A precision machined edge on the control piston uncovers the fuel metering slits in the fuel distributor barrel. This controls the amount of fuel injected into the engine cylinders.

Fuel pressure regulator (see fig. B4-12)
When the engine is operating primary fuel pressure is maintained by the fuel pressure regulator.

Fuel from the main fuel pump and via the fuel distributor enters the regulator through the port on the right-hand side. Fuel returning from the fuel distributor differential pressure valve lower chambers enters the regulator via the connection on the left-hand side. The fuel return line (to the tank) is situated at the bottom of the assembly.

High pressure fuel returning from the fuel distributor enters the fuel pressure regulator via the inlet port. This fuel pressure pushes the diaphragm up against control spring pressure. This relieves the downward pressure on the valve body. The valve body will now be pushed upwards by the counterspring until it reaches its mechanical stop.

This action opens the return line and allows fuel from the differential pressure valve lower chambers and control plunger fuel leakage to return to the fuel tank via the return port.

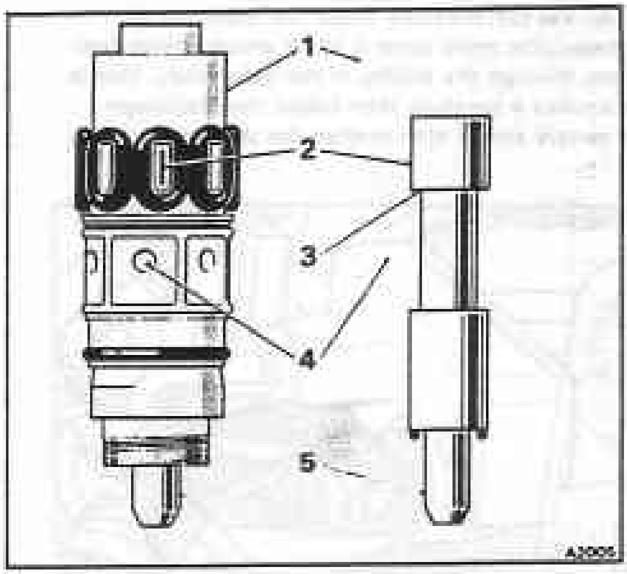


Fig. B4-11 Fuel distributor barrel and control piston
1 Fuel distributor barrel
2 Fuel metering slits
3 Piston control edge
4 Fuel inlet ports
5 Control piston

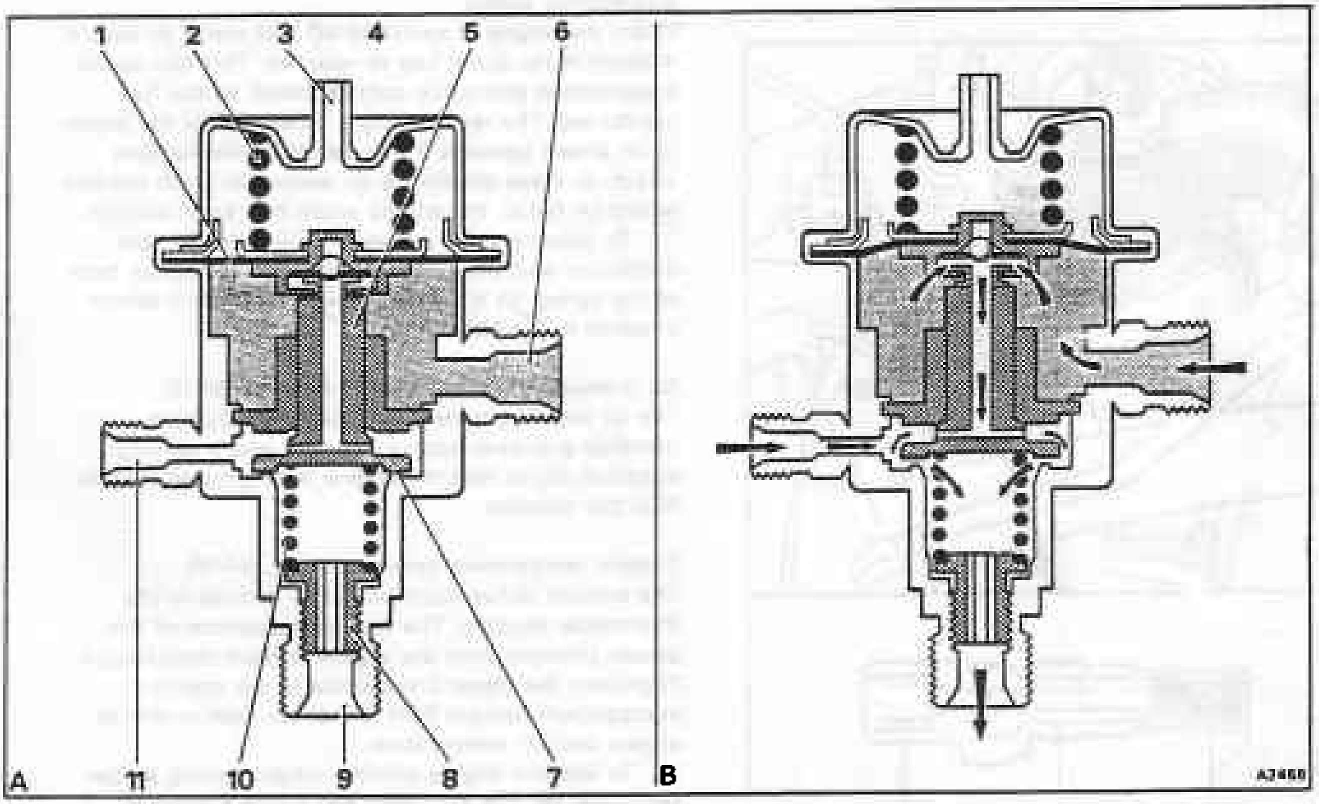


Fig. B4-12 System pressure regulator
1 Diaphragm
2 Control spring
3 Vent to atmosphere
4 Plate valve
5 Valve body
6 Inlet
7 Seal
8 Adjustment screw
9 To fuel tank
10 Counterspring
11 From fuel distributor
A Regulator closed
B Regulator opened

As the fuel pressure under the diaphragm increases, the valve plate is lifted which allows fuel to flow through the drilling in the valve body. This in turn causes a pressure drop below the diaphragm. The control spring then pushes the diaphragm down which pushes the valve plate down restricting the fuel returning through the valve body.

