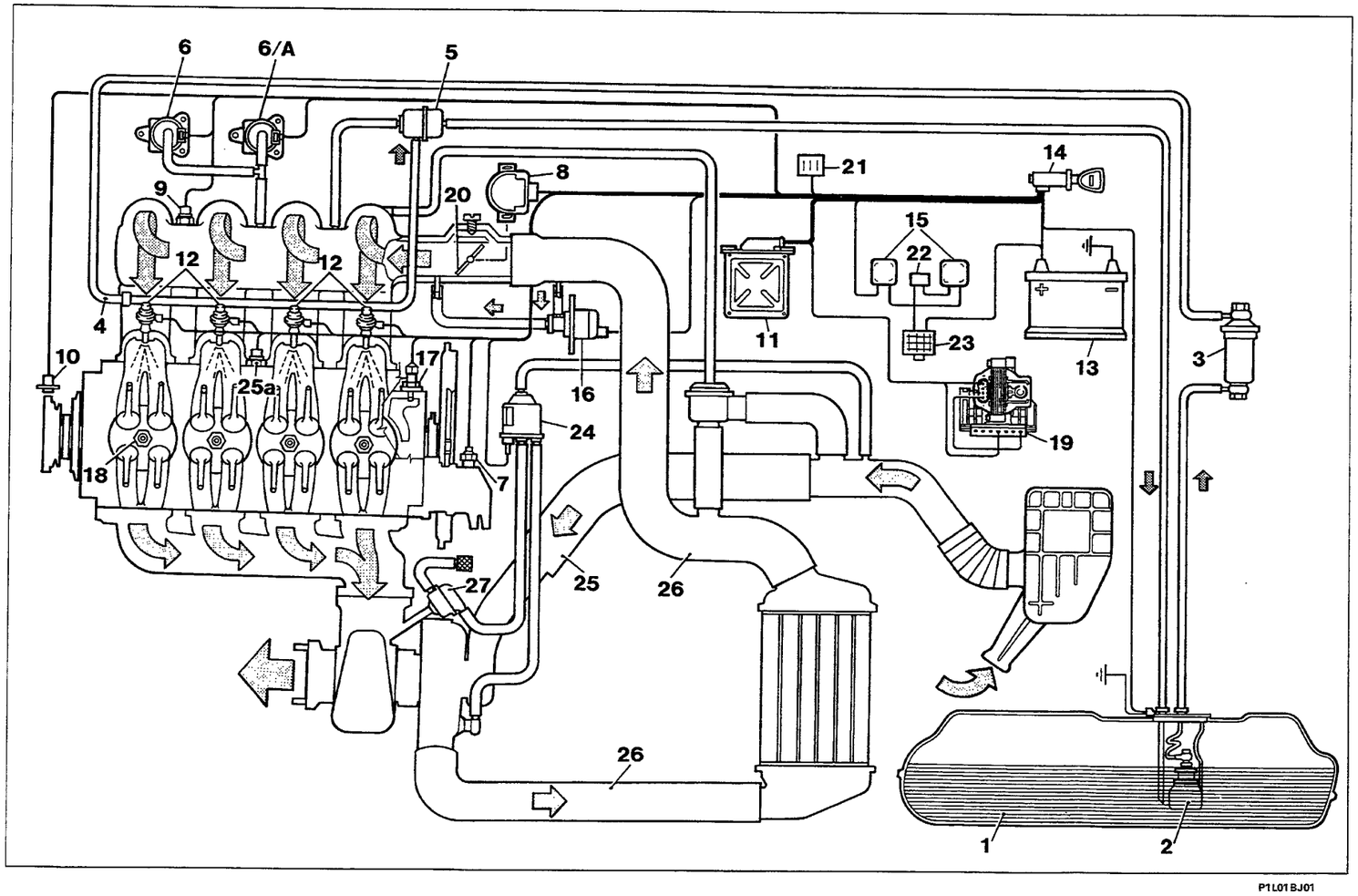
page

I.A.W. FUEL SYSTEM.

DIAGRAM SHOWING I.A.W. (M.P.I.) INJECTION/IGNITION SYSTEM



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1. Fuel tank
2. Electric fuel pump
3. Fuel filter
4. Fuel manifold
5. Fuel pressure regulator
6. Intake air absolute pressure sensor

6A. Intake air absolute pressure sensor

7. HT distributor with injection timing sensor
8. Butterfly valve position sensor
9. Intake air temperature sensor
10. Rpm and TDC sensor
11. Electronic control unit
12. Injectors
13. Battery
14. Ignition switch
15. Injection/ignition relay feeds
16. Supplementary air solenoid valve for automatic engine idle adjustment
17. Coolant temperature sensor
18. Spark plugs
19. Ignition coil with power module
20. Butterfly valve
21. Diagnostic socket
22. Unattached fuse
23. Connector block
24. Solenoid valve controlling supercharging pressure
25. Air intake duct from filter

25A. Detonation sensor

26. Compressed air ducts from turbocharger
27. Supercharging adjustment actuator (waste-gate valve)

Description of system

The injection system on this version belongs to the latest generation of injection/ignition system developed by Marelli - Weber known as I.A.W. The injection system of the type with multiple injectors (multipoint-injection), one per engine cylinder, supplied at low pressure and controlled directly by the control unit in a SEQUENTIAL AND TIMED manner.
It uses two absolute pressure sensors and a solenoid valve controlling the supercharging pressure operating in Duty-Cycle.

The calculation of the amount of air drawn in for a given quantity of fuel to be injected is carried out by the control unit, also known as the electronic control unit, by processing the signals sent by the temperature sensor and the engine intake air absolute pressure sensor.
The ignition is of the inductive discharge, digital electronic type; the optimum ignition advance is decided on by the control unit by consulting a map stored in its memory according to different operating parameters in order to optimize the opposing requirements of maximum power and minimum consumption, at the same time keeping harmful exhaust emissions to a minimum level.
The idle speed is controlled by the control unit through a special additional air solenoid valve V.A.E. which (according to requirements) adjusts a flow of air parallel to the butterfly when the latter is in a closed position.

