

VOLVO

Service Manual

Fault tracing

Design

Repair

Function

Maintenance

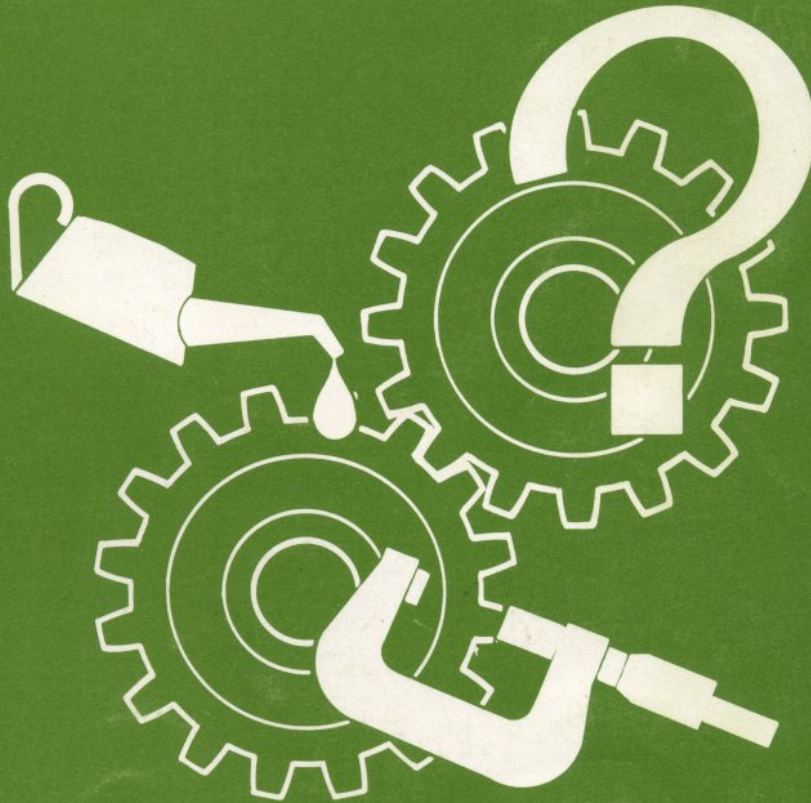
Section 2 (28)

Ignition systems

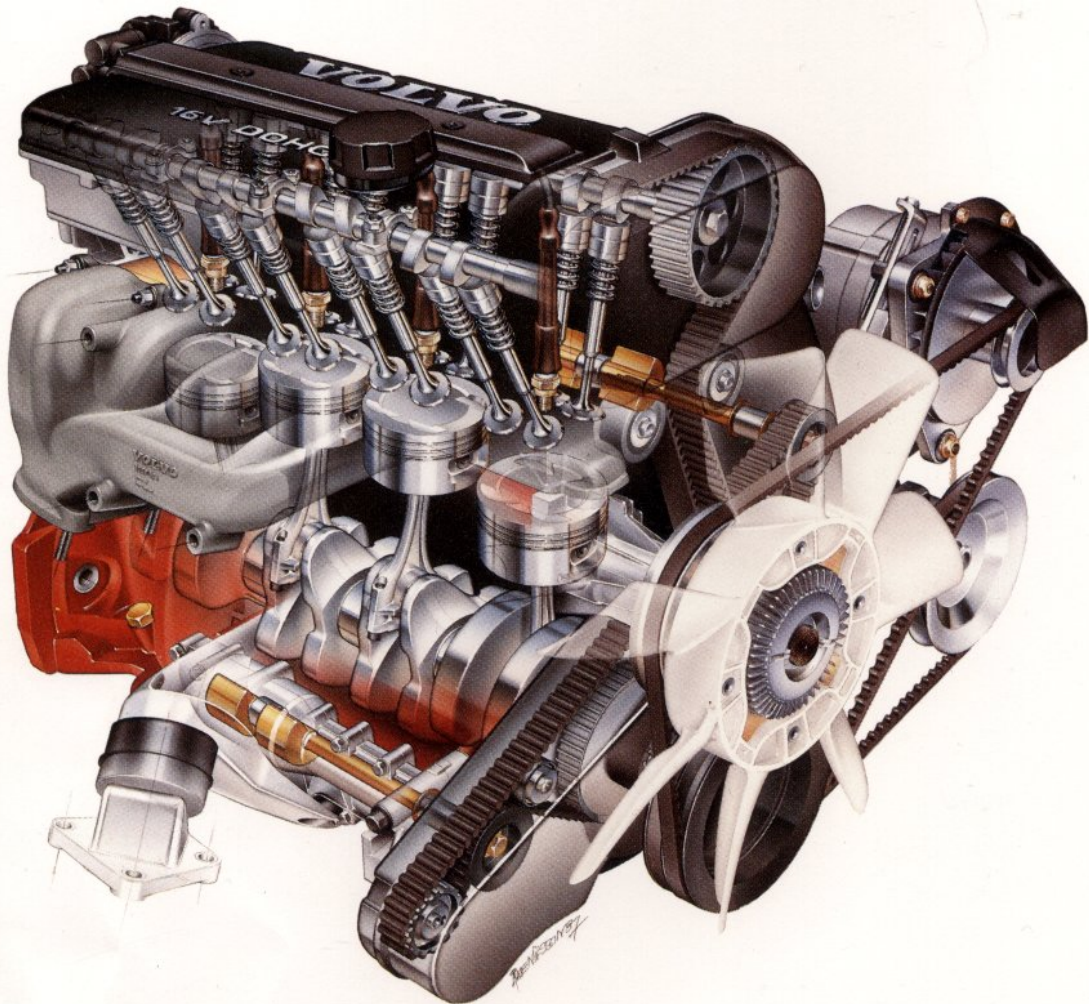
700
1982-

TP 31397/1

July 1989



Volvo Car Corporation



This manual deals with the following engine variants:

Engine	Model year(s)	Engine	Model year(s)
B 19 E	1984	B 230 FT	1985-
B 23 E	1984	B 230 K	1985-
B 23 FT	1984-88	B 200 E	1985-
B 28 A	1982-85	B 200 K	1985-
B 28 E/F	1982-86	B 280 E/F	1986-
B 230 A	1985-86	B 204 E	1989-
B 230 E	1985-	B 234 F	1988-
B 230 F	1985-		

Volvos are sold in versions adapted for different markets. These adaptations depend on many factors including legal, taxation and market requirements.

This manual may therefore show illustrations and text which do not apply to cars in your country.

Volvo owners planning to export their car(s) to another country should investigate the applicable safety and exhaust emission requirements. In some cases it may be impossible to comply with these requirements.

Group 28 Ignition systems

Contents

	Page
Introduction	3
Design and function:	
Overview	
Review of electronic ignition systems – I	4
Review of electronic ignition systems – II (type EZ-K and Rex-I)	6
General	
Function of ignition system; combustion theory in brief	9
Ignition systems – basic parameters	11
Contact-breaker versus electronic systems	13
Components	
Control unit	14
Control unit, power stage and ignition coil configurations	16
Power stage and ignition coil	17
Distributor	19
Speed and crankshaft position information	
Hall generator	20
Speed/position pick-up and flywheel configuration	22
Load information	
Induction manifold vacuum	25
Fuel injection system control unit	26
Compensation functions	
Theory of knock	28
Knock sensor	30
Knock control	32
Knock-controlled fuel enrichment	39
Throttle switch/idling switch	40
Temperature sensor	41
System descriptions	
TSZ	43
TZ-28H	44
Renix-F	45
EZ-102K	47
EZ-117K	49
EZ-118K	51
EZ-115K	55
EZ-116K	58
Rex-I	60
Diagnostic system, EZ-116K and Rex-I	63

Test equipment	68
Instructions	69
Specifications	71-78
Breakerless ignition systems	79
Fault tracing	105
TSZ-4	106
Renix-F	115
TZ-28H	125
EZ-102K	135
EZ-115K	151
EZ-117/118K	169
EZ-116K	187
Rex-I	215
See Service Manual, Fault tracing, repair and maintenance, Section 2 (23), B 23, B 200, B 230 ET Engines, 740, 760 Turbo, for details of Motronic systems. (Order No. TP 30949/1)	

Index, page 227

Order No.: TP 31397/1
Supersedes TP/31059/1 USA

We reserve the right to make changes
without prior notification

Introduction

Comprehensive development work by Volvo has resulted in the design of engines boasting high performance, low fuel consumption, cleaner exhaust gases, a high standard of reliability and simplified service procedures. The ever-increasing use of microelectronics for the control and regulation of ignition and fuel systems has been one of the most significant factors in this development.

Compared with their mechanical counterparts, electronic (or microprocessor-controlled) ignition systems offer advantages such as greater reliability, optimum timing under all driving conditions and few moving parts, reducing service requirements to a minimum. As a result, Volvo has, in recent years, completely replaced its relatively simple, mechanically-controlled, contact-breaker systems with sophisticated systems controlled by microprocessors and electronics.

Equipping system control units with various additional program functions, and integrating them with other control systems and components, has enabled traditional ignition systems to be augmented by features such as temperature-compensated timing for faster engine warm-up, improved exhaust gas composition and lower working temperature. Other functions which may be controlled by an electronic ignition system control unit include fuel cut-off under engine braking (deceleration) conditions and ignition retardation in individual cylinders to eliminate knock.




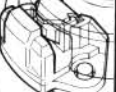
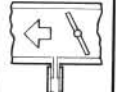
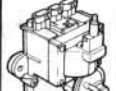


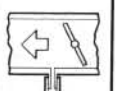
Volvo markets a wide range of models with a series of engine options. This, combined with rapid developments in the field of electronics, means that a wide variety of electronic ignition systems of different types and degrees of refinement now exist.

Systems of this type impose completely new demands on fault-tracing procedures. A certain basic understanding of the input and output signals, the manner in which the components are connected and the function/purpose of each is essential to an understanding of the types of fault which may arise, and to ensuring that the correct diagnosis is made in each case.

Sensors and pick-ups providing fast and precise information on the prevailing running conditions are vital to ensure that the electronics control the working components of the system reliably and accurately.

This manual deals with the electronic ignition systems used by Volvo on its 700 series models, in terms of design and function, as well as fault tracing, repair and maintenance. The first part of the manual consists of a description of the features, components and compensation functions common to the various systems, followed by a description of each individual system and some of the special functions peculiar to each. The appropriate wiring diagrams are included.

Review of electronic ignition systems – I

	A	B	C	D	E	F	G	H
TZ-28H								
KENIX F								

147 077

The above figure shows the major components of each of the systems described below.

Summary

Control system

The control unit (A) houses the electronic circuits and the various program functions needed to compute the timing. The power stage (B) controls the primary current in the ignition coil in response to control signals from the control unit. The power stage may either be an integral part of the control unit or a separate unit assembled with it. The function of the distributor (C) is to deliver the high-tension pulse induced in the secondary winding of the ignition coil to the correct spark plug. The distributor may be driven either by bevel gearing (in which case it is installed vertically) or directly from the camshaft (horizontally installed units). In systems in which the rotor arm is the only moving part (such as types which employ inductive speed pick-ups) the timing cannot be varied by altering the position of the distributor.

Sensors

The remaining components in the table (D-E) comprise part of the sensor system. Together with the control unit, these supply information on prevailing engine running conditions.

Basic parameters

The control unit is supplied with information on engine speed and crankshaft position (D) either by a Hall generator activated by a trigger rotor (with four vanes) mounted on the rotor shaft or by an inductive pick-up mounted close to the flywheel (on manuals) or carrier plate (automatics). In this case, the periphery of the flywheel/carrier plate is provided with a series of holes whose passage is detected by the pick-up and indicated in the form of electrical signals. The engine load (E) is measured either by means of a vacuum line attached to the intake manifold or, if the engine is equipped with an LH-Jetronic fuel injection system (i.e. most engines equipped with EZ-K ignition systems), by an air mass meter (see next illustration). The various signals – engine speed, crankshaft position and engine load – comprise information which is used by ignition systems of all types to compute the timing.

