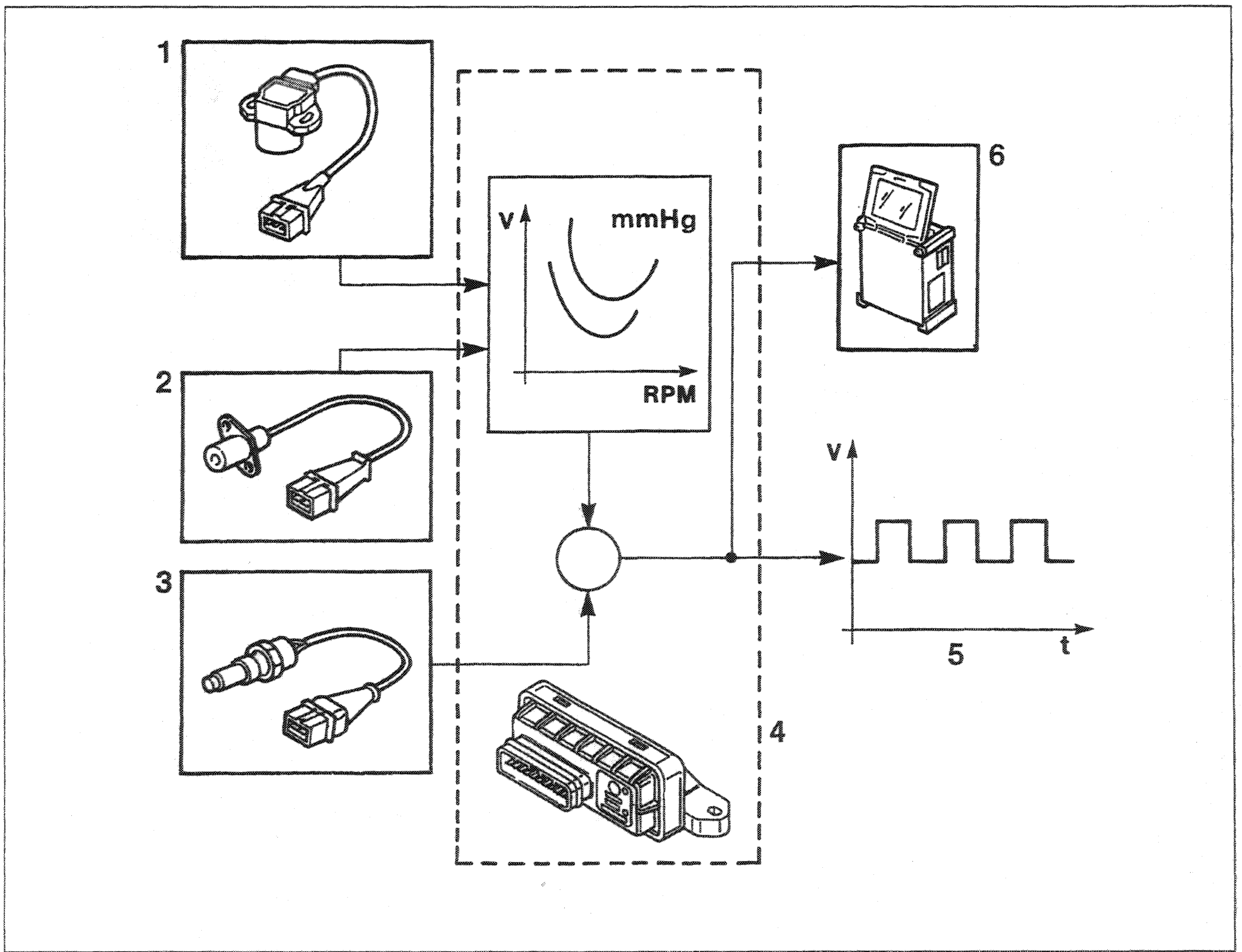
1. BITRON EGR/F 106A – 110A control unit
2. Throttle lever position sensor on fuel injection pump
3. Rpm sensor
4. Engine coolant temperature sensor
5. Brake servo vacuum pump
6. E.G.R. modulating solenoid
7. E.G.R. valve
8. Diagnostic socket for EXAMINER tester