At this point fuel pressure below the diaphragm and the control spring are in equilibrium, hence the fuel pressure will be stable.

When higher power output is required from the engine a higher volume of fuel will need to be supplied with as little fluctuation in fuel pressure as possible.

As this demand is made there will be a split second reduction in the fuel pressure that is being fed into the inlet. At this point the control spring will push the diaphragm down which causes the valve plate to restrict the flow of returning fuel. This action will cause the fuel pressure to stabilize at the pre-determined limit again, whilst allowing the engine a higher volume of fuel.

This process is reversed when the fuel demand is reduced.

When the engine is switched off, the fuel pumps stop and the system pressure drops rapidly. As this pressure reduction occurs the control spring pushes the diaphragm, valve plate and valve body downwards very rapidly. This action completely seals off all the fuel return lines to the fuel tank and allows the fuel accumulator to maintain a reduced pressure in the system for some considerable time.

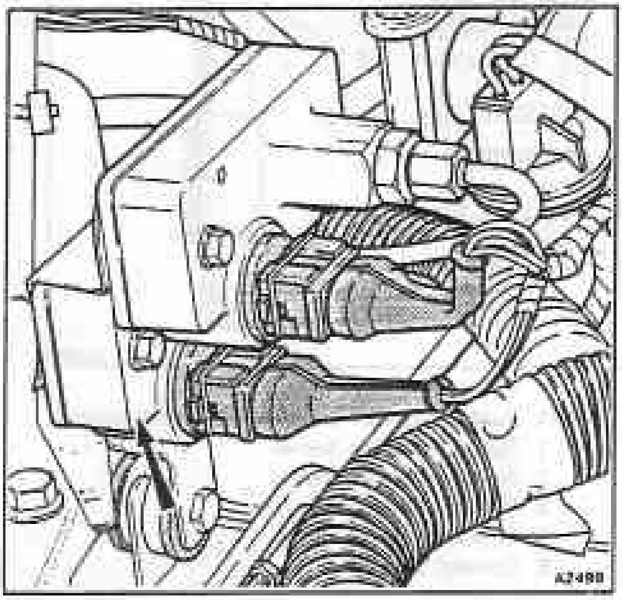


Fig. B4-13 Air pressure transducer

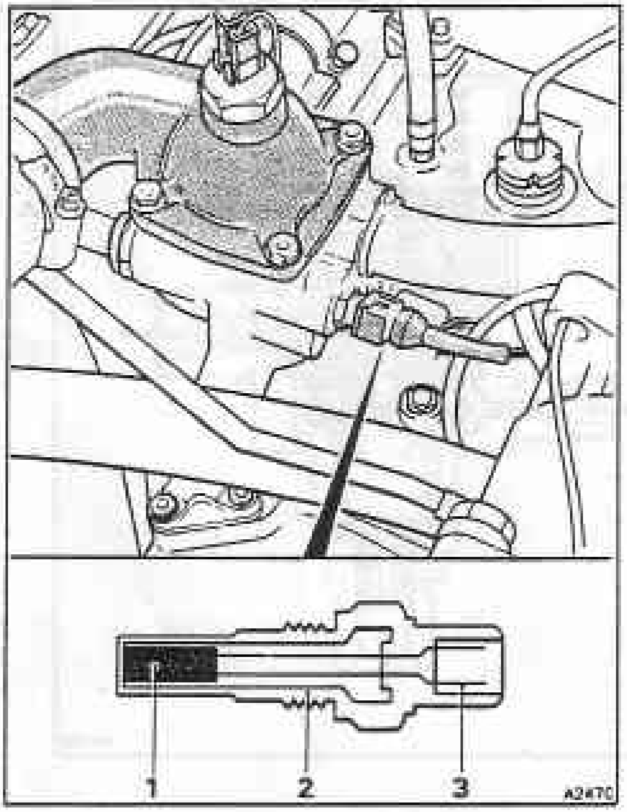


Fig. B4-14 Engine coolant temperature sensor
1 Resistor
2 Housing
3 Electrical connections

Anti-suction spring
When the engine is switched off and starts to cool, it is possible for some fuel to vaporize. This can cause a depression above the control piston as the fuel condenses. The result being a tendency for the piston to be drawn upwards in the barrel by the vacuum effect. In these conditions an excessively rich mixture would be fed to the engine when it is again started.

To prevent this a spring is fitted into the fuel distributor above the control piston. The applied force of the spring on the piston, prevents it being drawn upwards in the barrel.

Air pressure transducer (APT) (see fig. B4-13)
The air pressure transducer converts induction manifold pressure/vacuum changes into a varying electrical signal that the engine management system ECU can process.

Coolant temperature sensor (see fig. B4-14)
The coolant temperature sensor is located in the thermostat housing. The internal resistance of the sensor changes with the engine coolant temperature. Therefore, the signal it transmits to the engine management system ECU is a direct relationship to engine coolant temperature.

To improve engine running when starting at low temperatures, the ECU uses the signal it receives from the coolant temperature sensor to help compute the correction factors for the ignition timing and the fuel injection system EHA.

Throttle position switch (see fig. B4-15)
This switch is mounted on the side of the throttle

body on the primary throttle spindle, the switch identifies idle, overrun, part load, and full load engine operation. This information is signalled to the engine management system ECU to help compute the correction factors for the ignition timing and the fuel injection system EHA, etc.

Air flow sensor potentiometer (see fig. B4-16)
The potentiometer monitors air flow sensor plate and lever moment, and thus the metered air entering the induction system.

The electrical signal generated within the potentiometer by the movement of the sensor plate lever is conveyed to the K-Motronic engine management system ECU, as a measure of engine load. It is used by the ECU in the calculations of correction factors for both the fuel injection system and the ignition control system.

Fuel injection system
The engine fuelling requirements are calculated by the K-Motronic ECU using information supplied by the air flow sensor potentiometers. Any necessary corrections are transmitted to the EHA which continually adjusts the air/fuel ratio.

Ignition control system
Part load ignition timing is dependent upon engine load and speed, and is generated by the K-Motronic ECU from a characteristic map. Engine load is sensed by the air flow sensor potentiometer and engine speed, by the sensor mounted adjacent to the timing wheel at the rear of the engine (see fig. B4-62).

Electro-hydraulic actuator (EHA) (see fig. B4-17)
This assembly incorporates two polarity conscious electrical pin connectors in addition to a plastic location pin. The plastic location pin ensures that reversal of the pin connectors does not occur.