Review of electronic ignition systems – I




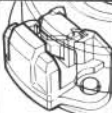







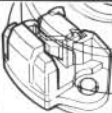







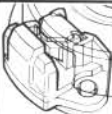


























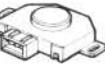

TSZ: An electronic ignition system in which the function performed by contact breaker points in conventional systems is carried out by an inductive pulse generator. (Roughly translated, the abbreviation TSZ – which stands for Transistor Spolen Zündung – means ‘Transistorized coil ignition’.) The pulse generator signals are transmitted to a ‘control unit’ which regulates the coil charging period. The system also incorporates a centrifugal generator and a ballast resistor. Designated TSZ-4, the variant for 6-cylinder engines (B 28 A/E/F) was used on 700 series cars from 1982 to 1986.

TZ-28H: As the designation indicates, this is a transistorized system employing a Hall generator to supply the signals used by the ‘control unit’ to control the primary current in the ignition coil. A vacuum advance unit on the distributor varies the timing with engine load. Although the system was used on some 700 series models produced in 1984, it was almost completely superseded by other systems in 1985 as the new family of engines entered production. (Unlike other systems discussed in this context, TZ-28H is not fully electronic; indeed, it is usually regarded as one of the group of transistorized systems.)

RENIX-F: The name is a trademark of the Bendix company. In this system, the control unit, power stage and ignition coil comprise a single unit. Since 1985, Renix-F has been used on 740s equipped with the B 200 K engine and Solex carburettor.

* The letters used in the designations of the various systems are usually derived from the maker’s native language, while the figures usually denote the version and/or variant designation.

Review of electronic ignition systems – II (Type EZ-K and Rex-I)

	A	B	C	D	E	F	G	H
EZ-102K								
EZ-117K								
EZ-118K								
EZ-115K								
EZ-116K								
REX-I								

147 078

The illustration shows the main components of type EZ-K and Rex-I ignition systems.

Common features:

An abbreviation of the German term Elektronischer Zündung mit Klopfregulung (roughly, 'Electronic ignition with knock sensor') the designation EZ-K describes a group of systems manufactured by the Bosch company. The various systems in the EZ-K group are relatively similar in terms of functions and components. All feature microprocessor control and incorporate a memory which is programmed with a family of ideal timing curves for the particular engine. Each system also includes a sensor which detects engine knock and retards the ignition in response to a memory program which is individual to each cylinder. This means that the timing in each cylinder may vary at any given instant.

As column E indicates, systems in this group are normally supplied with engine load information by an air mass meter located in the intake system. A measure of the quantity of air supplied to the engine, the air mass meter signal is transmitted to the LH-Jetronic control unit (in which it is converted and used to determine the quantity of fuel to be injected) and then to the ignition system control unit.

Differences

Within the EZ-K group, the individual systems are distinguished by the timing curves used for different engine variants, by whether a Hall generator or inductive speed/position pick-up is used, and by when the ignition compensation functions are activated.

Review of electronic ignition systems – II

EZ-102K was introduced in 1984 in conjunction with the launch of the 760 Turbo with the B 23 FT engine and LH 2.1 fuel injection system on the American market. EZ-102K is equipped with a thermostat which transmits a signal to one of the control unit terminals when the engine temperature becomes excessive, commanding it to advance the timing if the throttle is closed. The first EZ-K system to be used by Volvo, EZ-102K remained in production only for a year before being superseded by more up-to-date variants according as the new family of engines was introduced.

EZ-117K is very similar to EZ-102K in configuration, although designed for the B 230 F and B 230 FT engines with the LH-Jetronic 2.2 fuel injection system. The system was introduced with the new family of engines in 1985. The B 230 FT variant features a knock-controlled fuel enrichment function. Like its predecessor, EZ-102K, the turbo engine variant is equipped with a thermostat which activates a timing advance function to protect the engine from overheating.

EZ-118K differs most from the other systems in the group, due to the fact that it depends on a vacuum connection between the intake manifold and control unit to supply engine load information, rather than on a load signal supplied by an air mass meter via the fuel system control unit. The system also employs an idling switch mounted on the throttle pulley rather than a switch mounted on the throttle housing. EZ-118K was introduced in 1985 on the B 200 E, B 230 E and B 230 K engines. Two idling compensation functions may be used on all EZ-118K variants. The B 230 K variants are equipped with a temperature sensor, while the control unit operates a solenoid valve which interrupts the fuel supply under engine braking conditions. Most of the differences are attributable to the fact that the system is used on carbureted engines (now with Pierburg carburetors) and on E engines with the CI system (K-Jetronic).

EZ-115K has been designed especially for the B 280 engine. Its features include two knock sensors (one for each bank of cylinders), a position detector for No. 1 cylinder, a knock-controlled fuel enrichment function and an inductive speed/position pick-up mounted at the flywheel. Depending on the temperature sensor signal, the control unit can apply timing compensation by retarding the ignition when the engine is cold to achieve faster heating of the coolant, and by advancing it when the engine tends to run too hot. The system appeared in 1987 with the introduction of the B 280 engine to replace the B 28, and is, therefore, used only on the 760/780. EZ-115K is used in combination with LH-Jetronic 2.2 on both the E and F variants.

EZ-116K is a refinement of other EZ-K systems. However, it features advanced self-diagnostics which facilitate fault tracing and monitoring. The control unit continuously monitors the various sensors and functions, and any faults present may be displayed with the aid of a diagnostic unit mounted in the engine compartment. EZ-116K was introduced in 1988 on the 16-valve B 234 F engine used in the 740 GLT. Unlike other EZ-K systems used on 4-cylinder engines in the 700 series, EZ-116K is equipped with an inductive speed/position pick-up mounted close to the flywheel instead of a Hall generator in the distributor. The system is used in combination with the very latest fuel injection system (LH-Jetronic 2.4).

Manufactured by Bendix, the **Rex-I** system is equipped with the same type of diagnostic system as EZ-116K. Used in conjunction with the Regina fuel injection system, Rex-I was introduced in 1989 on B 230 F engines sold in the USA.

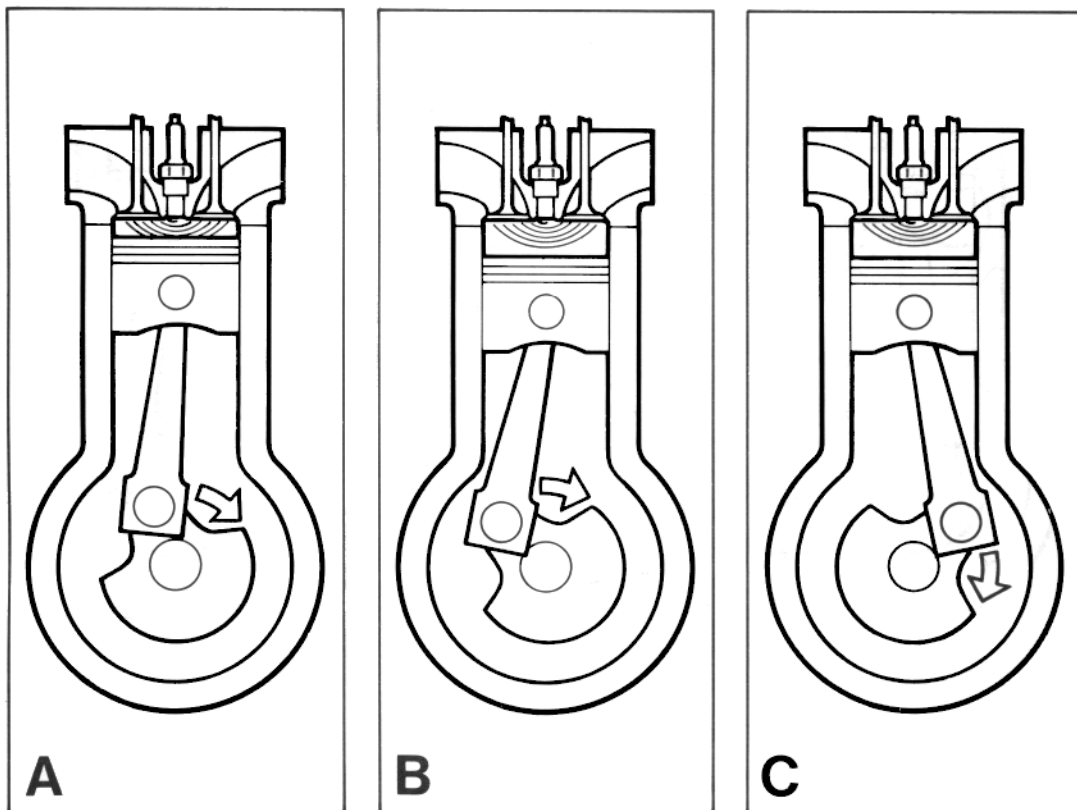
Compensation functions

However, most electronic ignition systems are equipped with additional sensors which enable the control unit to adjust the timing to compensate for unusual running conditions. Thus, sensors (F-H) may be regarded as providing the ignition system with compensation functions. In the event of engine knock (the phenomenon whereby the fuel/air mixture is ignited by a source other than the spark plug), the knock sensor (F) mounted on the engine will transmit a signal to the control unit commanding it to retard the ignition. Complete closure of the throttle is indicated by a throttle switch/idling switch (G). When the engine is idling, the control unit regulates the timing in accordance with an 'idling program' to ensure optimum comfort, while the timing under engine braking conditions is controlled to minimize exhaust emissions. The signal supplied to the control unit by the temperature sensor/thermostat enables the unit to apply the appropriate timing compensation when the engine temperature is unusually high or low.

IGNITION SYSTEM	ENGINE	YEAR
TSZ-4	B 28 A	82–85
TSZ-4	B 28 E	82–86
TSZ-4	B 28 F	82–86
TZ-28H	B 19 E	84
TZ-28H	B 23 E	84
TZ-28H	B 230 A	85–86
MOTRONIC	B 23 ET	84
MOTRONIC	B 200 ET	85–
MOTRONIC	B 230 ET	85–
RENIX-F	B 200 K	85–
REX-I	B 230 F	89–
EZ-102K	B 23 FT	84 (USA)
EZ-117K	B 230 F	85–88
EZ-117K	B 230 FT	85–
EZ-118K	B 200 E	85–
EZ-118K	B 230 E	85–
EZ-118K	B 230 K	85–86
EZ-118K	B 230 K	87–
EZ-115K	B 280 E	87–
EZ-115K	B 280 F	87–
EZ-116K	B 234 F	88–
EZ-116K	B 230 F	89–
EZ-116K	B 204 E	89–

N.B. Due to differences in model specifications from country to country, the number of control unit variants used for the various ignition systems and engines may exceed that listed above.

General



147 079

Function of ignition system; combustion theory in brief

Correct ignition timing

A. The function of the ignition system is to ignite the compressed fuel/air mixture in each cylinder at exactly the correct instant. Ignition is followed by the propagation of a flame front through the combustion chamber until the complete charge has been burned. The combustion pressure, which is higher than that of the compressed mixture, generates a high force which drives the piston downwards in the cylinder. (Although a proportion of the energy released is converted into mechanical work by the crankshaft, most of the energy in the fuel (approx. 70%) is dissipated in the form of cooling losses, exhaust gas losses and mechanical losses.)