With the simultaneous control of the fuel injection, the ignition and the idle speed being carried out by a single control unit, this makes it possible to adjust each parameter according to the others with total interaction, in such a way as to fully exploit the potential of all three systems.

Composition of the system

The system, see the reference numbers on the previous page, is composed of:

1. A control unit or electronic control unit (11)
2. A set of sensors which send information to the control unit concerning the engine operating conditions to allow it to process the most suitable intervention strategies:
   a. Engine rpm and TDC sensor (10)
   b. Timing sensor (located in ignition distributor)
   c. Intake air temperature sensor (9)
   d. Intake air vacuum/pressure sensors (6) and (6/A)
   e. Coolant temperature sensor (17)
   f. Butterfly position sensor (8)
3. A set of actuators which carry out the strategies processed by the control unit:
   a. injectors (12)
   b. ignition control module (19)
   c. additional air solenoid valve (16) for adjusting idle speed (V.A.E.)
   e. fuel pump (2)
4. A diagnostic socket (21), located near the control unit, to link the Fiat-Tester with the control unit, the diagnosis of the sensors and the manual control of the actuators.
5. Two relay feeds for the injection/ignition system (15)

Operating principle

Injection system

The control unit establishes the amount of fuel to be injected on the basis of the result of the calculation of the quantity (weight) of air drawn in by the invidual cylinder.
The system used is the **"engine speed - air intake density"** (Speed-density) type, i.e. it calculates the quantity of air according to the density of the air in the inlet manifold and the engine speed; this density is determined by the control unit according to the information received from the temperature and intake air pressure sensors.
The control unit also consults a map stored in its memory which, on the basis of the required engine speed and load conditions (i.e. vacuum or pressure in the inlet manifold) supplies the optimum volumetric output for the engine. The map stored in the memory is based on results obtained from practical tests.

Ignition system

The ignition system is operated by the control unit which controls the advances. The map of advance values stored in the control unit memory helps in calculating the optimum advance values according to the rpm parameters and vacuum in the engine inlet manifold, suppling the control unit with the correct value to use.
The engine timing sensor sends the control unit the position of each cylinder in relation to TDC. This allows it to decide the exact moment in which to send the power module the signal to strike the spark at the spark plug for the relevant cylinder.
The power module, having received the command from the control unit, lets the current flow from the ignition coil primary winding until it it completely energized, then it cuts off the current flow creating the high tension in the secondary winding necessary for the spark between the spark plug electrodes.

Idle adjustment system.

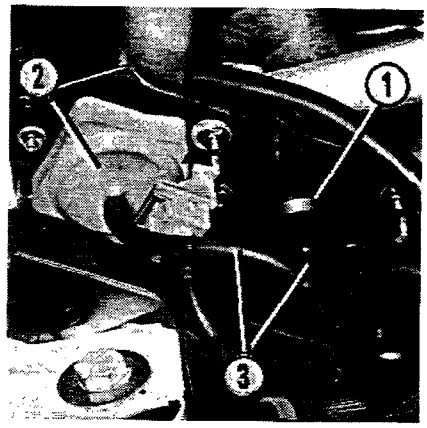
In order to idle, in other words run with the butterfly valve completely closed, the engine requires a certain amount of air and fuel in order to supply a power which is sufficient to overcome the internal friction and maintain the rotation speed; this power should increase whilst the engine is warming up and when an additional load is applied due to a service being switched on.
The increase in power supplied by the engine involves a greater amount of fuel and air being sent to the cylinders for combustion.
The V.A.E. valve allow the flow of air parallel to the butterfly valve under the direct control of the control unit, varying the flow rate of the air according to the fuel injected and keeping the engine at a constant idle speed.
Whilst the engine is warming up (i.e. after starting until it reaches operating temperature), as well as the additional flow of air to maintain the idle speed, an increase in the stoichiometric ratio of the fuel/air mixture is required, or an increase in the amount of fuel injected; the electronic control unit takes care of this using the signals coming from the coolant temperature sensor.

Operating strategy

The system is controlled by the control unit, which receives signals from the sensors and on the basis of which it decides the strategy for controlling the actuators.
In order to determine the operating strategy, the control unit consults information stored in its memory.
The data is condensed in the form of maps which for an input value corresponding to the signal sent by a sensor, supply output data, equivalent to the signal to send to the actuator: the output information is further modified according to the operating conditions which are read by the control unit by means of signals sent by other sensors.
The operation of calculating the parameters is carried out for each engine rev in such a way that the system adapts instantly to the operating conditions and the engine usage requirements.
The control unit is also capable of adjusting the signal sent to the actuators according to the supply voltage, in as far as variations in the latter involve a different response for the actuators.

The electronic control unit is also able to carry out the following operations:
- Diagnosing the control unit input controls with "recovery" of the fixed, pre-memorized values, if there is a breakdown of the sensors.
- Lighting up the diagnosis bulb if there is a defect in one of the system components
- Dialogue with the FIAT-TESTER and activating the actuators for service checks.