Depending upon the milliamps (mA) relating signal received from the ECU (i.e. information as to the operating conditions of the engine) the EHA varies the fuel flow to the lower chambers of the differential pressure valves.

An increase or decrease in the milliamps (mA) supply from the ECU to the EHA will result in a corresponding change in the fuel flow to the injectors and hence the CO concentration. An increase in mA signal to the EHA will increase the mixture strength.

This alteration in mixture strength is not related directly to any mechanical air flow measurement.

K-Motronic engine management systems ECU (see fig. B4-18)
The ECU evaluates input data from the various engine mounted sensors. With this information the ECU computes correction signals for both the fuel injection system and the ignition control system.

Heated oxygen sensor (see fig. B4-22)
Fitted to cars with catalytic converters.

The oxygen sensor (part of the lambda control system) measures the oxygen content in the exhaust gas and by means of an electrical signal transmits

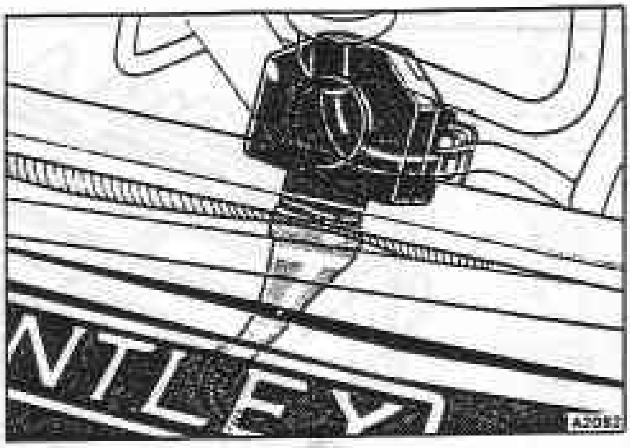


Fig. B4-15 Throttle position switch

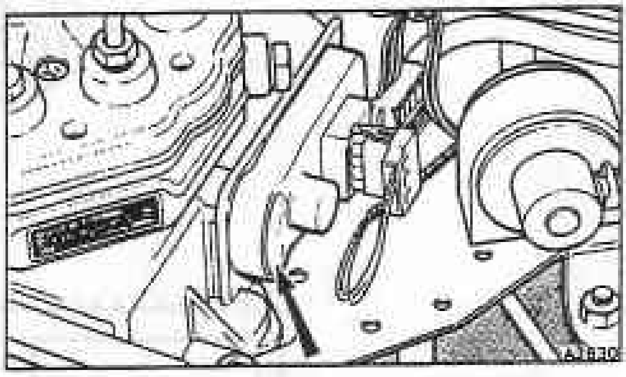


Fig. B4-16 Air flow sensor potentiometer

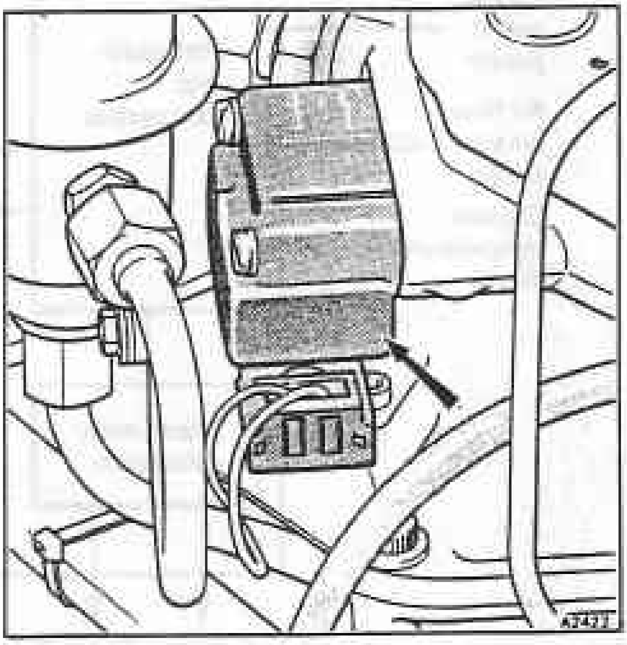


Fig. B4-17 Electro-hydraulic actuator

the information to the K-Motronic ECU.

The assembly consists of a sintered zirconium dioxide ceramic, impregnated with certain metal oxides. The surfaces of the tube are coated with a