COMPONENTS OF THE EXHAUST EMISSION CONTROL SYSTEM	
Exhaust gas emissions control unit (◆)	BITRON EGR/F 106A (110A for versions with air conditioning)
Modulating solenoid (◆)	Borg - Warner BITRON - (alternative)
Rpm sensor	M. Marelli SEN 8 I
Temperature sensor	Weber WTS – 05/01
Fuel injection pump with engine load potentiometric sensor	Bosch VE R 537
Exhaust gas recirculation E.G.R. valve	Pierburg 7.21303.00

(◆) From chassis no. 791217 (organization 754782)

DESCRIPTION OF OPERATION OF COMPONENTS OF BURNT GAS RECIRCULATION SYSTEM - E.G.R.

BITRON EGR/F 106A electronic control unit (110A for versions with air conditioning) The control module of the exhaust gas recirculation system used on this model is identified by the code BI-TRON EGR/F 106A (110A for versions with air conditioning).
It is a digital unit with microprocessor which receives data on the engine operating conditions, which are transmitted from the following sensors: engine load, throttle lever position on fuel injection pump (1) and rpm (2).
On the basis of these signals, the control unit (4) is able to drive the modulating solenoid (5) with a square-wave signal, using the E.G.R.'s intervention mapping stored in its memory. The mapping is represented on the basis of throttle lever angle / engine rpm, and the parameters of the level curves are the E.G.R. valve control vacuum values in mmHg.
The correction, depending on the coolant temperature, is made later by the control module, in accordance with the signal from the relevant sensor (3). This correction corresponds to a zeroing of the intensity value for temperatures below 20°C, and a reduction from 100% to 0% varying linearly between the temperatures of 20°C and 80°C. For coolant temperatures above 80°C, there are no corrections of the solenoid control current.
Finally, the control module has a serial output connector for the EXAMINER tester (6) which, during maintenance, diagnoses any operating faults.



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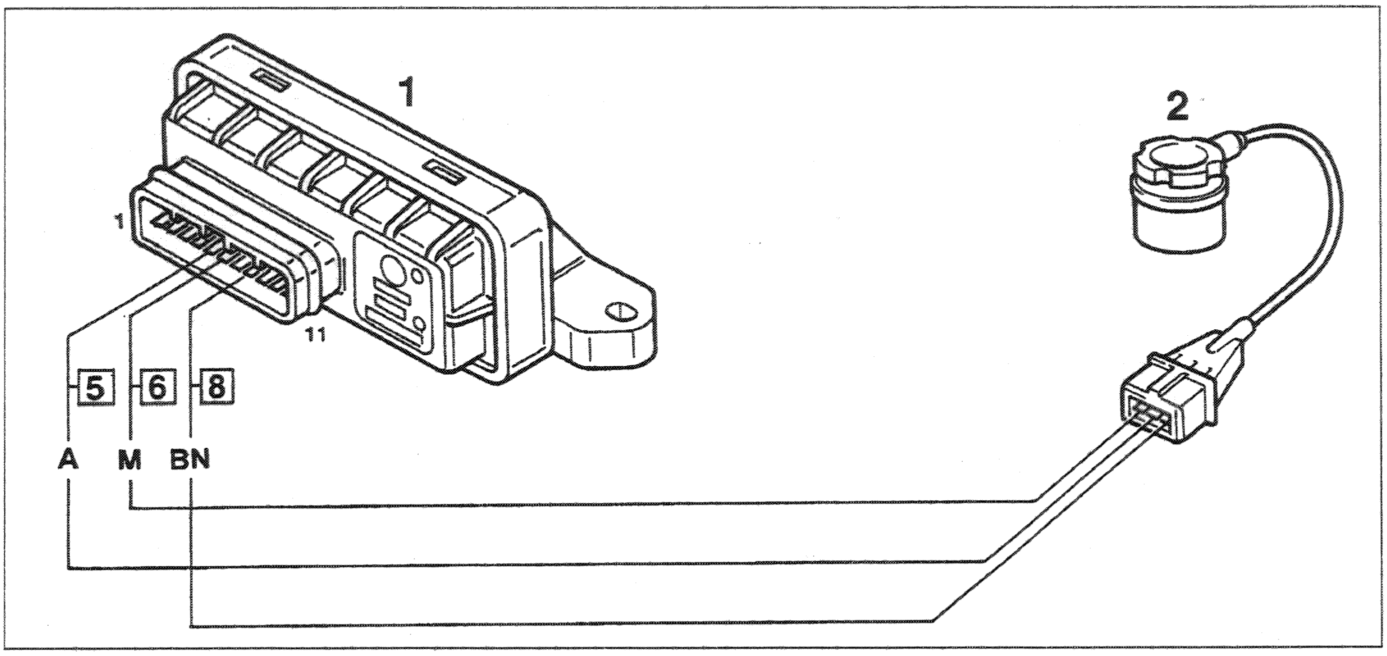
10.