Location of absolute pressure sensors under the mounting bracket



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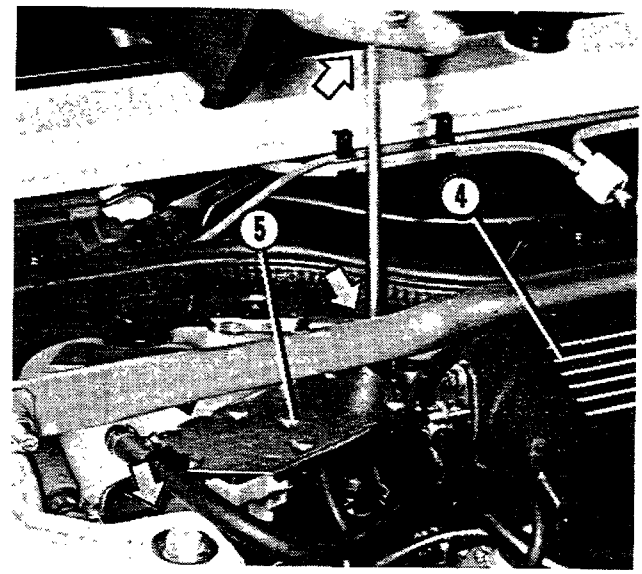

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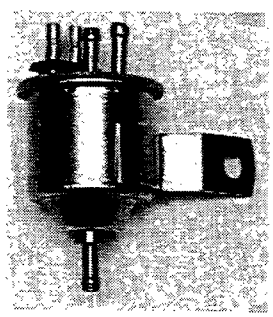
Removing-refitting absolute pressure sensor carrier bracket (the arrows show the fixing bolts)

1 - ABSOLUTE PRESSURE SENSORS

For the Delta HF integrale 16v version two absolute pressure sensors are used. These are connected via a rubber pipe (3) to the inlet manifold (4) and fixed under the bracket (5) in the engine compartment.
The pressure sensor (1) provides the voltage signal proportional to the absolute pressure in the inlet manifold for pressure values of up to 1600mmHg, whilst the absolute pressure sensor (2) supplies it for pressure values of up to 2280 mmHg. **With the use of two absolute pressure sensors a clearer signal is obtained in as far as for supercharging pressures greater than 0.7 bar the sensor (1) is no longer sufficient to fuarantee the reading of the signal with good reliability.** Therefore when the supercharging pressures in the inlet manifold exceed 0.7 bar, the electronic control unit switches the reading of the signal over to sensor (2).

The sensors can be differentiated through the different colour of their base and cover, one is black, the other grey. When removing-refitting the sensors, always match the sensor and electrical connector which are the same colour.

2 - SOLENOID VALVE CONTROLLING SUPERCHARGING PRESSURE



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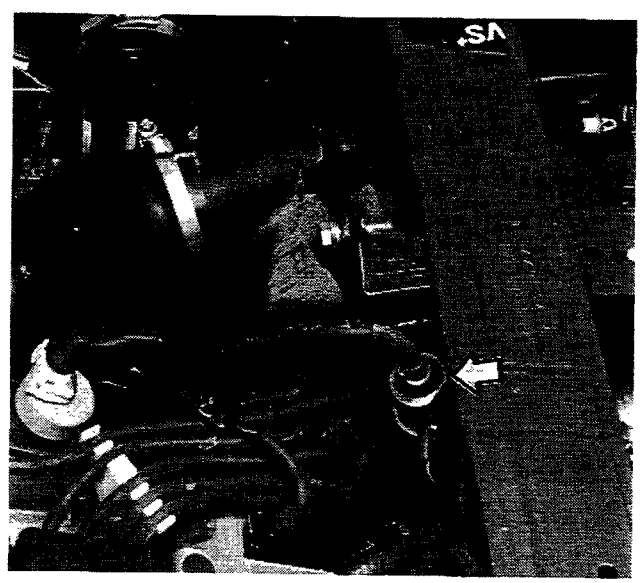

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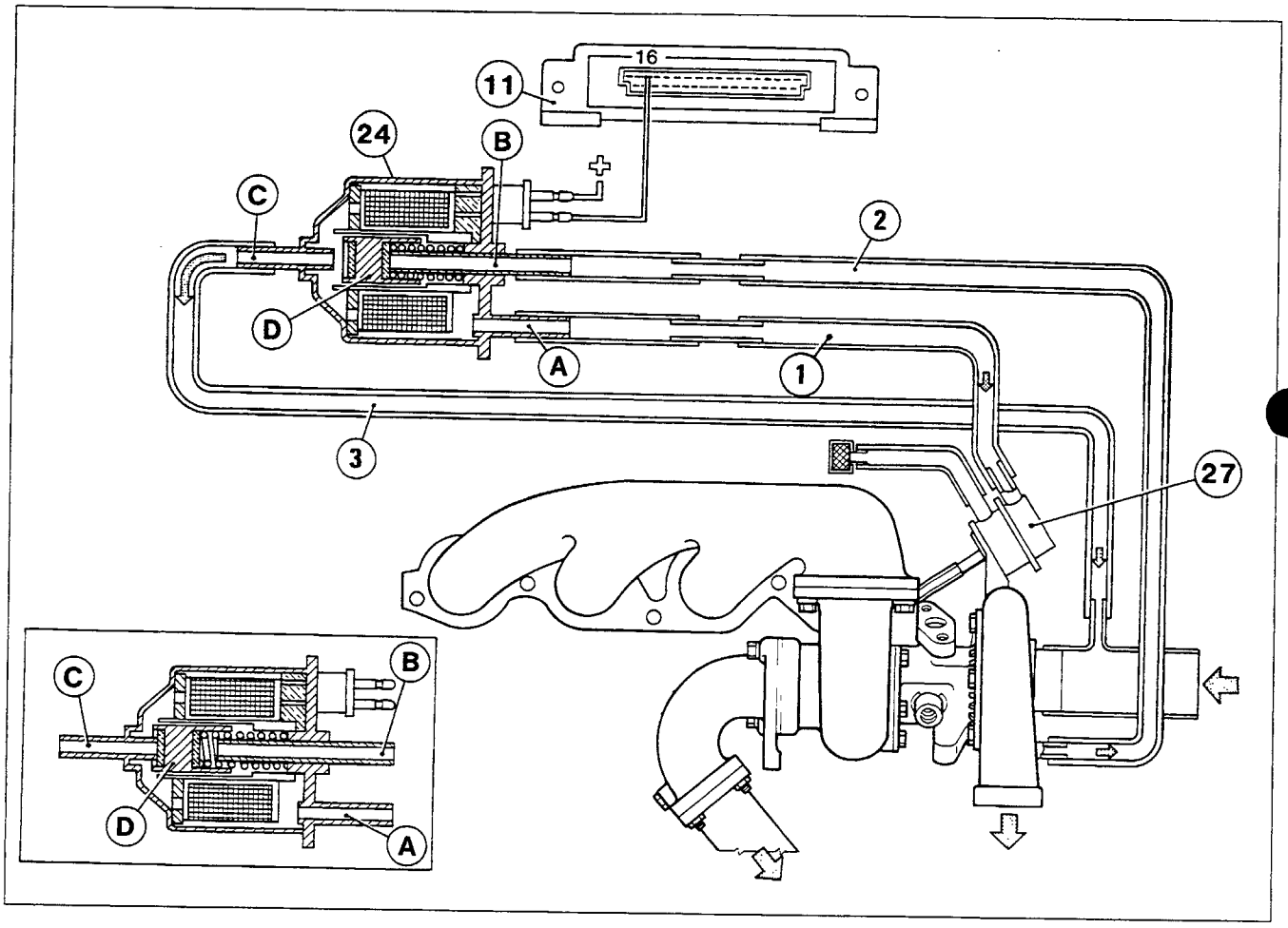
Location on vehicle of solenoid valve for controlling supercharging pressure