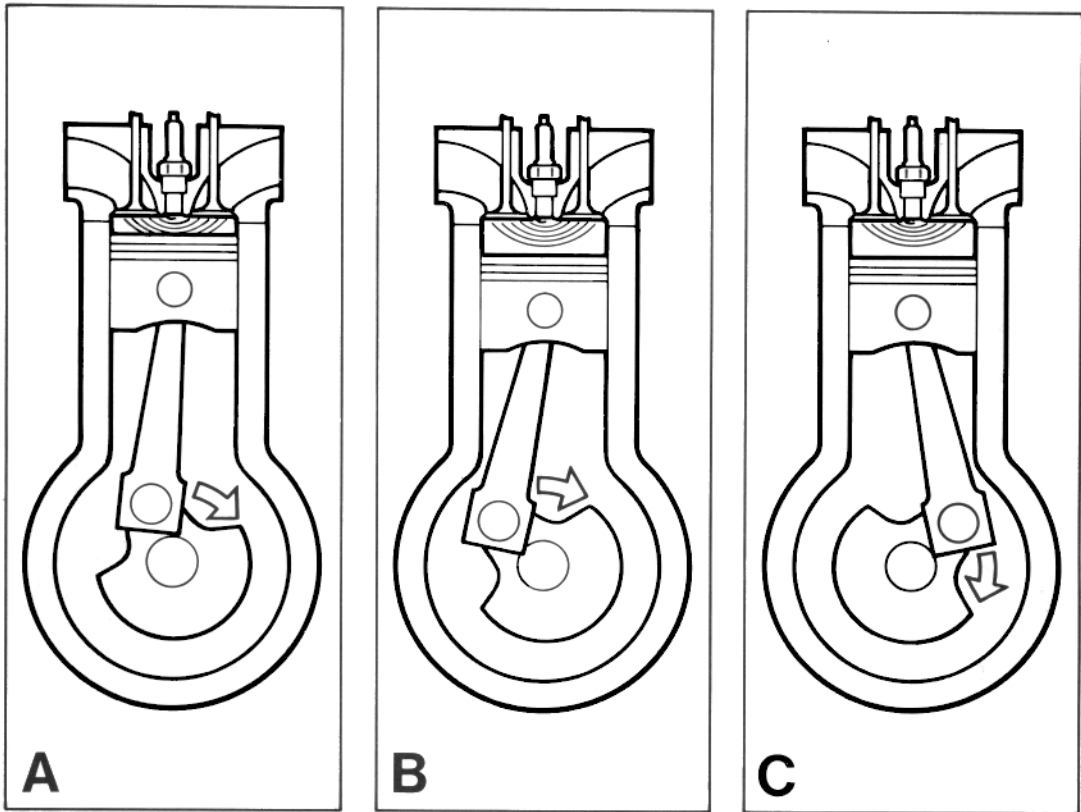
To ensure that the ignition timing is as close as possible to the 'correct' setting under all running conditions, the timing must be adjusted continuously to take account of variations in the conditions. In other words, the optimum timing is not a fixed setting for each engine, but varies with factors such as engine speed, load, fuel/air ratio and temperature. Furthermore, the timing may be adjusted for optimum comfort, maximum torque or maximum power as appropriate.

In the rest of this discussion, the term optimum timing shall be taken to mean a setting which takes account of all the factors influenced by the ignition. In other words, it is a compromise between the demands of high power, low fuel consumption and the cleanest possible exhaust emissions. The emergence of ever-stricter emission standards has been the main factor in the development of ignition systems designed to optimize the combustion process under all running conditions.

Early ignition

B. Early ignition prevents efficient expansion of the fuel/air mixture since the piston is still travelling upwards towards TDC as the pressure rise occurs, generating an abnormally high pressure accompanied by an excessive temperature rise. As a consequence of early ignition, part of the unburnt fuel/air mixture may ignite spontaneously, causing the engine to knock.

In general, early ignition also has an adverse effect on the exhaust emissions. The quantity of unburnt hydrocarbons (HC) increases, while the pressure and temperature rises cause the nitrogen in the trapped air to react with the oxygen to form greater quantities of nitrogen monoxide (NO) and nitrogen dioxide (NO₂ or NO_x, oxides of nitrogen).



147 079

Late ignition

C. Late ignition reduces engine power since the piston is travelling downwards from TDC when the pressure rise occurs. As a result, the engine does not utilize the full energy content of the fuel. Although the concentrations of undesirable constituents such as HC, CO, NO and NO₂ are lower under these conditions, the engine requires more fuel to deliver the same output, producing a greater total volume of exhaust gases.

Effects on cylinder and exhaust gas temperatures

Advancing the ignition (i.e. generating the spark to ignite the fuel/air mixture when the piston is further from TDC) produces a higher combustion temperature and a lower exhaust gas temperature than when the timing is retarded. This is due to the fact that the compression produced by upward movement of the piston reinforces the pressure wave developed by the flame front, causing the cylinder pressure and temperature to increase. The lower exhaust gas temperature is explained by the somewhat longer interval between the completion of combustion and the opening of the exhaust valve.

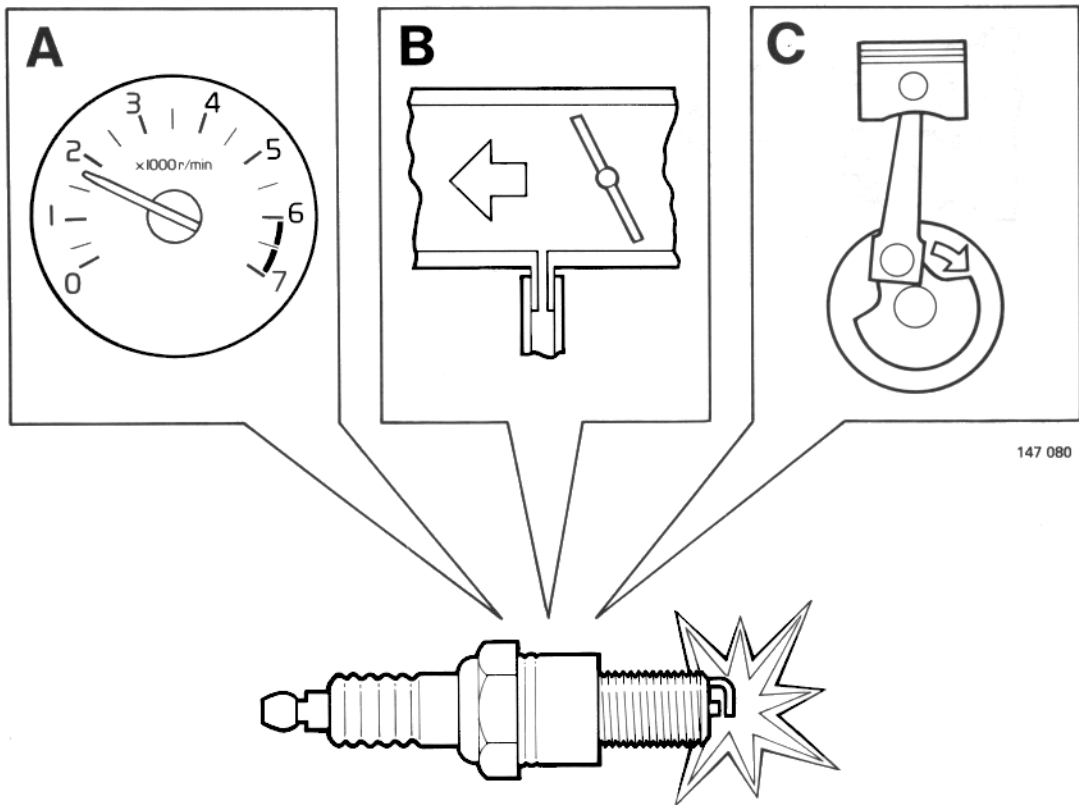
Retarding the ignition (generating the spark when the piston is closer to TDC) produces a lower combustion temperature, but a higher exhaust gas temperature than when the timing is advanced. Under these conditions, a higher proportion of the energy is released during the expansion stroke (when the piston is moving downwards), reducing the maximum temperature somewhat. The higher exhaust gas temperature is explained by the shorter interval between the completion of combustion and the opening of the exhaust valve.

***NOTE:** It is important that the following terms be clearly understood in order to avoid confusion:

- Advancing the ignition timing means that the ignition pulse is delivered when the piston is at a point further from TDC.
- Retarding the ignition means that the ignition pulse is delivered when the piston is at a point closer to TDC.

* Under normal conditions, the aim is to develop 'peak' pressure in the cylinder about 10° after TDC. Under idling conditions, the timing is advanced (to approx. 10–15° before TDC) to ensure smooth running.

* The foregoing discussion of how the emissions are affected by the ignition timing is somewhat simplified, since there are naturally many other factors which influence the composition of the exhaust gases.



147 080

Ignition systems – basic parameters

The ignition system control unit must be supplied with certain basic information in order to compute the frequency or rate at which HT ignition pulses must be delivered to the spark plugs, when (in relation to the position of the particular piston before TDC) each pulse must be generated and to which plug the pulse is to be delivered. The signals required for this purpose are derived from the engine speed (A), engine load (B) and crankshaft position (C).

Speed information

A. The engine speed provides information on the number of ignition pulses which must be generated per unit of time. The number of high-tension (HT) pulses delivered to the plugs must be increased as the engine speed rises.

The speed signal is the most vital piece of information supplied to the control unit. For example, the engine cannot be started in this signal is unavailable.

The control unit also uses the engine speed to determine the point at which the ignition pulse must be delivered in relation to the position of the piston before TDC. Ignition must take place earlier at higher speeds since the upward and downward movement of the pistons is faster under these conditions. As a result, the time available for combustion of the fuel/air mixture is less and the timing must be advanced to ensure that the mixture is burned as completely as possible.

Load information

B. Except in turbocharged engines, the engine load varies with the vacuum in the intake manifold. At low loads, the throttle is only partially open and the flow of induction air is low, resulting in a high vacuum. At higher loads, the throttle opens wider and more air is supplied to the engine. Under these conditions, the vacuum in the manifold approaches closer to atmospheric pressure as the load is increased. It follows from this that a greater quantity of fuel/air mixture is available for combustion as engine load increases and that the higher volume of gas produced reinforces the pressure due to compression. Since the rate of combustion is accelerated by higher gas compression, the timing is retarded as engine load is increased. At low engine loads, on the other hand, the timing may be advanced to compensate for the lower rate of combustion and to improve fuel utilization.

Crankshaft position information

C. The crankshaft position (i.e. angle) provides information on the position of each piston in relation to TDC. This information is essential to the system control functions, which compute the timing continuously on this basis.

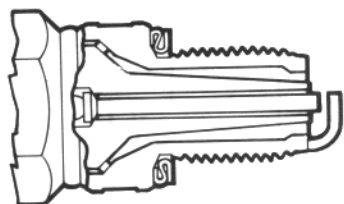


Fig. 1 'Hot' plug

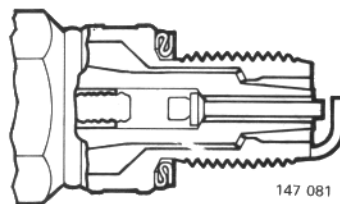
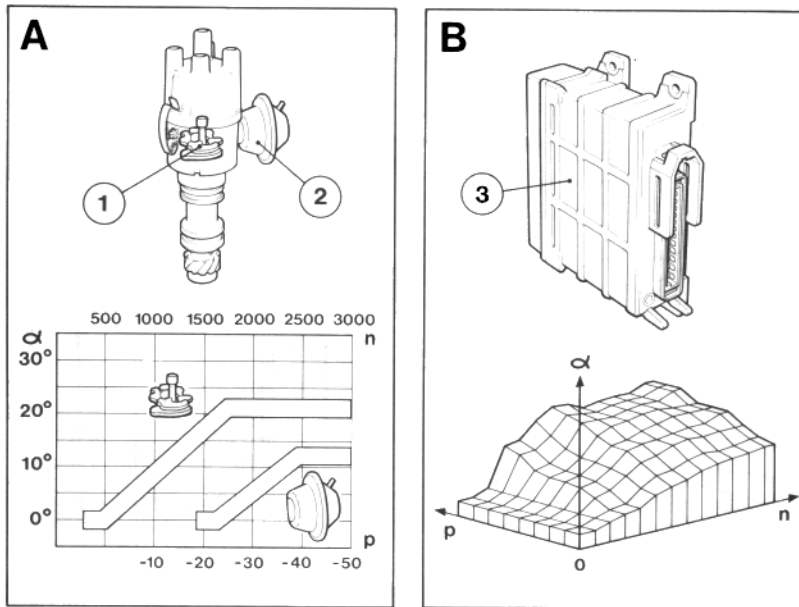


Fig. 2 'Cold' plug

* **Spark plugs:** Use of the correct type of spark plug, correctly installed and replaced at the recommended intervals, is essential to the satisfactory operation of the ignition system. Assuming the engine to be in good condition, adherence to these recommendations will ensure maximum plug life, making the component one of the most reliable in the ignition system.