Throttle lever potentiometer on fuel injection pump

The potentiometer (2) mounted on the fuel injection pump detects the angle of the throttle lever located on the fuel injection pump, and sends the control unit (1) information on the engine load.
The rotation of the lever varies the internal resistance of the potentiometer so, with a constant supply of 3.7 ± 0.2 V provided by the control unit, output voltages are obtained varying from 3. V during idling to 1 ÷ 1.4 V at maximum load.
This voltage thus represents an important piece of data on engine operation and it is used by the control unit to drive the opening of the modulating valve.



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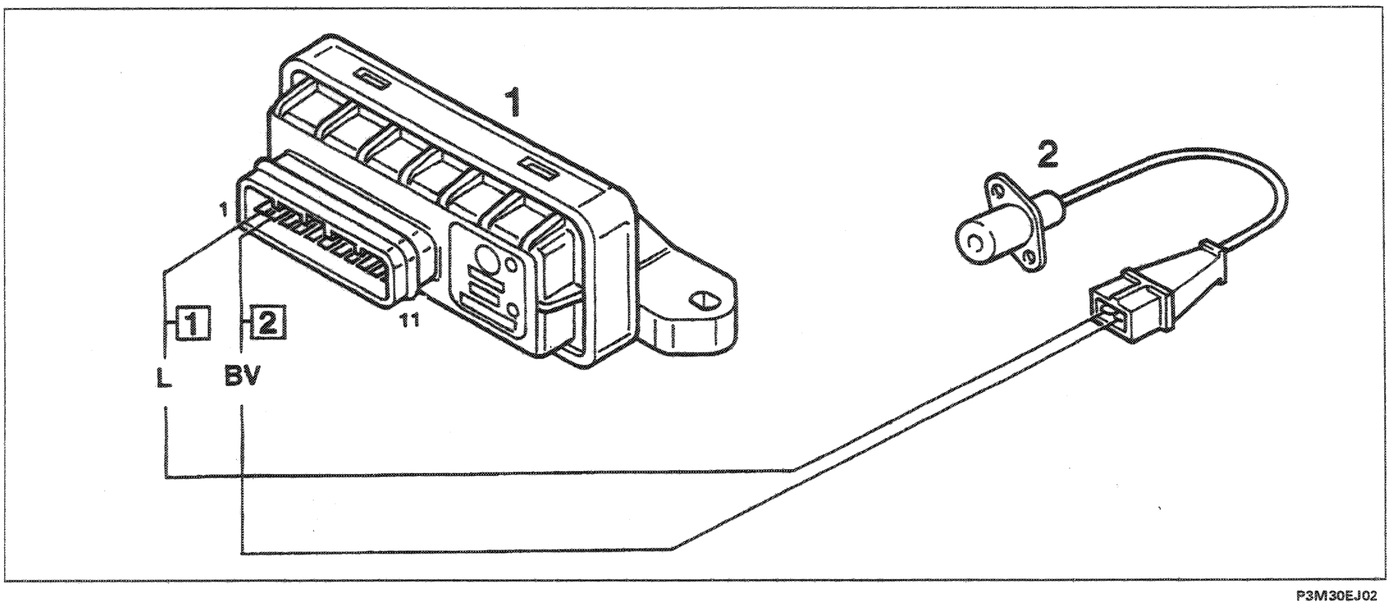
Rpm sensor The angular speed sensor (2), mounted on the gearbox bellhousing level with the flywheel, is of the passive electromagnetic type. When each flywheel tooth passes, it supplies a sinusoidal wave voltage signal, whose amplitude and frequency vary in accordance with the engine rpm.