DIAGRAM SHOWING CONNECTION OF SUPERCHARGING DEVICE SOLENOID VALVE



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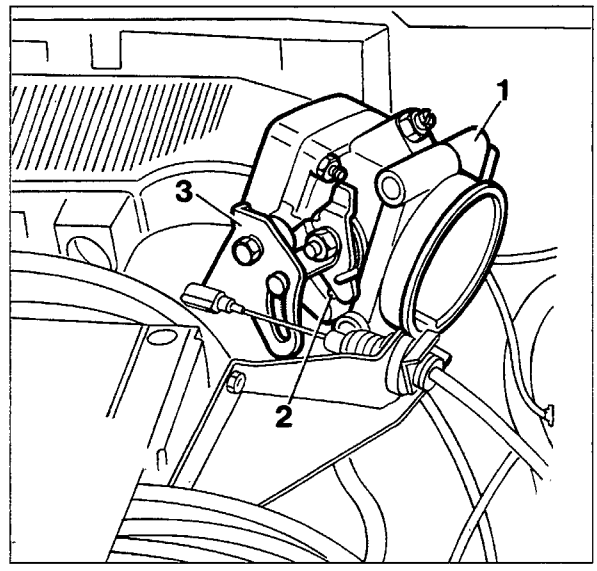
Operation of controlled supercharging device

The solenoid valve (24) for the above mentioned device is permanently controlled by the injection/ignition electronic control unit via the terminal (16).
The supercharging device solenoid valve (24) is a three way A-B-C solenoid valve.
Duct A is connected by means of the sleeve (1) to actuator (27) for the waste-gate valve.
Duct B is connectred by means of the sleeve (2) to the turbocharger excess pressure duct.
Lastly, duct C is connected by the sleeve (3) to the turbocharger intake duct.
When the solenoid valve, operating in Duty-cycle, is not activated by the control unit, cylinder D closes channel C, leaving ducts A and B in contact with one another, on account of which the excess supply pressure arriving in duct.B acts on the waste-gate valve actuator (27).In this way the excess supply pressure is only reguated by the mechanical calibration of the waste-gate valve.
When the solenoid valve is activated by the electronic control unit, cylinder D, magnetized by the coil winding, starts generate an impulse controlled by a Duty-cycle signal: in this way duct C opens for variable periods. These opening periods vary according to the sample curves stored in the control unit memory which take into account the pressure in the inlet manifold, the engine speed and the position of the butterfly valve.
The opening of duct C allows part of the pressure, which was previously acting on the waste-gate valve actuator (27) in the turbocharger inlet manifold to be discharged via sleeve 3, thereby increasing the supercharging pressure.

ADJUSTING BUTTERFLY VALVE CONTROL ROD

NOTE *The butterfly valve stop screw (2) is regulated in the Factory and should never be tampered with because it is adjusted in such a way that a pre-arranged flow of air can enter the engine with the butterfly closed.*

1. Butterfly casing
2. Butterfly valve stop screw
3. Control lever
4. Butterfly valve control cable
5. Bush stop plate
6. Rod adjustment bush
7. Butterfly valve control rod end



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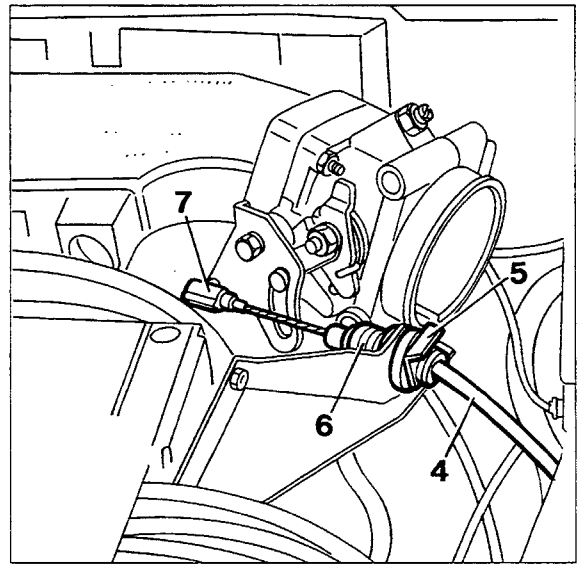
To check whether the control valve is properly adjusted (in terms of length) simply start up the engine, let it reach operating temperature and allow it to idle.
At this point disconnect the end of the rod from the control lever: the engine should continue idling without a change in speed.
If the speed alters, the length of the rod must be altered until it is correct by regulating the adjustment bush (6), after having removed the stop plate (5).
The length of the control rod is correct when, reinserting the end (7) in the butterfly valve control lever (3), the engine speed, which should be 900 ± 30 rpm, does not alter.