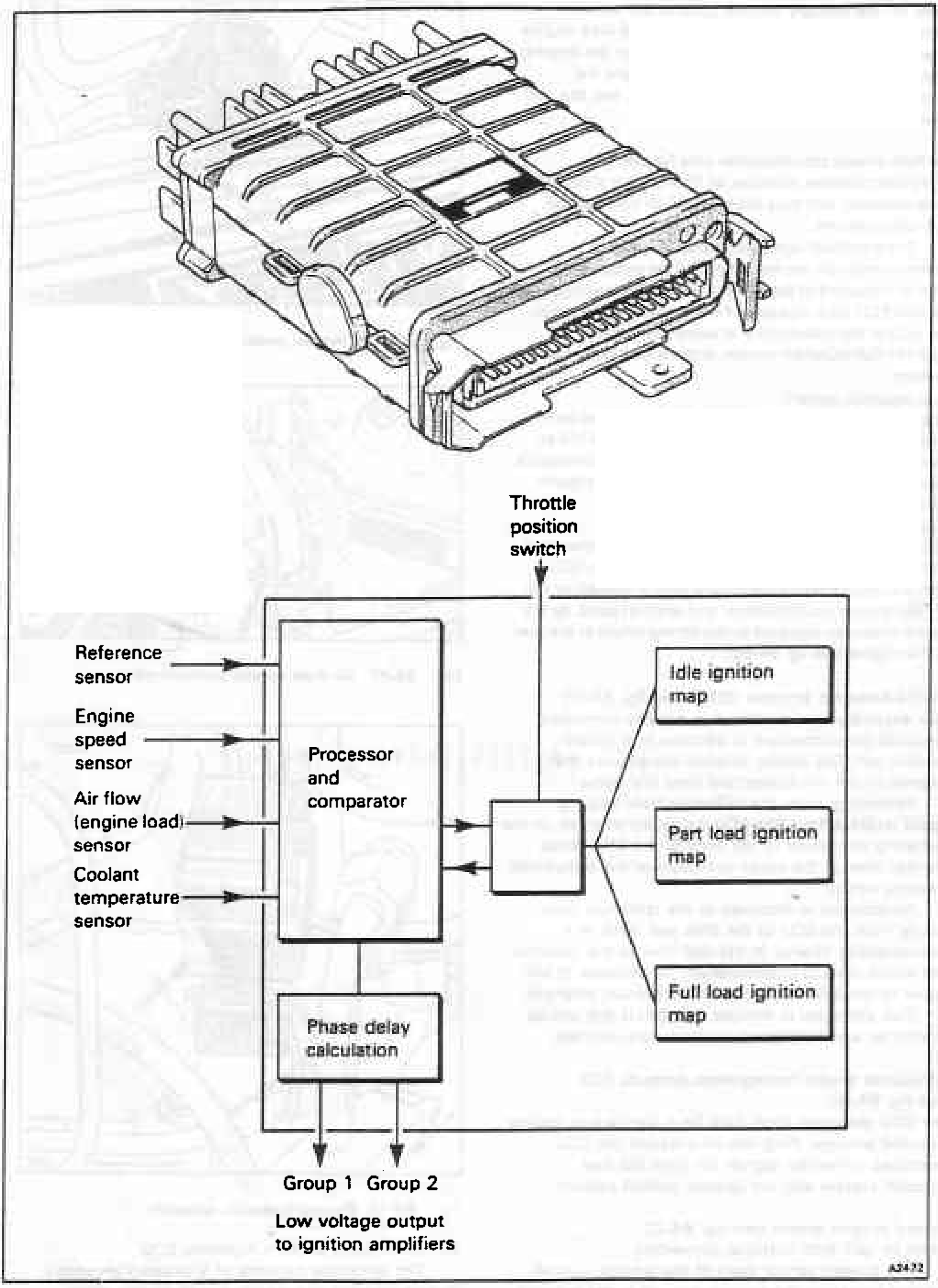


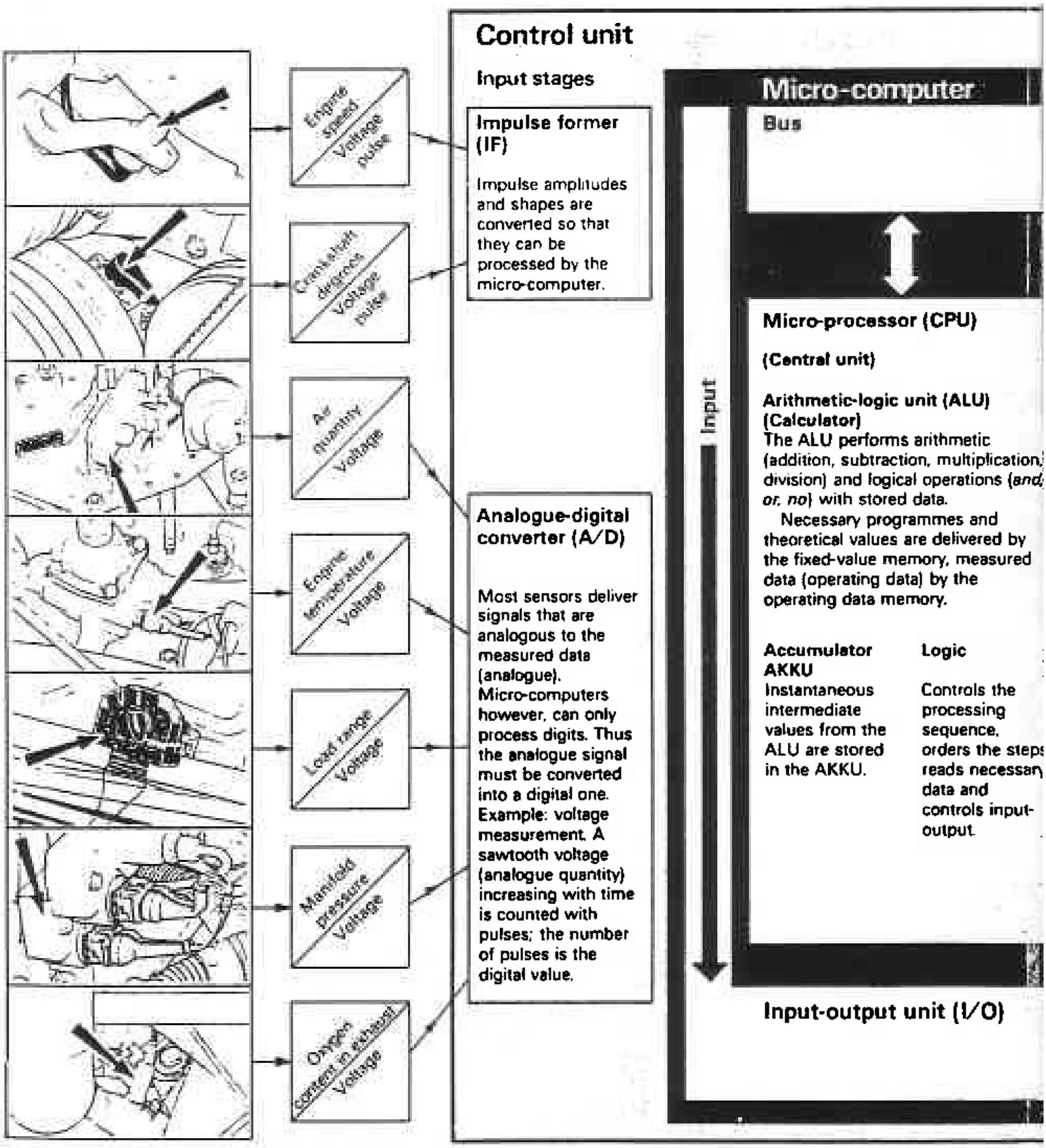
Fig. B4-18 K-Motronic ECU – Ignition timing control