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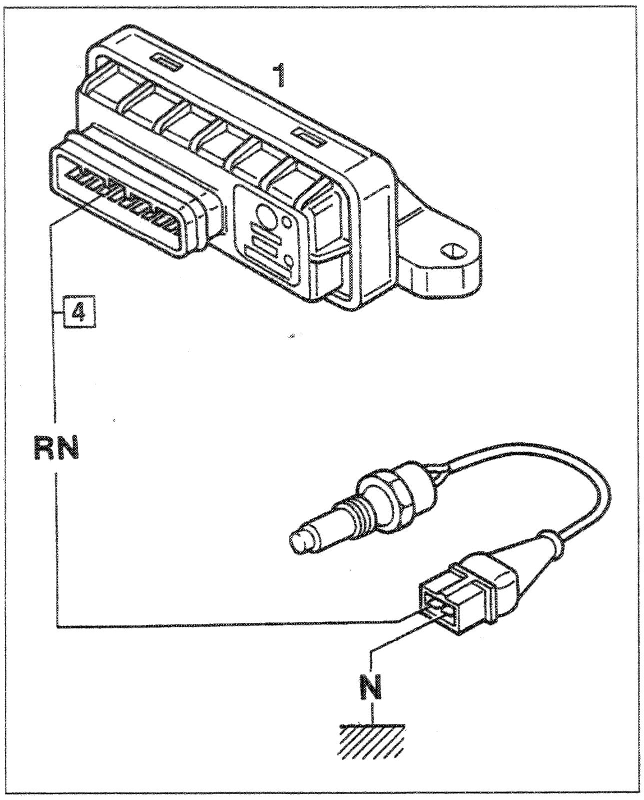

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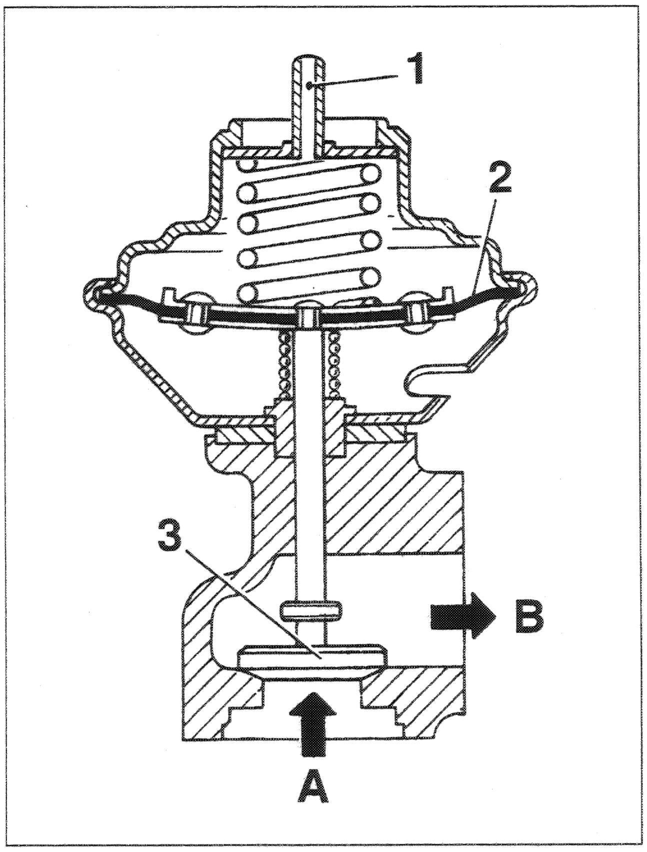
Engine coolant temperature sensor

The sensor is mounted on the thermostat casing with the sensitive part in contact with the coolant.
It consists of an NTC resistor Negative Temperature Coefficient) whose resistivity varies in inverse proportion to the temperature.
Depending on the resistance value, the electronic control unit (1) supplies the NTC sensor (2) and measures the coolant temperature in accordance with the variation in voltage, proportional to the intensity of the current circulating in the sensor, so as to correct the driving of the solenoid.
In this way the engine is prevented from drawing in an excessive quantity of burnt gases when it has not yet reached an optimum working temperature, or when particularly severe environmental conditions prevent this temperature from being reached.