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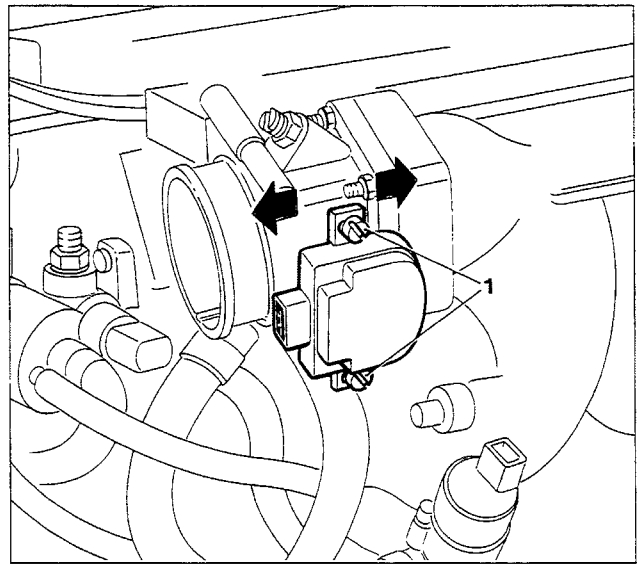
ADJUSTING CORRECT POSITION OF BUTTERFLY VALVE SENSOR

Loosen the bolts (1) which fix the sensor to the butterfly casing, rotate the sensor until it is in the end of travel position in both directions and then release it.
The two springs (the one inside the sensor and the butterfly valve return spring) opposing each other determine the exact position of the sensor.

NOTE *It is advisable, given the importance of this operation on the initial adjustment of the system, to* ***always*** *carry it out using the FIAT-LANCIA Tester.*



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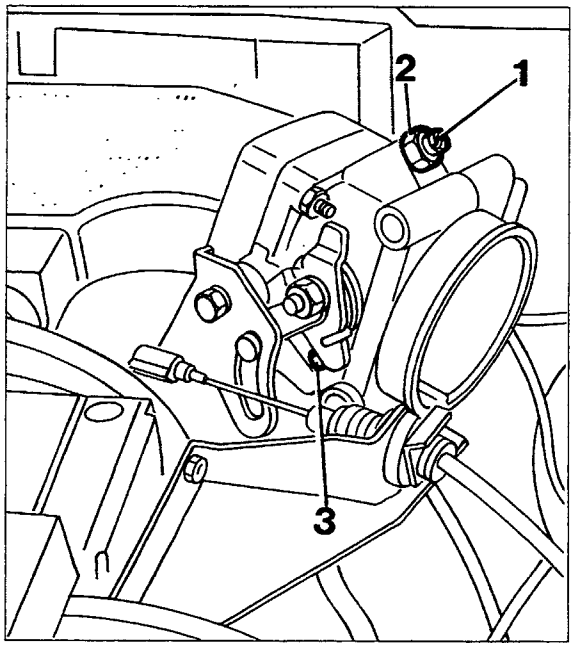

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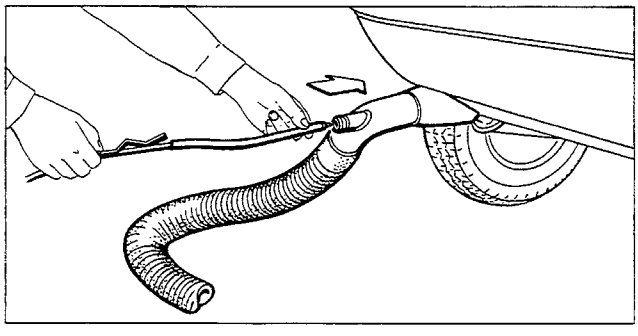
ADJUSTING IDLE SPEED AND CARBON MONOXIDE (CO)

Idle speed adjustment (ignition advance 14° ± 3°)

Previoulsy check the condition of the connection pipes between: the inlet manifold and the absolute pressure sensors; the fuel pressure regulator and the inlet manifold; the servo brake vacuum pipe; the air pipes for the automatic idle adjustment solenoid valve (VAE).

The adjustment of the idle speed is carried out with the engine at operating temperature, i.e. when the cooling circuit fan has come on at least 4 or 5 times. **The adjustment of the idle is carried out with the fan switched off and the other services switched off (heated rear windscreen, air conditioning, headlampes, etc).** If the fan comes on during the adjustment, do not work until it has completely stopped.

- **Disconnect the connector for the V.A.E. valve** and check that the idle speed is **900 ± 30 rpm.**
- If the idle speed is not correct, loosen the by-pass screw (1) lock nut (2) until the speed is 900 ± 30 rpm.
- Reconnect the V.A.E. automatic idle adjustment solenoid valve connector: the engine operating speed should not undergo any variation but should stay at **900 ± 30 rpm without any speed oscillations.** However, when an additional load is engaged, such as the windscreen wiper, heated rear windscreen, etc. the engine speed may go down to the idle speed of **850 ± 30 rpm and stop at that speed until the intervention of the V.A.E. valve.**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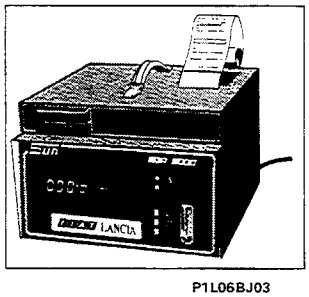
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NOTE *The butterfly valve stop screw (3) is adjusted in the Factory and* ***should never be tampered with,*** *since it is adjusted in such a way that a pre-set flow of air can enter the engine with the butterfly closed.*