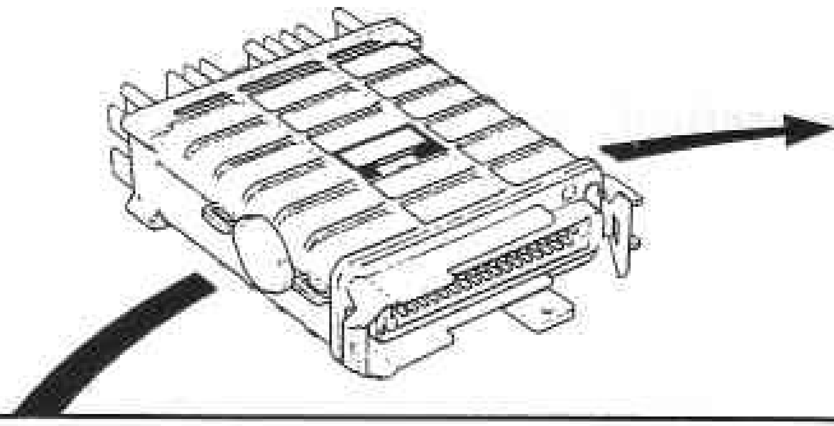
Figure B4-19

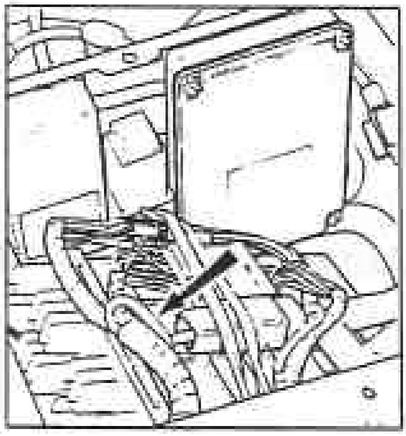
K-Motronic ECU – Theoretical

K-Motronic electronic control unit

This schematic illustration shows the operational principles for the engine management system ECU controlling fuel injection (including engine starting, after-start running, engine warm-up, part-load operation and full load operation), electronic ignition, idle speed regulation, lambda control system (if fitted), and on-board fault diagnosis (if fitted).







Buses are data-gathering bars by which all main units are connected. The buses provide all units with data (data bus), memory addresses (address bus) and control signals (control bus).

Fixed-value memory (ROM)

(Read-only memory)

Here, all programmes (software) and all characteristic curves, theoretical values, etc. are stored permanently. They are "burned" into the ROM-IC cannot be altered and are designed for the specific application.

Operating-data memory (RAM)

(Random-access memory)

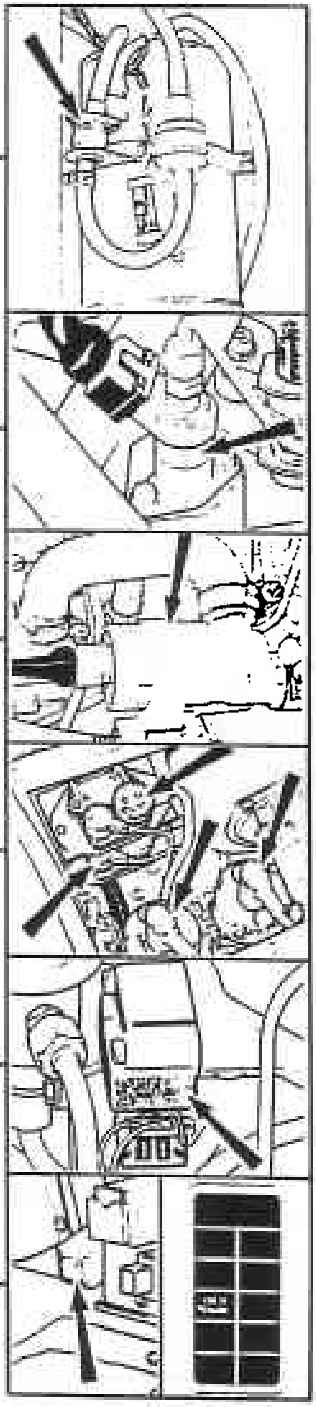
Here, data delivered by the sensors is stored until summoned by the microprocessor or superseded by more recent data. Data is erased when the system is switched off and must be continuously updated during operation. Intermediate storage of calculated values for subsequent processing also occurs here.

Output

Handles data traffic with the environment. Input signals are read with the required frequency; output signals are given at processing speed and in the optimum sequence or stored until being read.

Output stages

- Purge control canister
- Cold start injector
- Idle speed actuator
- Ignition coils and amplifier modules
- Electro-hydraulic actuator
- On-board fault diagnosis capability



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thin layer of platinum. In addition, a porous ceramic layer is applied to the outer side which is exposed to the exhaust gas. The surface of the hollow inner side of the ceramic tube is in contact with the ambient air.

When in position, the ceramic sensor tube is subjected to the exhaust gas on the outside, whilst ambient air is allowed to pass inside the sensing tube. If the oxygen concentration inside the sensor differs from the outside, a voltage is generated between the two boundary surfaces due to the characteristics of the material used. This voltage is a measure of the difference in the oxygen concentration inside and outside the sensor.

The ceramic sensor tube exhibits a steep change in signal output (approximately 1000 mV) when stoichiometric conditions are approached (see fig. B4-23).