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E.G.R. valve

This valve is driven by vacuum generaged by the brake servo vacuum pump and modulated by the E.G.R. valve solenoid, which operates as follows:
- following the signal received from the electronic control unit, the modulating solenoid places the pipe (1) in a vacuum. The diaphragm (2) and consequently the shutter (3) connected to it are lifted, opening, in accordance with the vacuum present in the pipe (1) the passage of gases permitting the recirculation of an appropriate quantity of burnt gases from the exhaust manifold to the inlet manifold;
- in the absence of an activation signal from the control unit, the solenoid places the pipe (1) in communication with the atmosphere, thus causing the shutter (3) to close. The recirculation of burnt gases is thus prevented, ensuring correct engine operation when cold, during idling and under medium-high load conditions.

The opening of the passage of exhaust gases is in accordance with the vacuum, modulated by the solenoid, which reaches the pipe (1).

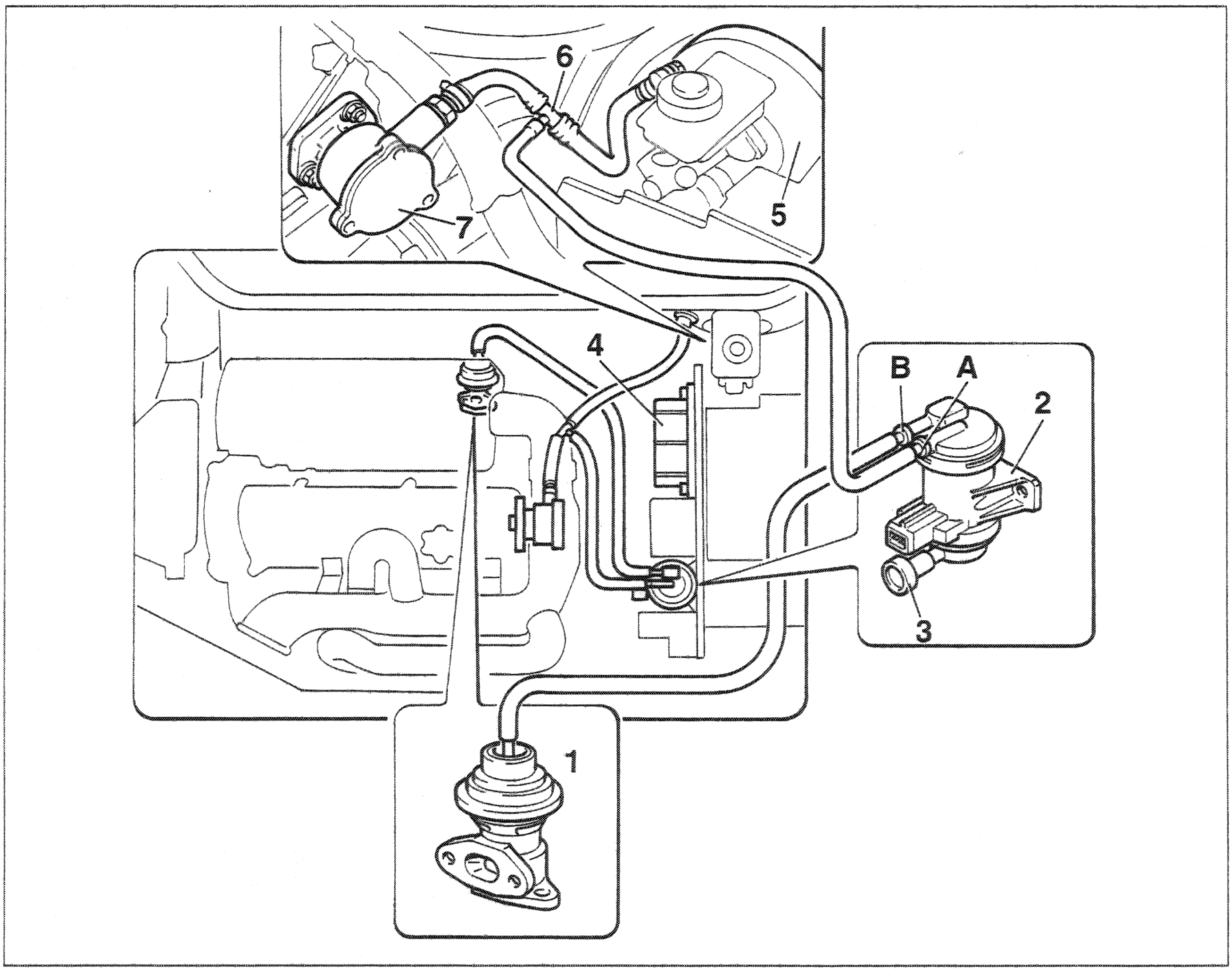
10.