Checking and adjusting CO idle percentage

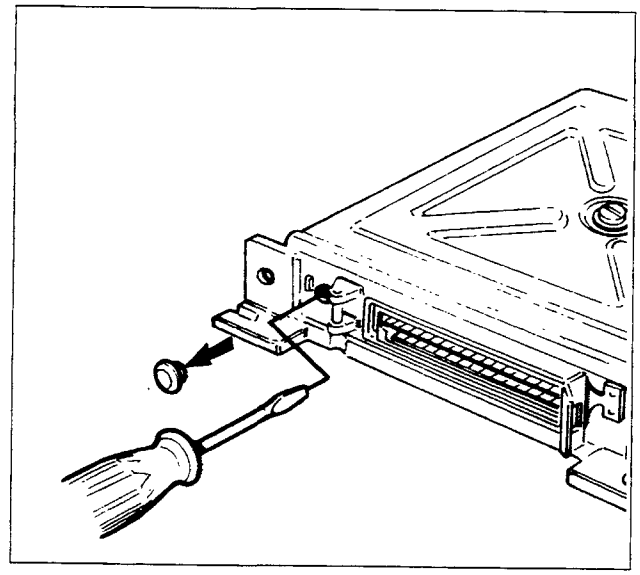
- Insert the exhaust gas analyzer probed into the rear silencer;
- connect the exhaust gas analyzer sensor;
- read off the CO values.

If the **CO** percentage is outside of the permitted tolerance (**1,5 ± 0,5%**) the trimmer adjustment screw on the injection control unit must be regulated as described below. For the location of the I.A.W. control unit see page 9.

Remove the CO anti-tamper plug from the control unit and adjust the CO strength with the engine at operating temperature and at the correct idle speed, using a 4 mm maximum screwdriver, to tighten or loosen the adjustment screw until the desired CO value is obtained.
The CO adjustment screw has a rotation range of several turns.**Do not force this screw, to avoid possible damage to the control unit.**

The rotation speed should not vary during the adjustment of the CO, if this is not the case, reset the correct rotation speed adjusting only the butterfly casing by-pass screw, checking, at the same time, that the CO content does not vary.

If it appears to be impossible to get the CO values within the permissible limits, the cause may be sought in the following problems: spark plugs worn or of the wrong type, sensors broken or defective (coolant/air temperature, absolute pressure), excess fuel pressure, injectors dripping, incorrect timing, poor engine cylinder compression, irregular ignition advance, air leaking into the inlet ducts or even CO adjustment trimmer broken.



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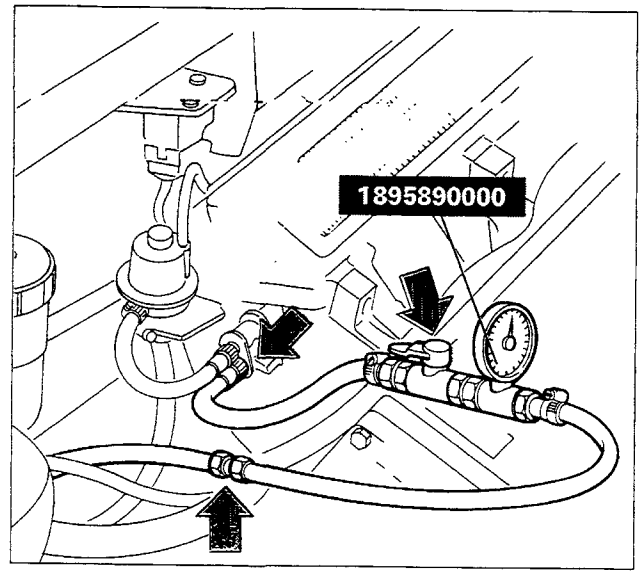
CHECKING FUEL SUPPLY CIRCUIT



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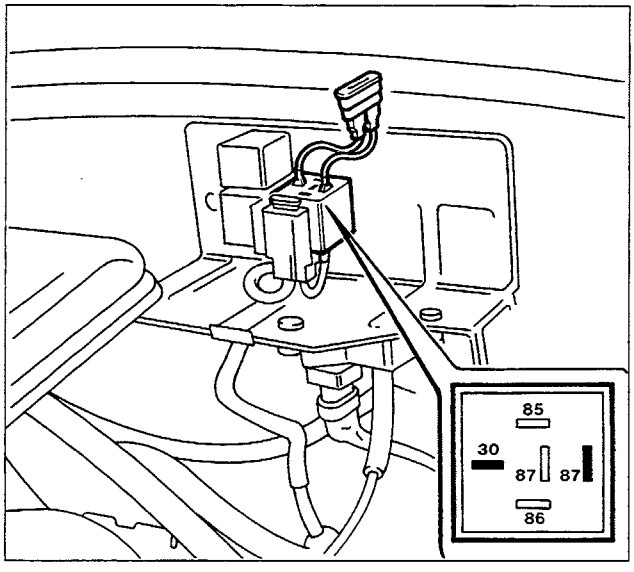
1st Test Checking fuel pressure

Disconnect the pipe coming from the filter, on the injector fuel manifold supply side.

Place pressure gauge 189589000 between the end of the disconnected pipe and the injector fuel manifold with the control lever in the open position as illustrated.