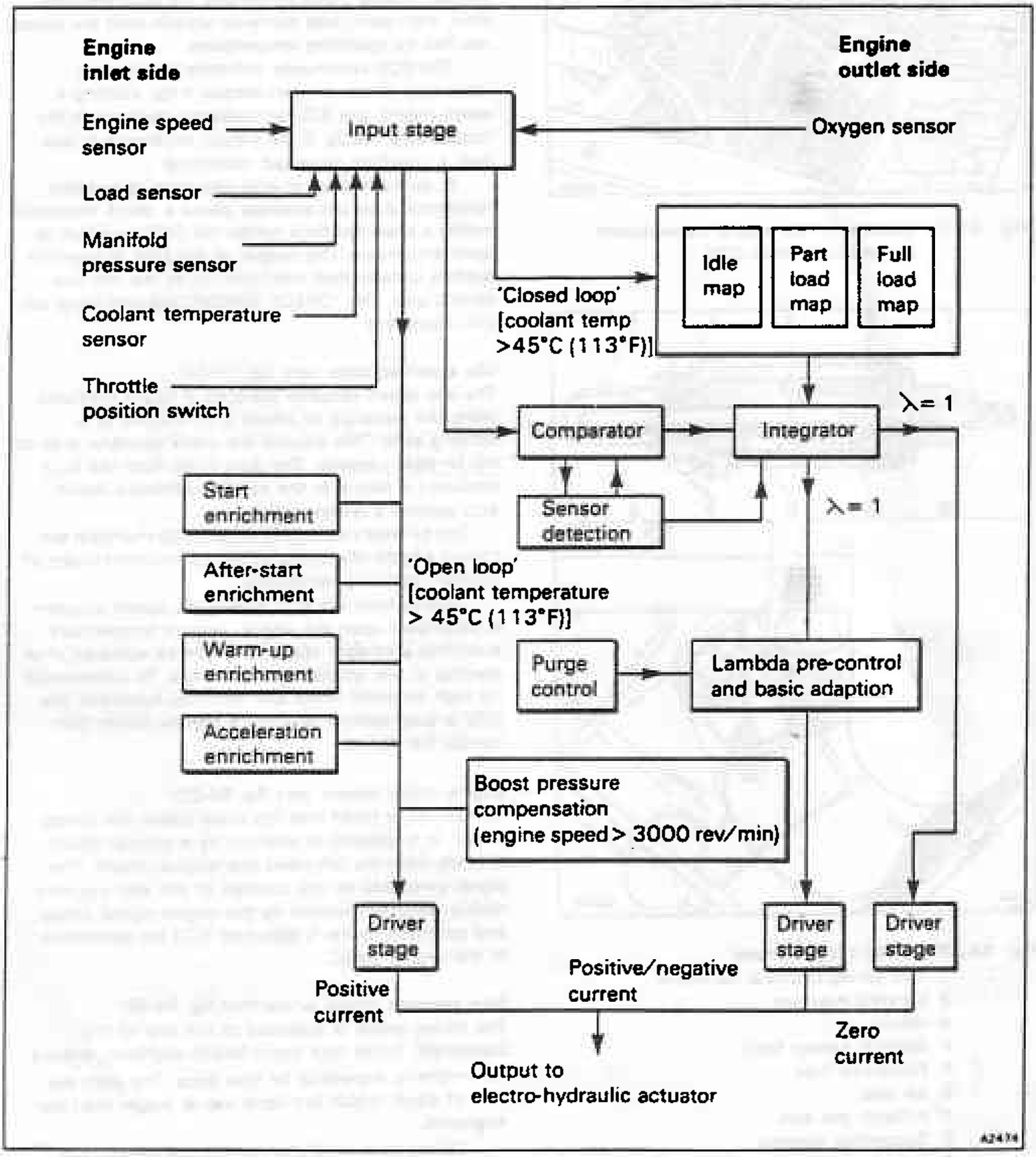

Fig. B4-20 K-Motronic ECU – Air/fuel ratio control

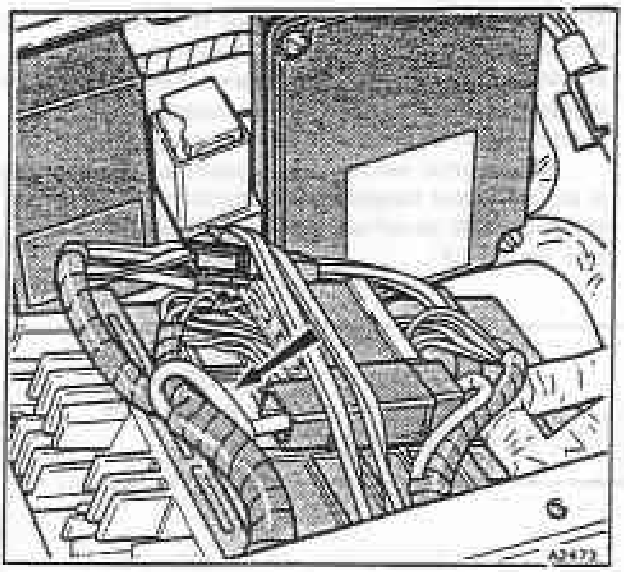

Fig. B4-21 **Location of the engine management system K-Motronic ECU**

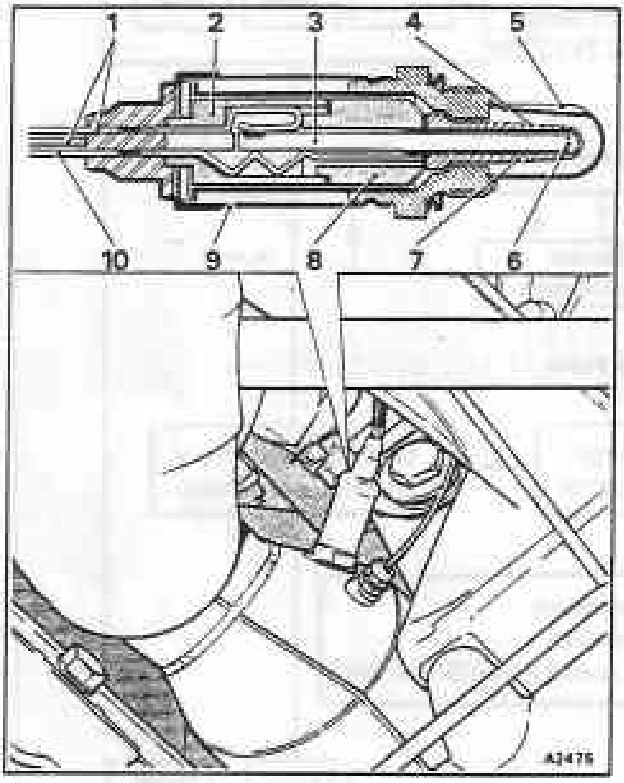

Fig. B4-22 **Heated oxygen sensor**

1 Two spring contacts for heater
2 Ceramic insulator
3 Heater
4 Ceramic sensor body
5 Protective tube
6 Air side
7 Exhaust gas side
8 Supporting ceramic
9 Protective sleeve
10 Contact for sensor

The oxygen sensor will only exhibit this steep change in signal output when a certain pre-determined operating temperature is attained. Therefore, to reduce the oxygen sensor's dependency upon exhaust gas to maintain it at operating temperature, the sensor is heated electrically, using a ceramic heating rod fitted inside the zirconium dioxide tube.

Following engine starting, particularly from cold, it is not possible to exercise satisfactory 'closed-loop' control. During these conditions the ECU provides start, post-start, and warm-up signals until the sensor reaches its operating temperature.

The ECU continually monitors the internal resistance of the oxygen sensor. After starting a warm engine, the ECU immediately operates in the 'closed-loop' mode, if the sensor resistance is less than a specified threshold resistance.

If, during normal engine operation, the sensor resistance does not oscillate about a check threshold within a specified time period the ECU switches to open loop mode. The output to the EHA is zero and fuelling is controlled mechanically by the mixture control unit. The 'CHECK ENGINE' warning lamp will also illuminate.

Idle speed actuator (see fig. B4-24)
The idle speed actuator contains a rotary magnetic drive, the armature of which is connected to a rotating slide. This adjusts the cross sectional area of the by-pass passage. The duty cycle from the ECU produces a torque at the rotating armature which acts against a return spring.