Modulating solenoid

To carry out its functions correctly, the modulating solenoid (2) must always be mounted in a vertical position; it is located on the car together with the E.G.R. system control unit (4) at the front left of the engine compartment near the battery. To gain access, remove the cover.
In addition to the electrical connection, the solenoid has three connection points:
- one, marked by a white ring and the word VAC, for the vacuum connection consisting of a blue flexible pipe connected to the T-connector, present on the pipe from the vacuum pump (7) to the brake servo (5);
- one, marked by a yellow ring and the word OUT, for connection to the E.G.R. valve (1);
- one, for connection to the atmosphere, on which a filter is mounted (3).

The solenoid is driven directly by the electronic control unit (4) with a square-wave signal of 12 V and variable duty cycle.
Duty cycle is the ratio between the time when the signal is at 12 V and the total period of the cycle (1/140 s).

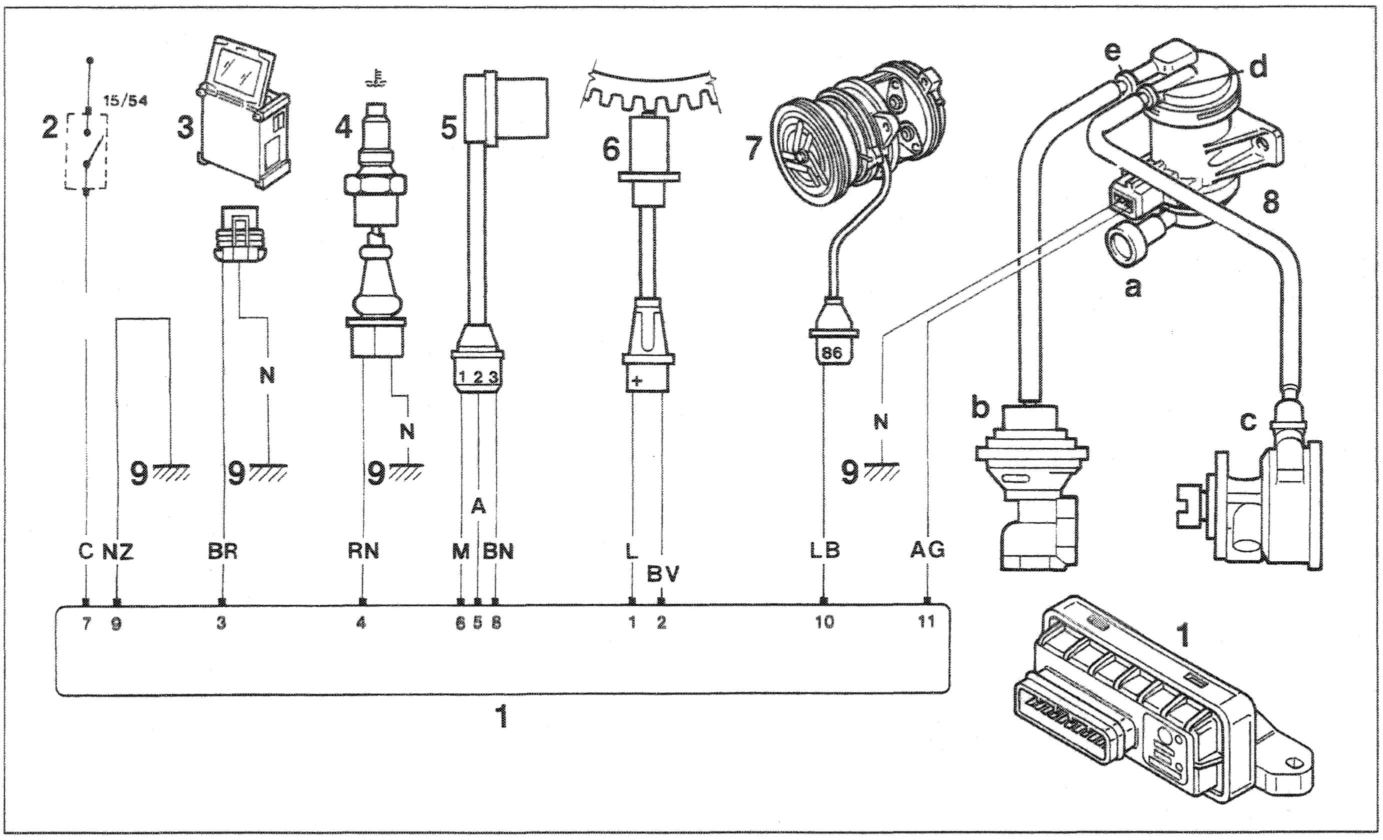
Diagram of E.G.R. system pipe connections