In this context, it may be of interest to consider some of the demands imposed on the spark plugs and to discuss a number of concepts.

- As the means used to ignite the mixture in the combustion chamber, the spark plug initiates the combustion process. The plugs are designed to supply up to approx. 25 sparks per second per cylinder at 6000 r/min in a 4-cylinder engine, from a high-tension source which, in the case of electronic ignition systems, **often operates at over 30 kV**.
- Spark plugs must be capable of withstanding the extremely rapid temperature and pressure fluctuations which occur in the combustion chamber. During the combustion process, the temperature rises at intervals to a value of **perhaps 2500°C and the pressure to approx. 60 bar (870 psi)**. Almost immediately, during the induction stroke, the plug comes in contact with the cold, uncompressed fuel/air mixture, which is likely to be at the same temperature as the outside air.
- To ensure operation within the correct operating temperature range, spark plugs are made with different heat ratings (or ranges) for different engine types. If the operating temperature is too low (i.e. below about 400°C), the plug will rapidly become coated with combustion residues. This type of fouling weakens the spark and causes the engine to miss. On the other hand, if the operating temperature is too high (over approx. 1000°C), the fuel/air mixture may be ignited by the incandescent plug surfaces, initiating uncontrolled combustion. Every engine manufacturer specifies the appropriate heat rating on the basis of parameters such as specific engine output, probable running conditions and climatic conditions.
- A plug with a high heat rating has a greater thermal retention capacity and conducts less heat away from the combustion chamber. This type is normally used on low-speed engines operating at relatively low combustion temperatures. Plugs of this type are also known as 'hot' plugs and are provided with a long insulator nose as shown in Fig. 1.
- A spark plug with a low heat rating has a lower thermal retention capacity and conducts a greater amount of heat away from the combustion chamber. This type is normally used on engines with high specific outputs operating at relatively high combustion temperatures. Plugs of this type are also known as 'cold' plugs and feature a short insulator nose as shown in Fig. 2.
- Fitting a plug with the recommended heat rating will ensure that the correct working temperature is reached quickly without the risk of overheating. This also assumes that the tightening torque is within the specified limits, since the thermal conductivity will be dependent on the degree of contact between the cylinder head and plug. The spark gap should also be checked; an excessive gap will cause the engine to miss.



147 082

Contact-breaker versus electronic systems

Figure (A) shows the timing curve for a contact-breaker ignition system, while (B) illustrates the settings with which an electronic system is programmed, in the form of a three-dimensional map. In each case, both engine speed and load are taken into account when determining the setting. However, in contrast with the electronic system, which computes the timing, the contact-breaker system controls it within a specified range.

The timing must be controlled to a high degree of accuracy to meet the demands of the modern engine for the cleanest possible exhaust emissions, maximum fuel economy and high performance under fluctuating conditions. Neither may these requirements be permitted to vary, even following an extended period of driving.

Timing curve symbols

Both figures illustrate the manner in which the timing angle (α) varies with the engine speed (n) and the vacuum (p) in the intake manifold. The angle (α) increases with speed; in other words, ignition of the fuel/air mixture takes place earlier as the speed rises. The angle also increases with the vacuum in the intake manifold i.e. as the engine load falls and the fuel/air charge supplied to the engine becomes smaller.

Contact-breaker ignition systems

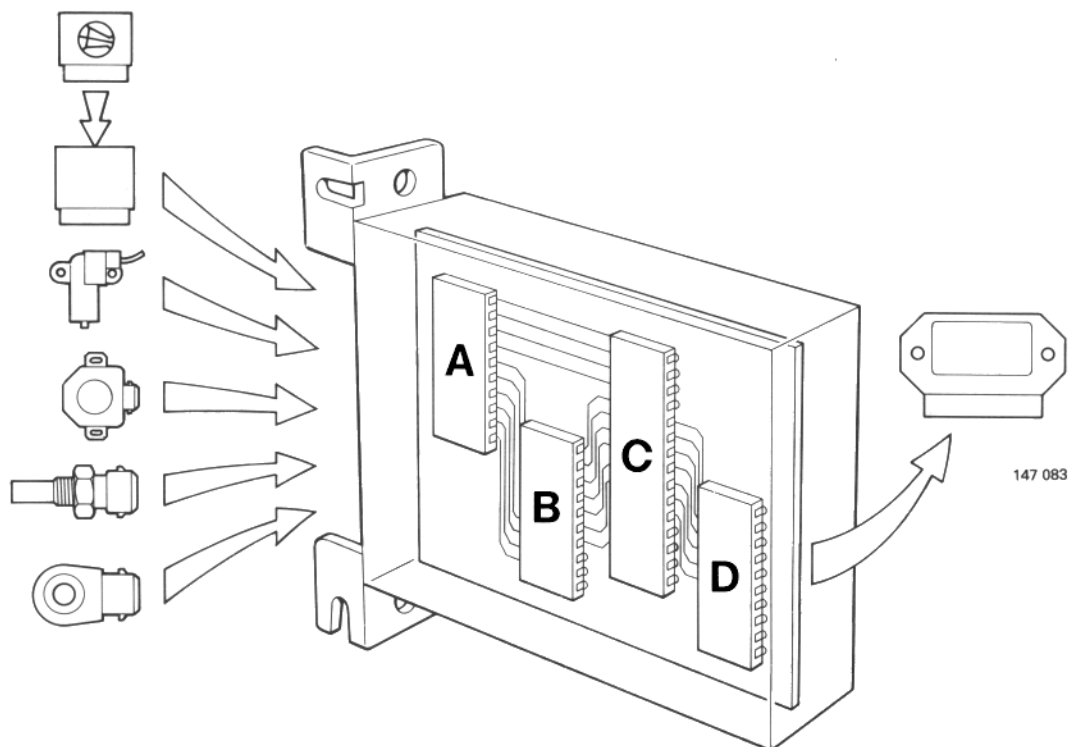
A. Contact-breaker ignition systems control the timing with the aid of a centrifugal governor (1) and a vacuum advance unit (2). (Being a speed-dependent device, the governor advances the ignition as the speed increases, while the vacuum advance unit retards it as the engine load increases in response to the vacuum signal from the intake manifold.) The two devices operate independently within a tolerance band of approx. 2–4°. Overall, this means that the system controls the timing within a tolerance range of approx. 4–8°, since the setting is the sum of the angles indicated by the two curves. Furthermore, the variation which results from wear of the breaker points affects the overall timing.

Electronic ignition systems:

B. The control unit (3) of an electronic ignition system, by contrast, is programmed with a series of specific settings for a number of defined speeds and engine loads. This means that the timing can be controlled to an accuracy as high as a fraction of a degree and that each ignition pulse is delivered as close as possible to the optimum point. (This high level of accuracy is achieved partly by the fact that the control unit interpolates between the programmed speed and load points. In other words, it is capable of computing an intermediate setting.) Furthermore, the timing can be computed over a wider range and is not restricted by the type of linear functions typical of a centrifugal governor.

The timing is computed with the aid of sensors which determine the engine load and speed. This information is transmitted electrically to the control unit electronics, in which details of a number of different speed and load combinations, together with the appropriate timing settings, are stored. Prior to each ignition pulse, the control unit computes a setting which is perfectly matched to the engine running conditions prevailing at the precise instant.

Adjustments required by the various timing compensation functions are added to the three-dimensional map.



Components

Control unit

The control unit in an electronic ignition system continuously computes the optimum timing based on information supplied by the various sensors, which combine to provide the unit with an extremely accurate picture of engine running conditions. The control unit receives immediate notice of any change in the conditions under which the engine is powering the car, enabling it to compute a new setting instantaneously. Once this has been completed (in an operation taking as little as a thousandth of a second!), the unit delivers an ignition pulse to the power stage.

The control unit consists of a number of electronic components. In simplified terms, these consist of four main elements – converter (A), memory (B), microprocessor (chip) (C) and output unit (D).

Converter

A. The converter (A) receives information from the sensors and converts the signals into digital (numerical) form. Some of the sensors supply analogue signals (such as the temperature-dependent change in resistance typical of a temperature sensor), while the signal transmitted by others depends on whether or not a voltage is present (as in the case of a throttle switch). The sensors may also transmit signals in the form of voltage pulses (like an inductive pick-up) or a variable-frequency voltage (like a load signal vacuum converter). All of these electrical signals, whether in the form of a single, variable voltage or a series of voltage pulses, are converted into standard digital form by the converter, the outputs from which are used by the microprocessor and memory.

Memory

B. All programs and pre-programmed values are stored in the memory (B), in which all possible values of parameters such as engine load and speed are available for immediate use by the microprocessor.

Microprocessor

C. The microprocessor (C) receives the digital signals from the converter. Depending on the signal configuration, the device selects the memory program which best meets the needs of the prevailing running conditions.

Output unit

D. The digital information supplied by the microprocessor is fed to the output unit (D) for conversion into the ignition pulses fed to the power stage. (This may either be an integral part of the control unit or a separate unit.)

Depending on the program selected at the particular instant, the control unit determines the point at which the ignition pulse must be delivered to the power stage. The latter controls the current in the primary winding of the ignition coil in response to the signals from the output unit.

Voltage stabilizer

The control unit is powered by a 12 V supply. However, since the battery voltage is too high for the internal integrated circuits, a voltage stabilizer is used to produce a stabilized 5 V supply for these.

* Engine speed limitation: All control units are programmed with some type of speed limiting function. On Bendix systems, the control unit normally commands the power stage to reduce the ignition coil charging period, producing a weaker spark which limits the engine output. On EZ-K systems, the control unit uses the power stage to interrupt the spark to every second plug. The speed limiting function normally intervenes at about 6200 r/min.

In the case of cars equipped with F engines, the speed limiting function controlled by the ignition system control unit is set to operate at a higher level than that controlled by its fuel system counterpart. This prevents unburnt fuel from reaching the catalytic converter, with the attendant risk of overheating.

* The control unit memory is programmed with a range of speed and load values. The unit improves the accuracy of control by interpolating between these values, performing up to about 10000 computations per minute to ensure that optimum timing is maintained under all conditions. As many as 4000 individual settings may be computed as required.