The by-pass passage is adjusted to maintain the correct engine idle speed of 580±20 rev/min under all normal operating conditions.

Output from the ECU to the idle speed actuator is dependent upon the engine coolant temperature such that a smooth idle quality can be achieved after starting at low ambient temperatures. To compensate for high frictional loads and warm-up functions, the ECU is programmed to allow a slightly higher than normal idle speed.

Engine speed sensor (see fig. B4-25)
The sensor is fitted into the cover below the timing wheel. It is retained in position by a bracket which extends from the left-hand rear engine mount. The signal generated by the rotation of the four segment timing wheel is received by the engine speed sensor and conveyed to the K-Motronic ECU for calculation of the engine speed.

Four segment timing wheel (see fig. B4-26)
The timing wheel is attached to the rear of the crankshaft. It has four equal length segments around its periphery, separated by four gaps. The gaps are also of equal length but each one is longer than the segments.

During each revolution of the crankshaft the timing wheel sensor fitted at the rear of the engine, detects four segment and gap combinations. This

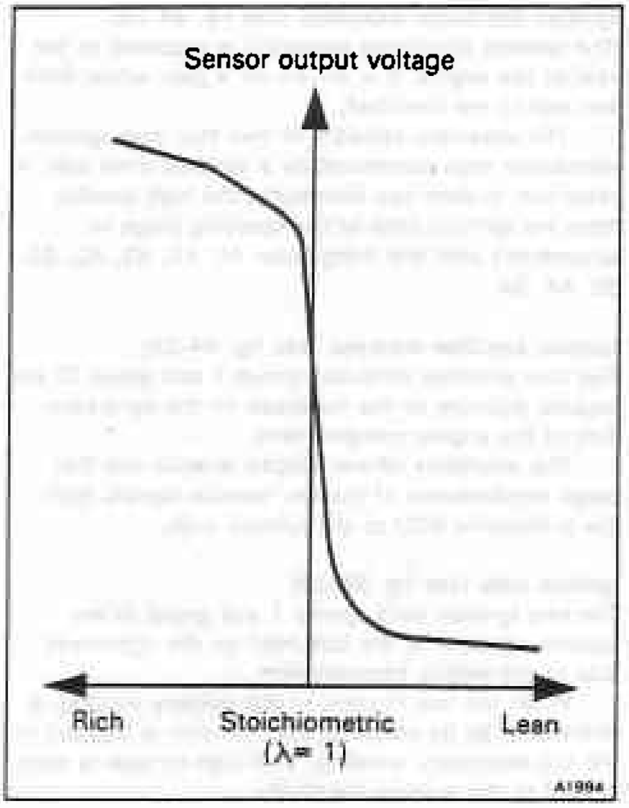

Fig. B4-23 Typical sensor output signal

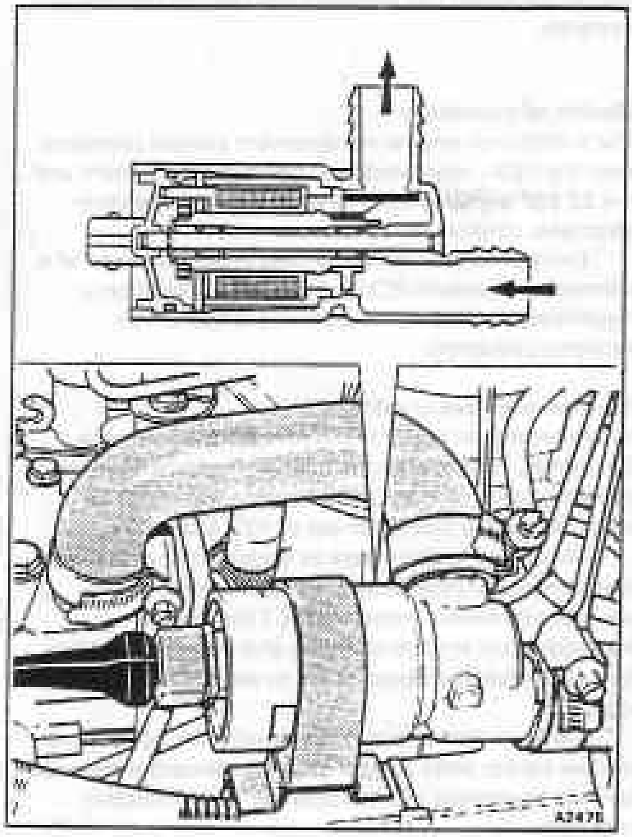

Fig. B4-24 Idle speed actuator

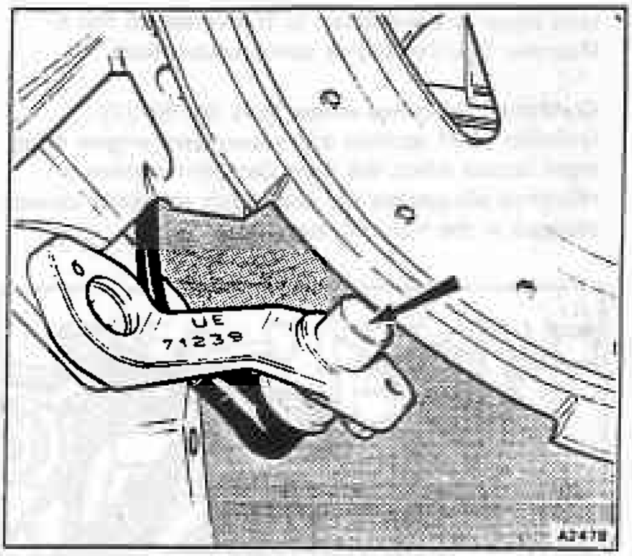

Fig. B4-25 Engine speed sensor

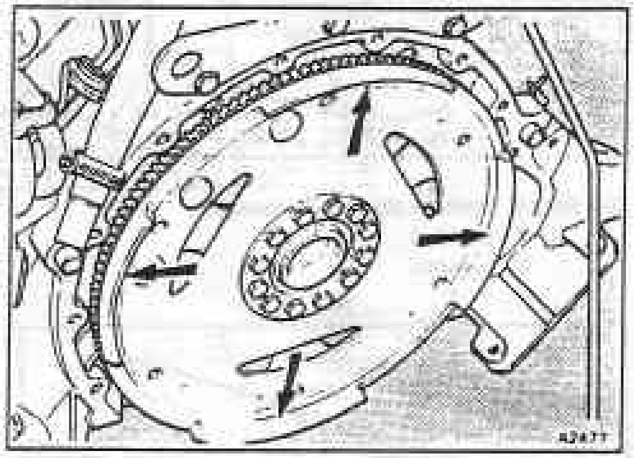

Fig. B4-26 Four segment timing wheel

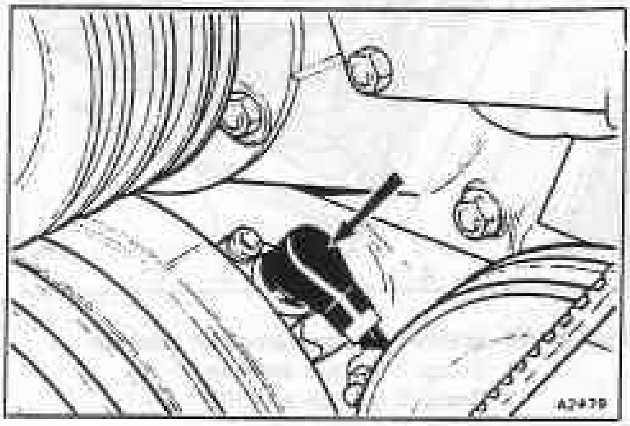

Fig. B4-27 Crankshaft reference sensor

ratio signal is transmitted by the sensor to the K-Motronic ECU for engine speed calculations.

Crankshaft reference sensor (see fig. B4-27)
Initiation of A1 ignition and subsequent engine firing order occurs when the front damper mounted reference pin passes the crankshaft reference sensor, situated at the front of the engine.

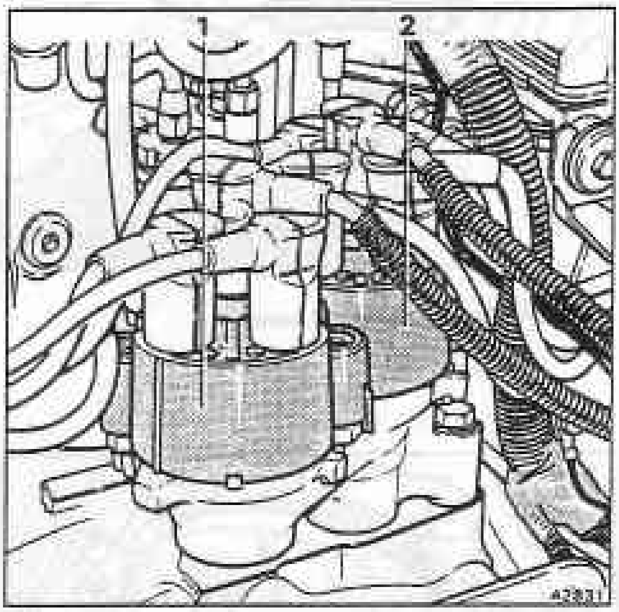

Fig. B4-28 Ignition distributor assembly
1 Group 1
2 Group 2

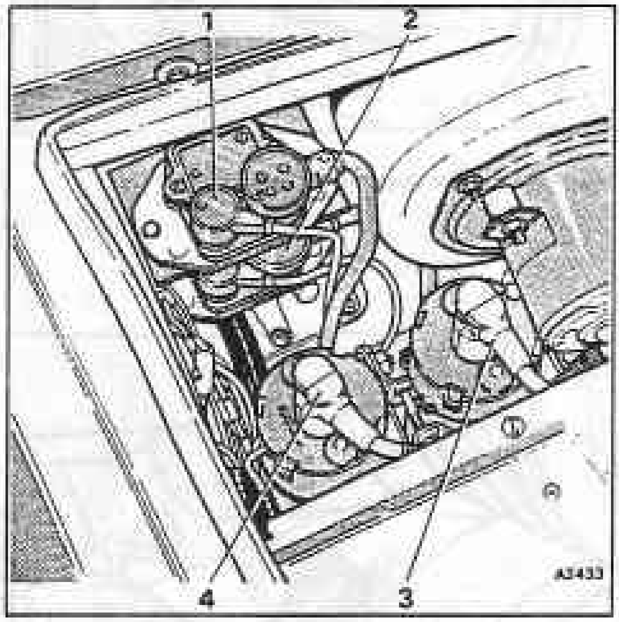

Fig. B4-29 Ignition coils and amplifier modules
1 Group 1 ignition amplifier
2 Group 2 ignition amplifier
3 Group 1 ignition coil
4 Group 2 ignition coil

Ignition distributor assembly (see fig. B4-28)