1. E.G.R. valve
2. Modulating solenoid
3. Atmospheric connection filter
4. Electronic control unit
5. Brake servo
6. T-connector
7. Vacuum pump

A- Vacuum connection (white ring)
B- Outlet to E.G.R. valve (yellow ring)

DIAGRAM OF E.G.R. ELECTROPNEUMATIC CONTROL SYSTEM



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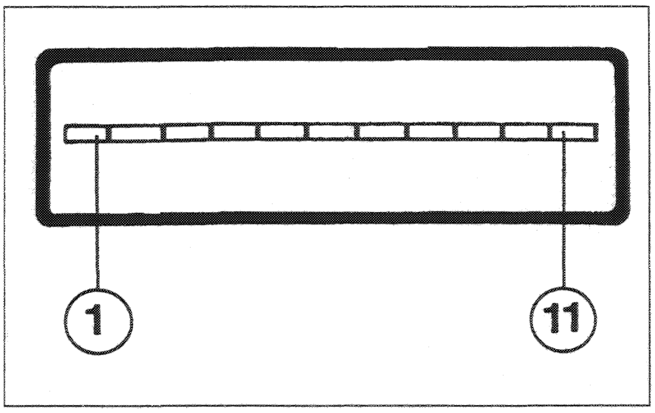
Key

1. BITRON EGR/F113A control unit
2. Key switch
3. Diagnostic socket for EXAMINER
4. Engine coolant temperature sensor
5. Throttle lever potentiometer
6. Rpm sensor
7. Compressor electromagnetic coupling
8. Modulating solenoid
9. Earth plate

a. Modulating solenoid atmospheric connection filter
b. E.G.R. valve
c. Brake servo vacuum pump
d. White mark
e. Yellow mark

CONTROL UNIT OUTPUT PINS



P3M33EJ02

1. Rpm sensor signal positive
2. Rpm sensor signal negative
3. Diagnostic signal for EXAMINER
4. Coolant temperature sensor positive
5. Throttle lever potentiometer signal
6. Throttle lever potentiometer negative
7. Control unit supply
8. Throttle lever potentiometer positive
9. Control unit earth
10. Signal for disconnecting compressor coupling
11. E.G.R. modulating solenoid positive