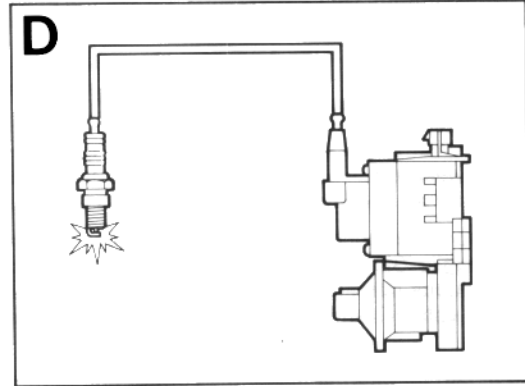
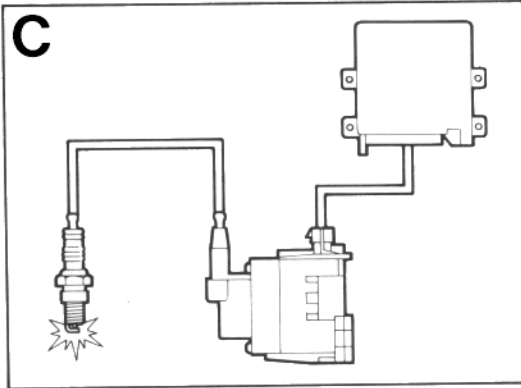
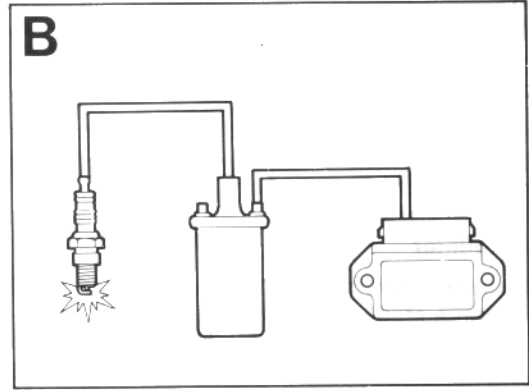
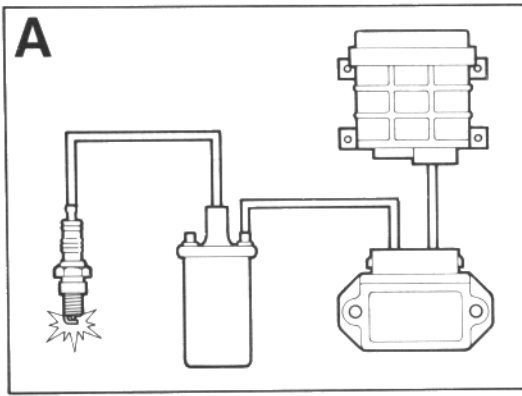
* Built from components such as integrated circuits, transistors, diodes and capacitors, electronic components like the control unit are relatively fragile. Since the electronics used in cars are exposed to such a diversity of operating conditions, they are subject to particularly arduous demands. The equipment must be designed to withstand vibrations, moisture, wide temperature fluctuations, variable voltages and other sources of outside interference (e.g. from radios) to which the electrical system is unavoidably exposed.

* In the case of certain internal faults, the control unit regulates the ignition in accordance with a fixed, pre-programmed timing curve.

* In the absence of a load signal, the control unit modifies the timing on the basis of the speed signals which it receives, and operates in accordance with the pre-programmed, full-load timing setting when the idling switch has opened.

* If the knock sensor signal is lost, the control unit computes the timing setting on the basis of a 'fail-safe' retardation of approx. 10°.

* The control unit electronics must not be exposed to excessively high temperatures. For example, removal of the unit prior to the completion of the stoving process during manufacture may result in its destruction. Because of its sensitivity to temperature, the unit is normally installed in a location well protected from engine heat.



147 084

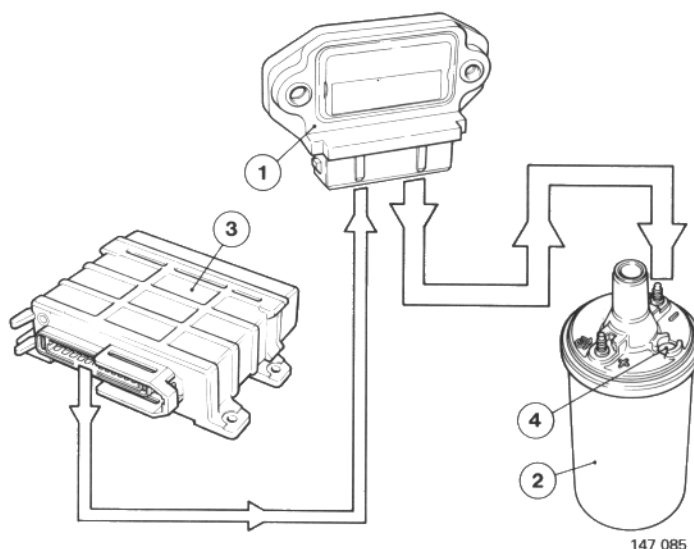
Control unit, power stage and ignition coil configurations

The control unit, power stage and ignition coil configuration may take one of four different forms.

As a general rule, the control unit delivers ignition pulses to the power stage (which controls the current in the primary winding of the ignition coil) in response to signals from the various sensors and pick-ups. A high-tension voltage is induced in the secondary and fed to the distributor, which delivers it to the appropriate spark plug, generating a spark across the electrodes and igniting the fuel/air mixture.

- A.** The control unit, power stage and ignition coil may all be separate components. This applies to EZ-K systems.
- B.** The control unit and power stage may be combined in a single unit, with a separate ignition coil. This applies to TZ-28H.
- C.** The power stage and ignition coil may be combined, with the control unit separate. This applies to Rex-I.
- D.** The control unit, power stage and ignition coil may comprise a single unit.

* Although the TZ-28H 'control unit' does incorporate a number of circuits additional to those used in EZ-K power stages, its primary function is closer to that of a power stage, and the term 'control unit' is somewhat misleading.



Power stage and ignition coil

Function of power stage

The power stage (1) functions as an electronic switch controlling the current in the ignition coil on command from the control unit (3). (The illustration shows the components of an EZ-K system. In the Renix-F system, the power stage is integral with the control unit, although the principle of operation is the same.)

The function of the power stage is analogous to that of the points in a mechanical ignition system, in that it alternately opens and closes the coil primary ground connection. Each time a cylinder fires, the power stage interrupts the current in the primary, inducing a high-tension voltage in the secondary.

Control signal

Once the control unit has computed a timing setting, based on the signals from the various sensors, the value is converted into a control signal for the power stage. When this signal goes high (+5 V), the power stage permits the ignition coil to charge. When the signal again falls (to 0 V), the power stage interrupts the current in the ignition coil primary and the stored energy is released in the form of a high-tension pulse in the secondary.

Constant charge

In the EZ-K and TZ-28H systems, the power stage incorporates a circuit which continuously monitors the primary current used to charge the ignition coil and ensures that the charging current remains constant, regardless of engine speed or battery voltage. This feature is designed to ensure that the ignition coil (2) receives a constant charge at all times, irrespective of these parameters. As a result, the charge in the coil is always a maximum and the ignition voltage remains constantly high.

Standing current protection

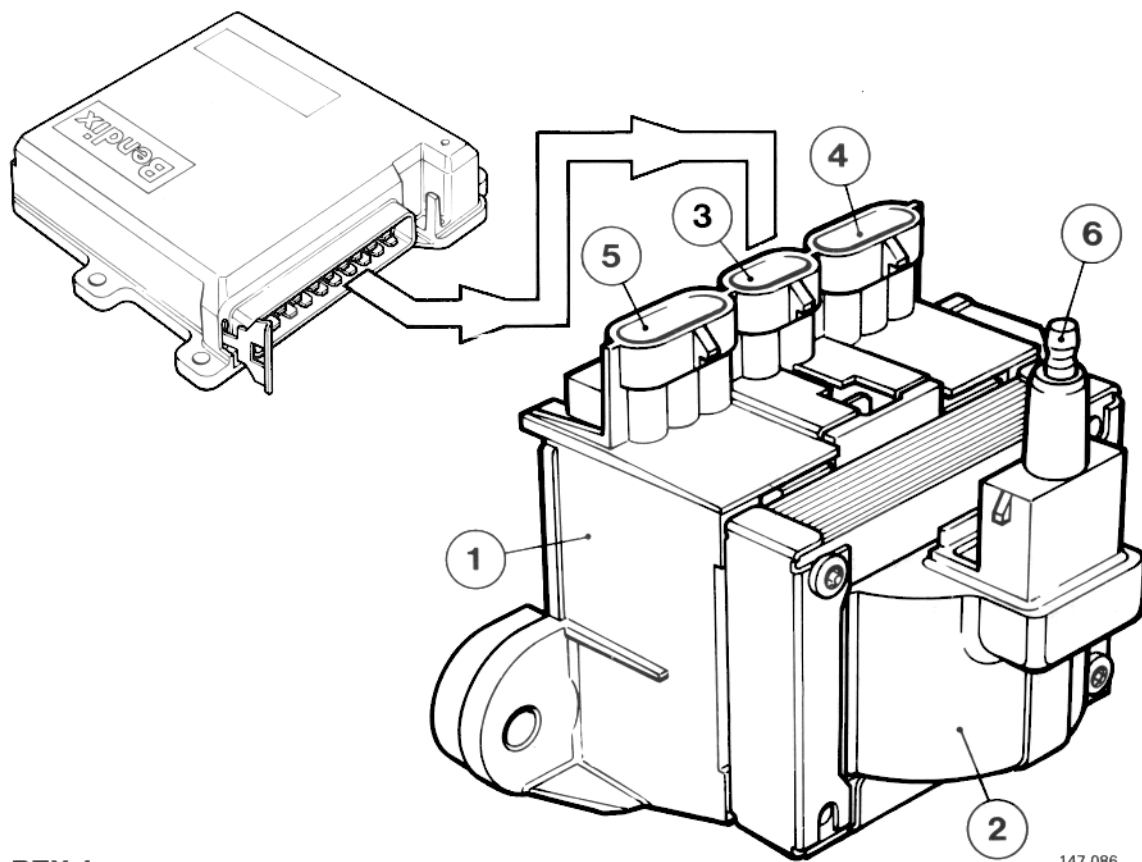
To avoid overheating of the ignition coil if the ignition is switched on with the engine at rest, the control unit incorporates a circuit which operates the standing current protection function via the power stage. Since the control unit no longer receives signals from the Hall generator or speed pick-up (whichever is applicable) when the engine has been stopped, it commands the power stage to interrupt the current in the primary winding of the coil.

Power stage cooling

Since operation of the power stage generates heat, the unit is mounted on a heat sink attached to the body. Secure contact between the unit and heat sink is essential to ensure that the working temperature is maintained within acceptable limits. The heat is generated by the power circuit which acts as the 'working' section of the power stage, making the 'control' circuits vulnerable to destruction. In systems in which the power stage is integral with the control unit, the former is mounted on the inside of the control unit frame to ensure adequate cooling.

Ignition coil

The primary winding of the ignition coil in an electronic ignition system (**which generates extremely high voltages up to a continuous 30 kV** compared with an average of 15–18 kV in a conventional coil) has a relatively low resistance. Consequently, coils of this type are fitted with a plug (4) which opens to relieve the pressure in the unit in the event of overheating and prevent deformation. **NOTE:** The plug **must** be fitted with a protective cap in the case of a coil installed vertically in the engine compartment.



147 086

REX-I

General

Since it is not technically practical to use the control unit to regulate the relatively high current in the ignition coil primary, this function is performed by a power stage which employs control signals from the control unit to vary both the charging time of the coil and the instant at which it delivers its high-tension pulse. The power stage opens and closes the primary circuit, inducing a high-tension voltage in the secondary each time the primary current is interrupted.