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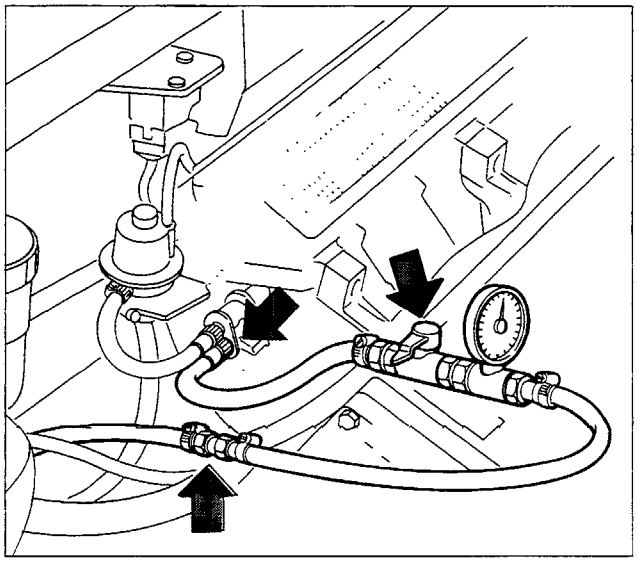
- with the help of the FIAT-LANCIA Tester, operate the electric pump (fuel pump test). If this equipment is not available, proceed as described below:
- Extract the electric pump relay feed; connect terminals 30 and 87 of the relay holder socket using an unattached cable with a 7.5 A fuse (see diagram)
- The pressure reading on the gauge should stabilize, under the test conditions at **2,5 bar ± 0,2 bar**. If the pressure is insufficient, carry out the next test.

Take great care when connecting terminals 30 and 87 in as far as an incorrect connection between the terminals (30 and 87) could irreparably damage the IAW electronic control unit.



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2nd Test

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

The same connections as for the previous test apply.

- close the control lever (shown by the arrow) fuel tap (upstream of the pressure gauge)
- operate the electric pump with engine switched off, as described above: the pressure should reach **4,5 bar and not exceed 7 bar** (pump safety valve calibration). If this is not the case, replace the electric pump because it is faulty.

If in the 1st test (see previous page) the pressure reading is **more than 2,5 bar it is necessary to:**

- disconnect the fuel return pipe from the pressure regulator and temporarily replace it with a pipe which goes into a container which is suitable for collecting the fuel
- operate the electric pump, with the engine switched off, as described above, then read off the pressure value reached on the gauge:
  a) if it reaches 2,5 bar the fuel return pipe to the tank must be replaced because it is obstructed or bent.

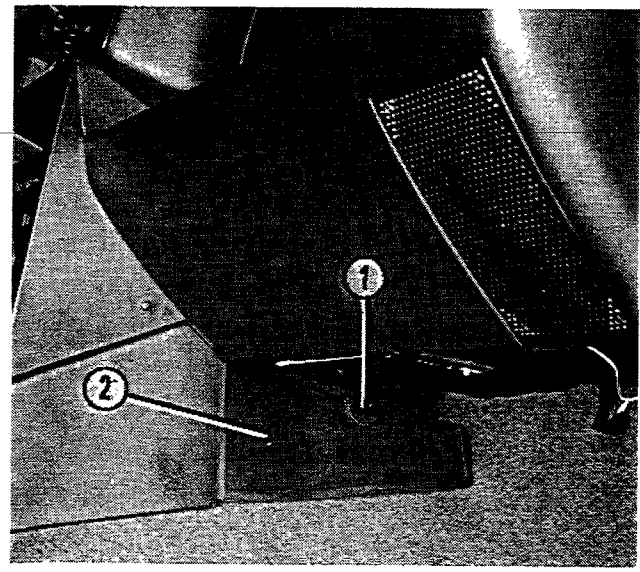
Checking injectors for leaks

To check if there are leaks from the injectors simply implement the connection for the 1st test (see page 7, adjustment pressure check), but take care to place the control tap operating lever downstream (instead of upstream) of the pressure gauge.
Then proceed to:
- start the electric pump with the engine switched off, as recommended
- completely close the tap lever (shown by the top arrow) on the pressure gauge once the adjustment pressure has been reached. In this way the pressure in the fuel manifold and the injectors is the same. Then:
- switch off the electric pump
- observe as soon as it stabilizes (i.e. decreases lightly) **that the pressure remains constant for about 60 secs.**

If this is not the case, there is a leak from one or more injectors or from a union.
- Proceed to remove the injectors and the fuel manifold from the inlet manifold, keeping the connection with the pressure gauge.
- Repeat the previous test, leaving the pressure gauge tap open.
- After having supplied the electric pump with the engine switched off (following the instructions on page 8), visually inspect whether there are drips from any of the injectors or from any sections of the pipe connections.
  Replace any leaking injector and/or renew any faulty seals where there is a leak from.

LOCATION OF IAW INJECTION/IGNITION CONTROL UNIT

To gain access to the control unit simply undo the knob (1) retaining the panel (2).



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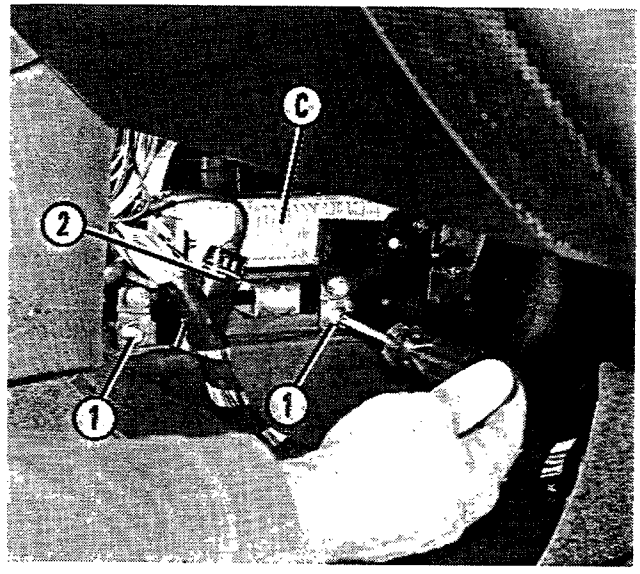
Removing-refitting injection/ignition electronic control unit

To regulate the control unit CO adjustment screw (C) the former must be removed from its housing. To do this, use a 7 mm screwdriver, to loosen the two bolts (1) fixing the control unit (C) to its mounting. After this it is easy to extract the control unit from its housing. To adjust the CO, see the instructions on page 7.