The tandem distributor assembly is mounted at the rear of the engine. It is driven via a gear wheel from the rear of the camshaft.

The assembly consists of two four pole ignition distributor caps connected by a toothed drive belt. A rotor arm in each cap distributes the high tension from the ignition coils to the sparking plugs in accordance with the firing order A1, A3, B3, A2, B2, B1, A4, B4.

Ignition amplifier modules (see fig. B4-29)
The two amplifier modules (group 1 and group 2) are located adjacent to the bulkhead on the right-hand side of the engine compartment.

The amplifiers (driver stages) provide the first stage amplification of the low tension signals from the K-Motronic ECU to the ignition coils.

Ignition coils (see fig. B4-29)
The two ignition coils (group 1 and group 2) are located adjacent to the bulkhead on the right-hand side of the engine compartment.

When the low tension to the primary winding is interrupted by its amplifier, high tension is induced in the coil secondary winding. This high tension is then passed to the ignition distributor.

Electronic components
The theoretical wiring diagram shown in figure B4-30, provides basic details of the electrical components within the digital fuel injection and ignition control systems.

Modes of operation

The K-Motronic engine management system combines both the KE3 - Jetronic digital fuel injection system and the EZ 58F digital ignition system into one common electronic control unit (ECU).

External pin parameter coding enables the use of a common K-Motronic ECU for all turbocharged cars, regardless of whether or not they are fitted with catalytic converters.

Stand current (pre-cranking)
Minimum engine speed to detect engine cranking is 30 rev/min. Hence, with the ignition on and an engine cranking speed of less than 30 rev/min, the EHA is energized with a stand current of 100 ± 2mA.

There is an audible buzz as both the pre and main fuel pumps energize for approximately one second when the ignition is switched on. This ensures immediate fuel system charging and a pressurized fuel feed at the fuel distributor inlet, to assist engine starting.

It is important to note that the mixture control unit air flow sensor plate should not be deflected, otherwise fuel will be sprayed into the cylinder head induction passages.

Stand current will remain constant whilst the ignition is switched on.