Construction

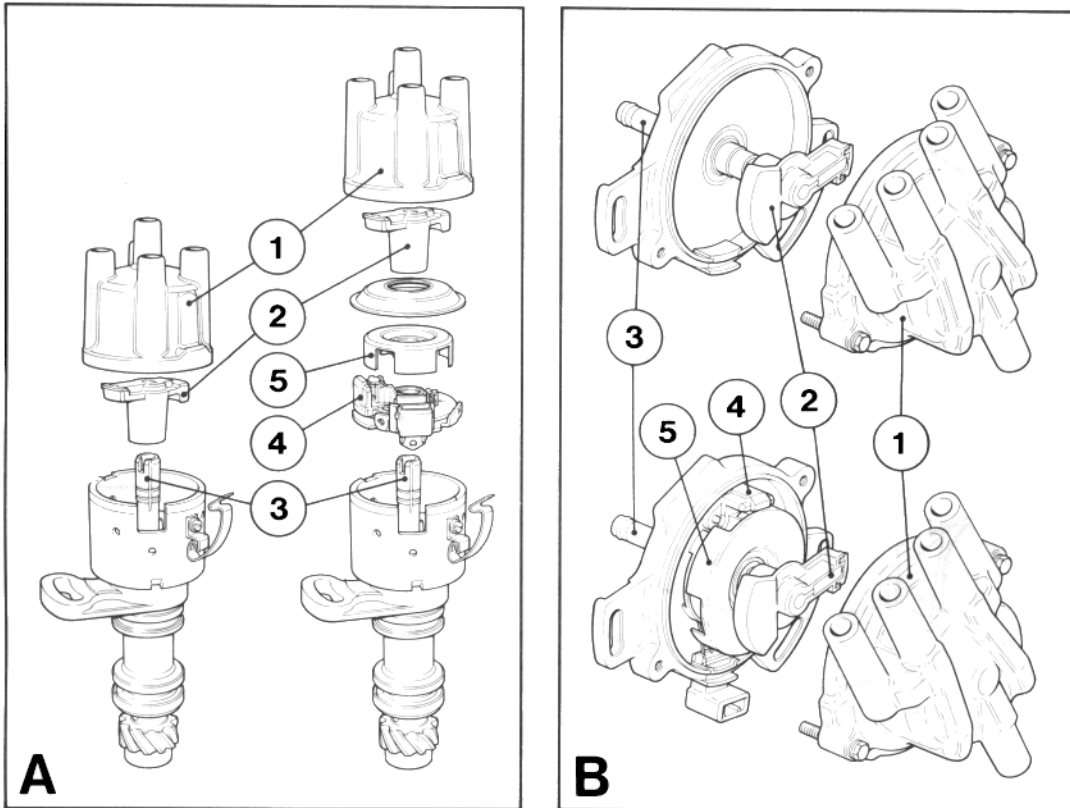
The power stage (1) and ignition coil (2) are assembled by means of screws (enabling the units to be replaced individually). The power stage receives control signals from the control unit (green lead) across the two-pole centre connector (3) (which is also used to ground the signal). The three-pole connector (4) on the right supplies the power stage and ignition coil with battery voltage, grounds the coil and supplies the rev counter with a signal. The connector (5) on the left is not used.

The power stage (1) incorporates the electrical circuits which control the primary current in the ignition coil. Mounted on a bracket in the engine compartment, the power stage/ignition coil assembly is provided with a large contact area with the suspension strut housing to ensure that the heat generated is dissipated.

The ignition coil (2) is of the conventional type with a primary and secondary wiring. The high-tension induced in the secondary is fed to the distributor from terminal (6). As on most modern ignition systems, **the HT voltage is of the order of 30 kV.**

Standing current protection

A function known as 'standing current protection' is provided to prevent overheating of the ignition coil when the ignition is switched on with the engine at rest. When the engine is stopped, the control unit receives no speed signals and delivers a 'low' control signal to the power stage, which responds by opening the primary circuit of the coil.



147 087

Distributor

Function

The function of the distributor is to conduct the high-tension pulse from the ignition coil to the appropriate spark plug. A distributor fitted with a Hall generator also provides information on engine speed with the aid of the trigger rotor driven by the distributor shaft.

Construction and variants

The distributor consists of a cap (1), rotor arm (2), shaft (3) and, in applicable cases, a Hall generator (4) and trigger rotor (5). (Older systems employ either contact breaker points or some form of pulse generator.)

A. 'Vertical' distributors are driven by an intermediate shaft through bevel gearing.

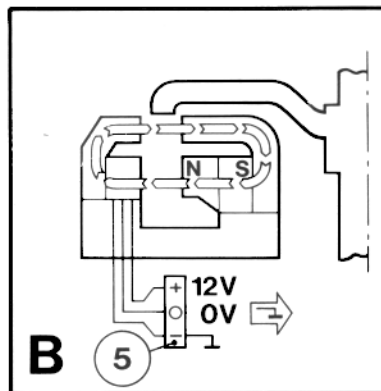
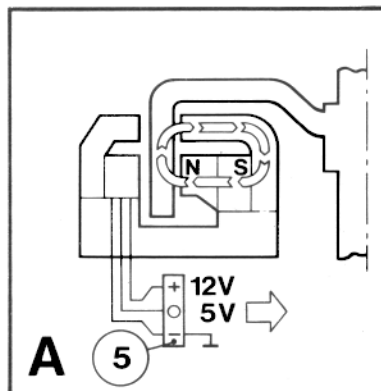
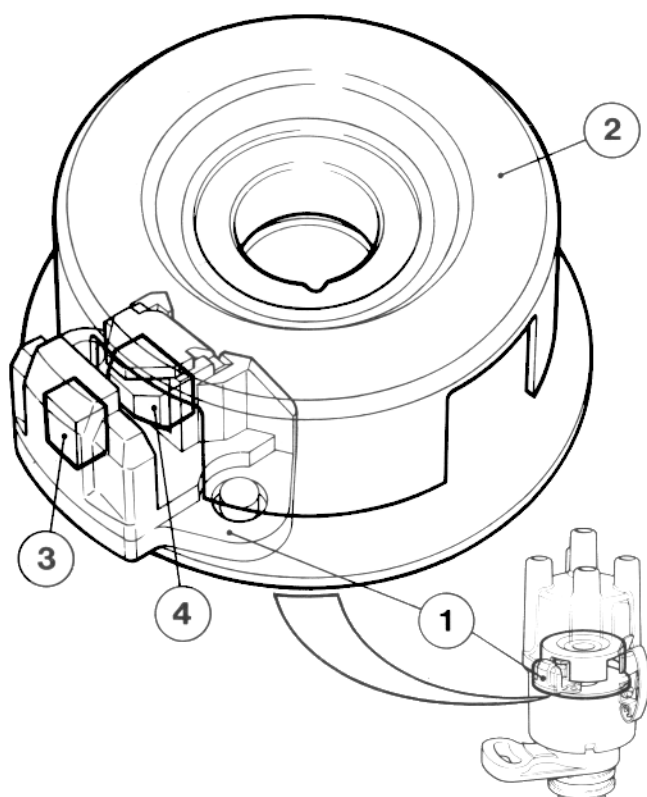
B. 'Horizontal' distributors are driven directly from the camshaft, minimizing the play in the transmission mechanism. This, in turn, affords more accurate control of the timing in systems in which speed information is supplied by a Hall generator.

700 series models from 1985 on (with the exception of the 740 with the B 230 A engine) are fitted with camshaft-driven units.

In the case of distributors which are not equipped with a Hall generator and, as a result, are fitted only with a rotor arm, the timing cannot be varied by rotating the unit. In systems of this type, since crankshaft position signals are supplied by an inductive pick-up at the flywheel, only the position of the rotor in relation to the contacts in the cap is altered by this procedure.

* The TZ-28H system employs a distributor, with a vacuum advance unit to supply engine load information.

Speed and crankshaft position information



147 088

Hall generator

Function and location

The Hall generator (1) supplies the control unit with information on engine speed and crankshaft position. The device is mounted inside the distributor cap.

Construction:

The generator is based on the principle of the Hall effect, whereby the flow of current in a semiconductor is deflected if the component is exposed to a magnetic field. This causes a potential difference (i.e. an excess of electrons on one side of the semiconductor and a deficiency on the other), producing a voltage known as the Hall voltage. Following amplification, this voltage is employed by the control unit as a signal to control the timing.

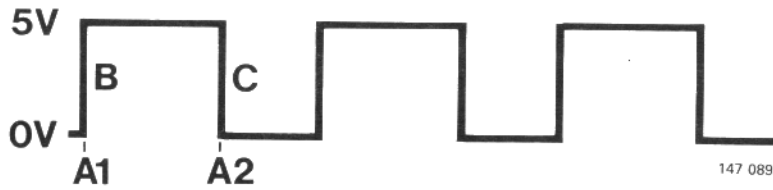
The Hall generator (1) is a U-shaped element with an opening for the trigger rotor (2). The number of rotor vanes is the same as the number of cylinders in the engine.

The generator consists of a Hall-IC element (3) comprising a Hall effect detector and a transistor amplifier. A magnet (4) with a three-pole connector (5) is located on the opposite side of the rotor to the Hall-IC element. The connector terminals are connected respectively to a 12 V supply (+), a 5 V reference signal from the control unit (o) and ground (-).

Signal

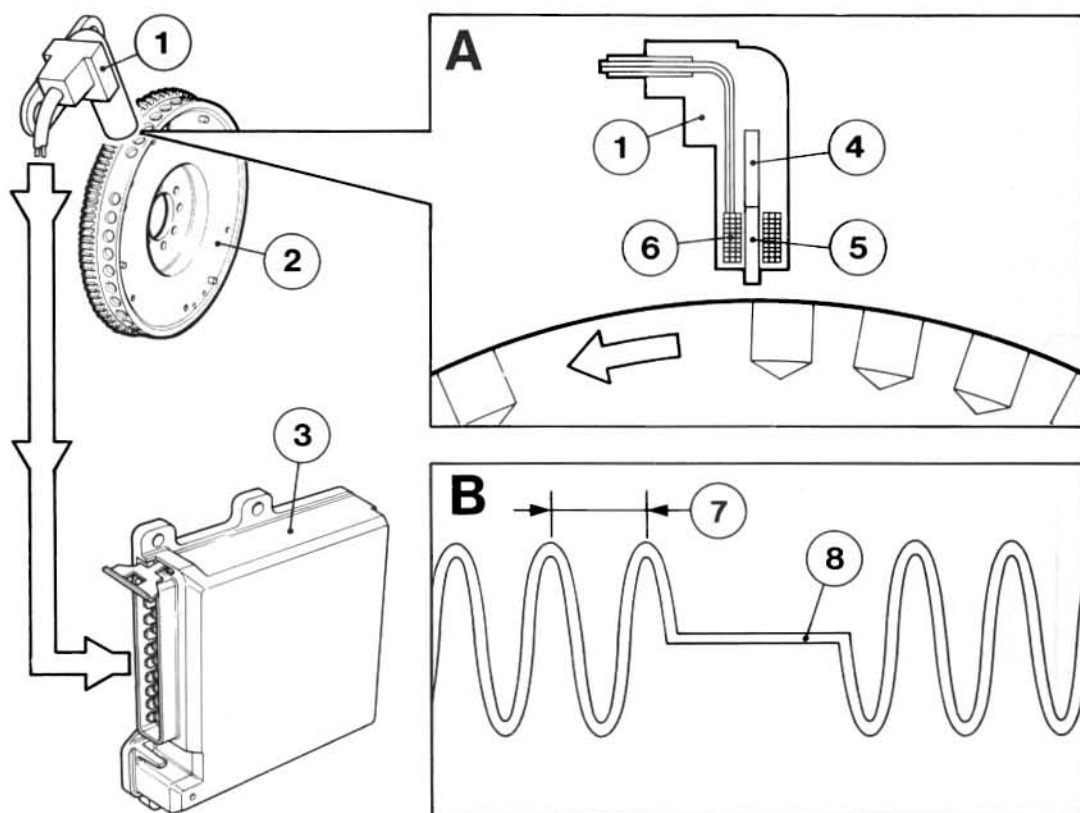
- A.** In this position, the magnetic field is blocked by the trigger rotor vane and the Hall effect is absent. No voltage is induced in the Hall-IC element and the ground connection remains open. As a result, a 5 V signal is present at terminal (o).
- B.** In this position, the rotor exposes the Hall-IC element to the influence of the magnetic field and the resultant Hall voltage is fed to the transistor amplifier. The 5 V signal at terminal (o) is then connected to ground across the (-) terminal and the voltage at (o) falls to 0 V.