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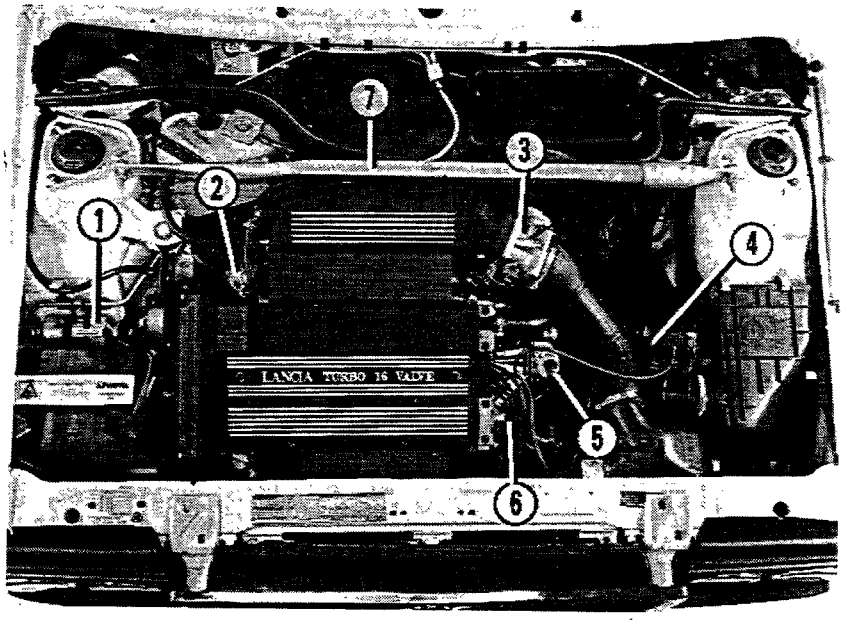
1. Bolts fixing control unit to mounting.
2. FIAT-LANCIA Tester diagnostic socket for repairs to the I.A.W. injection/ignition system



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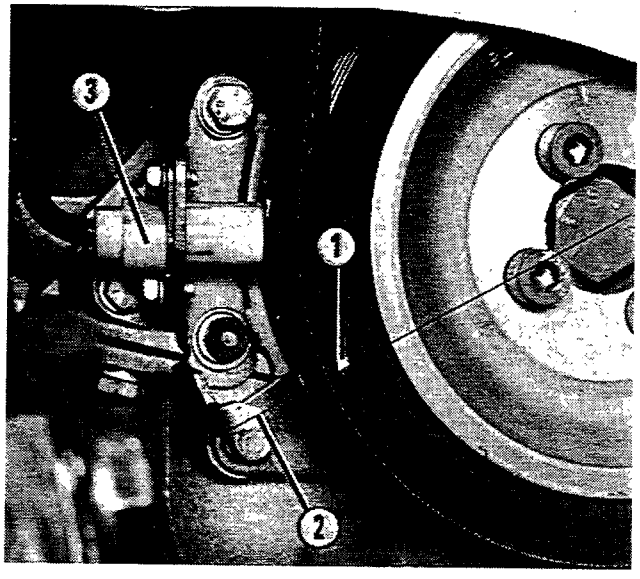
Engine compartment for DELTA integrale HF 1995 16v turbo i.e.

1. Fuel filter. It can **only be fitted in one direction** shown by an arrow stamped above its casing, which represents the direction of the flow of fuel inside it.
2. Engine fuel supply pressure regulator.
3. Butterfly casing. It is the heated type provided with **a screw for adjusting the engine idle speed with the supplementary air valve (VAE) disconnected.**
4. Ignition power unit and ignition coil
5. Supplementary air solenoid valve for automatic adjustment of engine idle speed (VAE)
6. High tension distributor, with built in timing sensor.
7. Strenghtening bar for front section of bodyshell.



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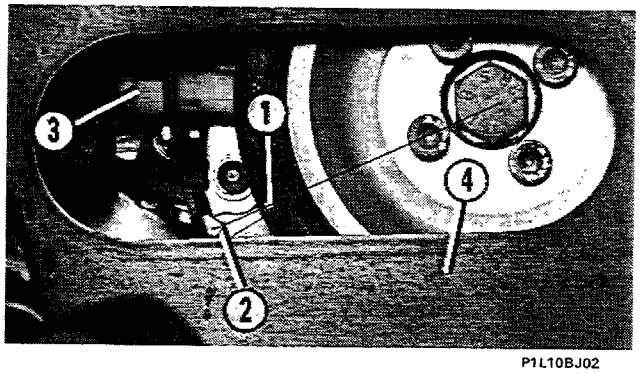

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Location of slit for checking TDC reference marks and engine ignition advance in right wheel arch liner (with protection removed)

1. TDC reference mark on crankshaft pulley.
2. End of sensor carrier plate for TDC reference with previous sign.
3. Rpm and TDC sensor
4. Plastic wheel arch liner

There are no variations as far as the various checks on the IAW system sensors are concerned compared to those for the previous model. In particular, the position of the rpm and TDC sensor is determined in the saem way and with the same tool. The only variation is that the TDC can be more easily detected using reference marks, designed for this purpose, on the crankshaft pulley and on the end of the rpm and TDC sensor carrier plate, which do not involve the use of a dial gauge on the piston crown.

Location of rpm and TDC sensor and TDC and ignition advance reference marks with right wheel arch liner removed