Thus, the signal from the Hall generator varies between 0 and 5 V in the form of a square-wave signal, the control unit deriving its engine speed information from measurement of the duration of the alternating half waves. The crankshaft position signal is obtained by adjusting the basic setting of the distributor to coincide with the positive flank of the Hall generator signal (i.e. the half-wave generated when the rotor blocks the magnetic field) a few crankshaft degrees before TDC.



- A1 Signal increases from 0 to 5 V. Control unit starts to compute timing of next ignition pulse.
- A2 Signal falls from 5 to 0 V. Control unit commences ignition countdown and delivers ignition pulse as computed.
- B Positive flank. Hall element unaffected by magnetic field.
- C Negative flank. Hall element influenced by magnetic field.
- * A Hall generator is used on TZ-28H (with a 12 V reference signal), EZ-102K, EZ-117K and EZ-118K systems.

Inductive speed/position pick-up



147 090

Function and location

The purpose of the speed/position pick-up (1) is to supply the control unit (3) with information on engine speed and crankshaft position. The pick-up is mounted close to the flywheel (2) (or carrier plate on automatic models), the periphery of which is provided with a series of drilled holes. The location of the pick-up is such that it is influenced by this configuration of holes.

Construction

A. The pick-up (1) consists of a permanent magnet (4), a pole tip (5) which concentrates the magnetic field at the end of the device and a coil (6). The magnet creates a magnetic field which varies in strength depending on whether a hole or 'tooth' is passing the tip.

Operation

An alternating voltage is induced in the pick-up coil when one of the projections or 'teeth' on the flywheel passes the tip. This variable signal is transmitted by a lead to the control unit.

In effect, therefore, the pick-up supplies the control unit with a unique alternating voltage – an electrical 'picture' of the flywheel from which the unit can determine both the engine speed and crankshaft position.

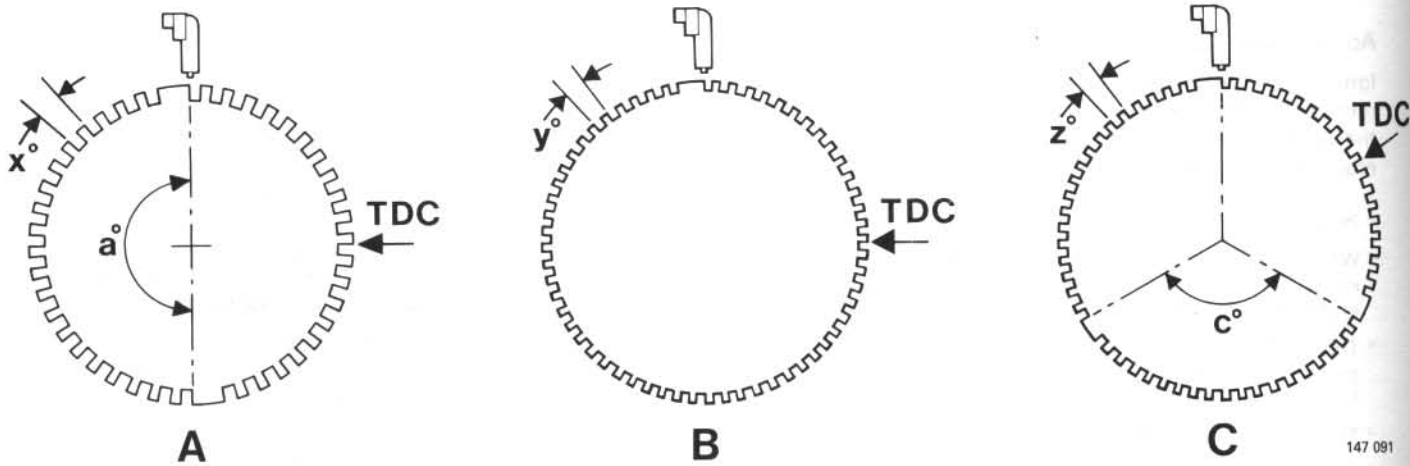
Signal

B. The frequency (7) of the signal (i.e. the period between two successive voltage peaks) is a measure of the engine speed. To provide a reference signal for the crankshaft position, one or more 'teeth' (one or two in the case of 4-cylinder engines and three on 6-cylinder units) on the flywheel/carrier plate are made longer than the others. The control unit detects the crankshaft position by sensing the interruption in signal (8) which occurs as a long tooth passes the pick-up. This reference signal is used to determine the top dead centre (TDC) position.

Advantages

Ignition systems employing inductive speed/position pick-ups (or pulse generators as they are also known) provide more accurate speed and crankshaft position signals than those equipped with Hall generators – due to the fact that the former have fewer mechanical components (which are invariably subject to some degree of play) and that a crankshaft position signal is generated on each revolution of the shaft.

- * Inductive speed/position pick-ups are used on Renix-F, EZ-115K, EZ-116K and Rex-I systems.
- * When working in the vicinity of the flywheel, care must be taken to avoid striking the pick-up with tools or dismantled components. The accuracy and reliability of the signal is dependent on maintaining the gap (1 ± 0.5 mm) between the tip and the toothed profile for which the device is designed. In addition, the pick-up must be mounted at right-angles to the profile.
- * The greatest care must be taken when replacing the flywheel/carrier plate if the component has been dismantled (e.g. as part of gearbox replacement). On 4-cylinder engines, it is possible to replace the component in the wrong position, thereby altering the timing.
- * The timing will be altered by approx. 3° if the pick-up leads are reversed.
- * Although the magnitude of the induced voltage will increase with flywheel speed, the voltage regulator in the control unit ensures that the voltage supplied to the IC circuits remains constant.



Flywheel/carrier plate profiles

The above figures show the three different 'toothed' or drilled crankshaft/carrier plate profiles which are used. (The profiles are shown in section.) Unlike the starter motor ring gear, which is mounted on the flywheel, the profile used for signal generation is usually an integral part of the component.

Volvo ignition systems are supplied mainly by two manufacturers – Bosch of Germany and Bendix, France. Among other factors, this means that several different profiles must be used, while the method whereby the control unit detects and processes the inductive pick-up signals may also differ.

The electronic circuit (which may be likened to a frequency divider or 'multiplier') in which the signal is first received and processed, also varies in design. The frequency of the incoming voltage pulses is divided by a certain factor to improve signal resolution. This, in turn, means that the control unit can regulate the timing in more precise steps, for example, when re-advancing the timing after knock in a cylinder has been eliminated.

A. Ignition systems supplied by Bendix employ a type 44/2 toothed profile. The figure 44 means that the flywheel is provided with 44 drilled holes, and the figure 2 that it has two 'long' teeth, each equal in length to two shorter teeth. In other words, the profile is provided with 40 (44-2x2) short teeth and two long teeth. The angular pitch between two adjacent short teeth (x°) is 8.18° ($360^\circ/44$). The two long teeth which comprise the crankshaft position reference points are located 180° apart (angle a). The control unit identifies TDC as the point 90° after the passage of a long tooth.

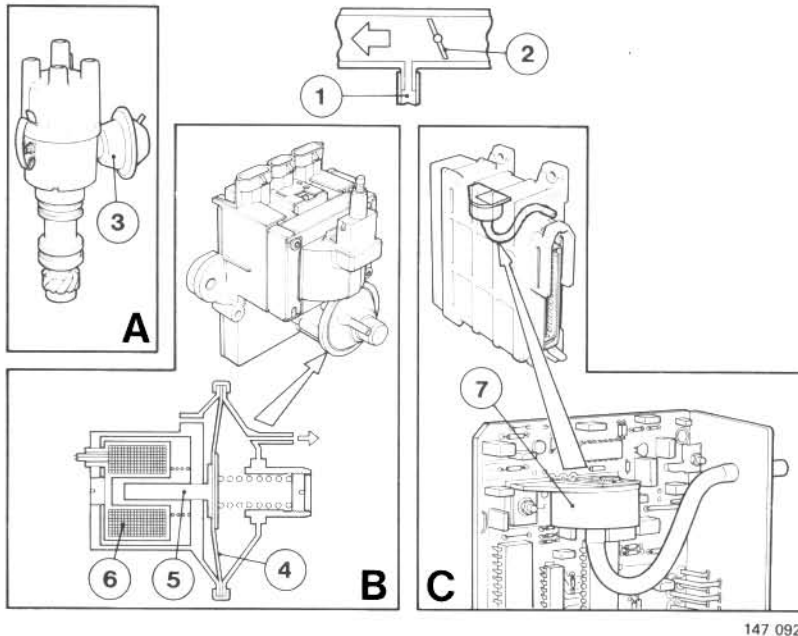
The type 44/2 profile is used on Renix-F and Rex-I systems. In each case, the control unit applies a factor of 8.18 to improve the signal resolution. This means that it can adjust the timing in steps of 1.0° .

B. Ignition systems supplied by Bosch for Volvo 4-cylinder engines feature a type 60/1 toothed profile. This means that the profile is provided with 60 drilled holes and with one 'long' tooth of twice the length of a 'short' tooth. In other words, the profile is provided with 58 (60-1x2) short teeth and one long tooth which represents the crankshaft position reference point. The angular pitch between two adjacent short teeth (y°) is 6.0° ($360^\circ/60$). The control unit identifies TDC as the point 90° after the passage of the long tooth.

The type 60/1 toothed profile is used on the EZ-116K system. This means that the control unit applies a factor of 16 to improve the resolution of the pick-up signal. In effect, the control unit can adjust the timing in steps of 0.375° .

C. The EZ-115K ignition system for B 280 engines is designed for a flywheel with a type 60/3 toothed profile. The profile is provided with 60 drilled holes and 3 'long' teeth, each of which is twice the length of a 'short' tooth. In other words, the profile is provided with 54 (60-3x2) short teeth and 3 long teeth as the crankshaft position reference points. The angular pitch between two adjacent short teeth (z°) is 6.0° ($360^\circ/60$). The three long teeth are located 120° apart (angle c). The control unit identifies TDC as the point 60° after the passage of a reference tooth.

The control unit applies a factor of 16 to improve the resolution of the pick-up signal. In other words, the unit can adjust the timing in steps of 0.375° .



147 092

Engine load information

Intake manifold vacuum

The control unit is supplied with information on engine load through the vacuum line (1) from the intake manifold.

Load information through vacuum line

When the engine load is low, the throttle (2) is only partially open and the vacuum in the manifold is high (approx. 60 kPa). As the engine load increases, the throttle opens further and the vacuum in the manifold gradually falls.

The ignition system may receive and process the load signal from the intake manifold by one of three basic methods in order to adjust/compute the timing setting.

Vacuum advance unit

A. On the TZ-28H system, the vacuum line is connected to a vacuum advance unit (3) on the distributor. The unit houses a diaphragm, one side of which is open to the vacuum in the manifold and the other to atmosphere. As the vacuum increases (at low engine load with a partially-open throttle), the distributor plate is rotated to advance the timing.

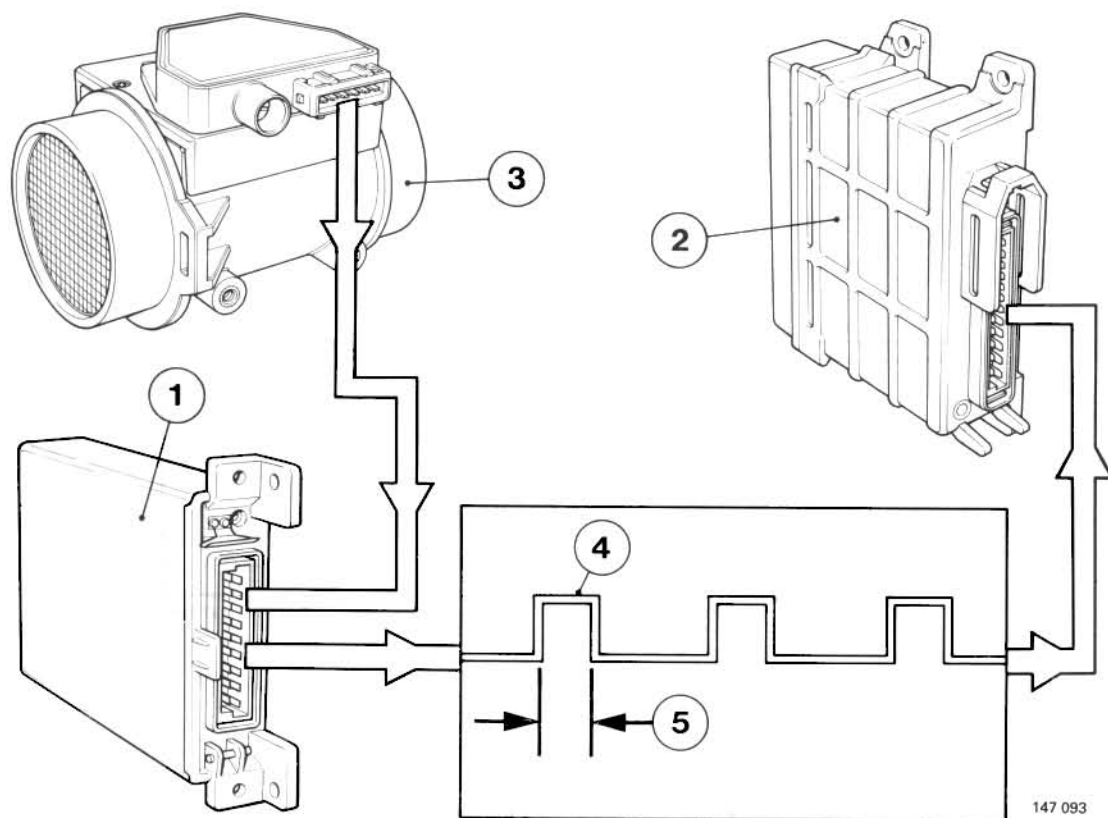
Electrical vacuum converter

B. The vacuum line on the Renix-F system is connected to a vacuum converter integral with the control unit. Although each vacuum converter is designed specifically for a particular system, the principle of operation is the same in all cases. The vacuum is applied to one side of a spring-loaded diaphragm (4), the other side of which carries an iron core (5) moving inside a coil (6). The coil is connected to an oscillator circuit in the control unit, the frequency in which varies with the position of the core and, as a result, is proportional to engine load.

Electronic pressure switch

C. On the EZ-118K system, the vacuum line is connected to a pressure switch (7) inside the control unit. The device consists of a diaphragm, a magnet and a semiconductor element. The diaphragm is actuated by the vacuum on one side, while the other is attached to the magnet. The position of the magnet influences the current flow in the semiconductor and, as a result, the value of the induced Hall voltage.

Thus, the voltage is proportional to the position of the magnet and, by extension, to the engine load. The load signal is received by the converter in the control unit and used to compute the timing.



Fuel injection system control unit (LH-2.1, LH-2.2, LH-2.4)

The fuel system control unit (1) supplies the ignition system control unit (2) with information on engine load. This is based on signals from an air mass meter (3), the quantity of induction air being used as a measure of the load.

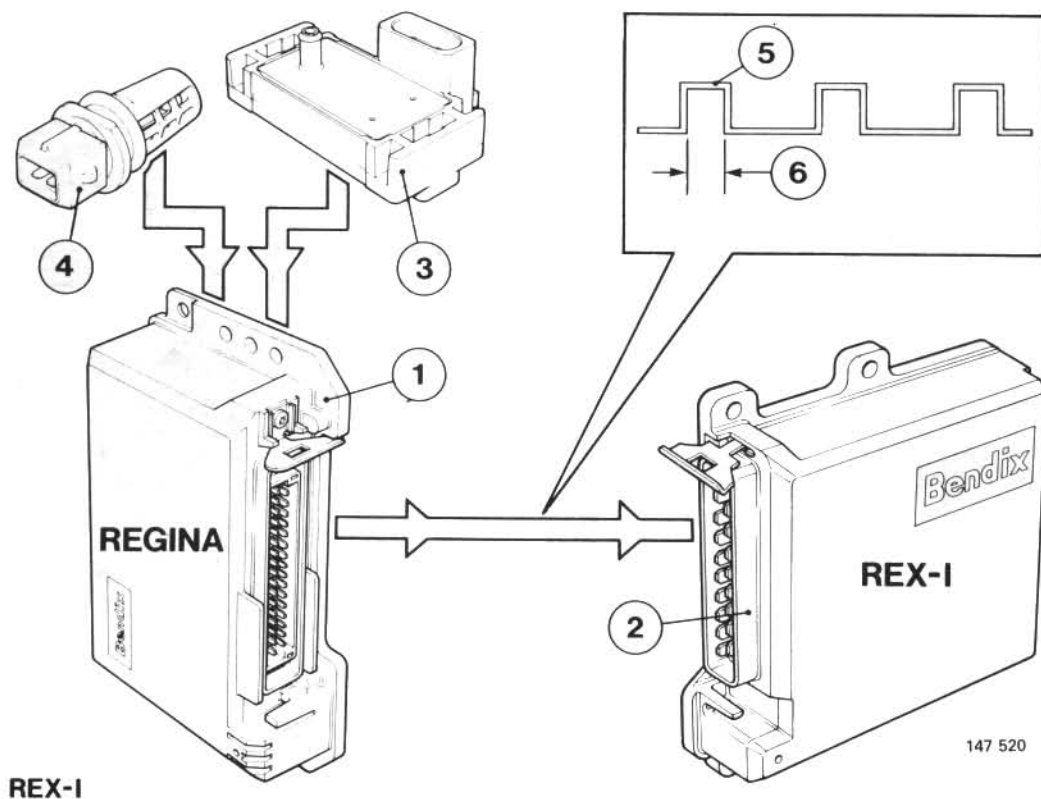
Signal

The air mass meter continuously measures the quantity of air drawn into the engine and delivers a variable signal to the injection system control unit, in which the signal is converted into digital form and used to compute the quantity of fuel to be injected. The signal is also relayed to the ignition system control unit. The digital signal consists of a series of current pulses (4) of a duration (5) proportional to the load.

Advantages

This type of load information is used in EZ-K systems with LH-Jetronic fuel injection and Rex-I systems with the Regina injection system, and is more accurate than that supplied by a vacuum line from the intake manifold. In addition, the air mass meter responds more quickly and is not subject to measurement errors caused by variations in air density. (In other words, it is independent of air temperature and height above sea level.)

* Should the fuel system control unit fail, for any reason, to supply the ignition system control unit with a load signal, the latter will compute the timing on the basis that max. load conditions prevail when the throttle has opened.



REX-I

147 520

Regina fuel injection system

General

The injection system control unit (1) supplies the ignition system control unit (2) with information on engine load – acting, in other words, as a ‘sensor’ for the latter.

The gas pressure in the cylinders during the compression stroke will rise as a greater charge of fuel/air mixture is supplied to the engine, and the ignition system will retard the timing according as engine load increases.

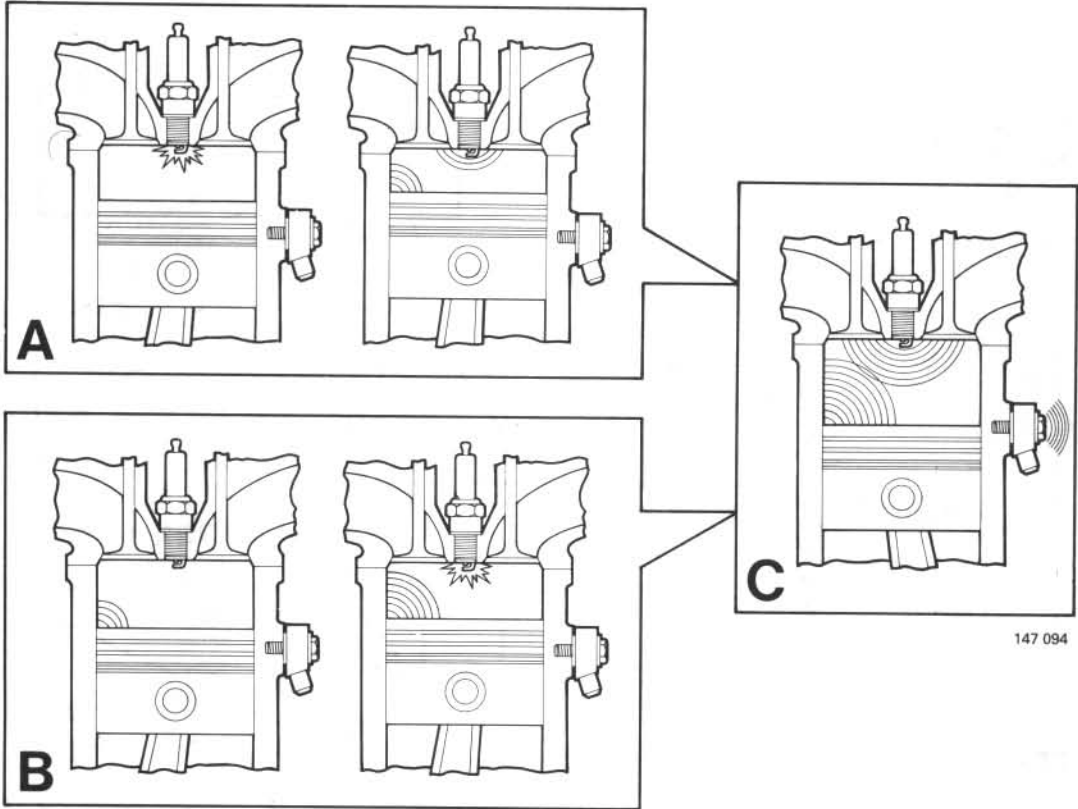
Signals

The electronic pressure sensor (3) and air temperature sensor (4) supply voltage signals to the Regina control unit (1). Taken together, these signals provide a measure of engine load and are processed by the Regina control unit to compute the quantity of fuel to be injected. Once the load signals have been converted into digital form (i.e. into square-wave pulses), they are transmitted to the Rex-I control unit (2).

The digital signal consists of current pulses (5) of a duration (6) proportional to the engine load.

* Should the load signal from the Regina control unit be lost for any reason, the ignition system control unit will compute the timing on the basis of max. load conditions, provided that the idling switch is not closed.

Compensation functions



Theory of knock

Knock is caused by detonation of the fuel/air mixture in the combustion chamber.

What is knock?

Detonation may occur either after (as in A) or before (as in B) the plug has delivered a spark. In either case, the mixture is ignited at two or more points in the chamber and combustion progresses from these points (C). This results in the simultaneous propagation of two or more flame fronts, causing abnormally rapid and uncontrolled combustion, accompanied by an explosive rise in pressure which produces the typical, metallic sound known as 'pinking' or 'knock'.

'Compression' knock

A. In the case in which knock occurs after the plug has delivered a spark, detonation is caused by the fact that the flame front initiated by the spark compresses and heats the unignited mixture to the point at which detonation is unavoidable. A relatively high engine load is required to produce this type of knock.

'Glow ignition' knock

B. In the type of knock which occurs before the plug has delivered a spark, detonation of the mixture may be due to incandescent carbon particles or gasket edges, fouled spark plugs or other areas of the combustion chamber which absorb heat more easily. (This phenomenon is sometimes known as 'glow ignition'.)

Effects of knock

C. The abnormal pressure rise which accompanies knock subjects the piston, gudgeon pin, connecting rod, crankshaft and bearings to abnormally high mechanical stresses. Furthermore, the temperature rise caused by the phenomenon is so high that the cylinder wall, piston and spark plug may easily suffer damage, while the energy content of the fuel is poorly utilized. The unusual engine resonance caused by knock is detected by a knock sensor mounted on the cylinder block. The sensor signal is transmitted to the control unit.

Knock 'threshold'

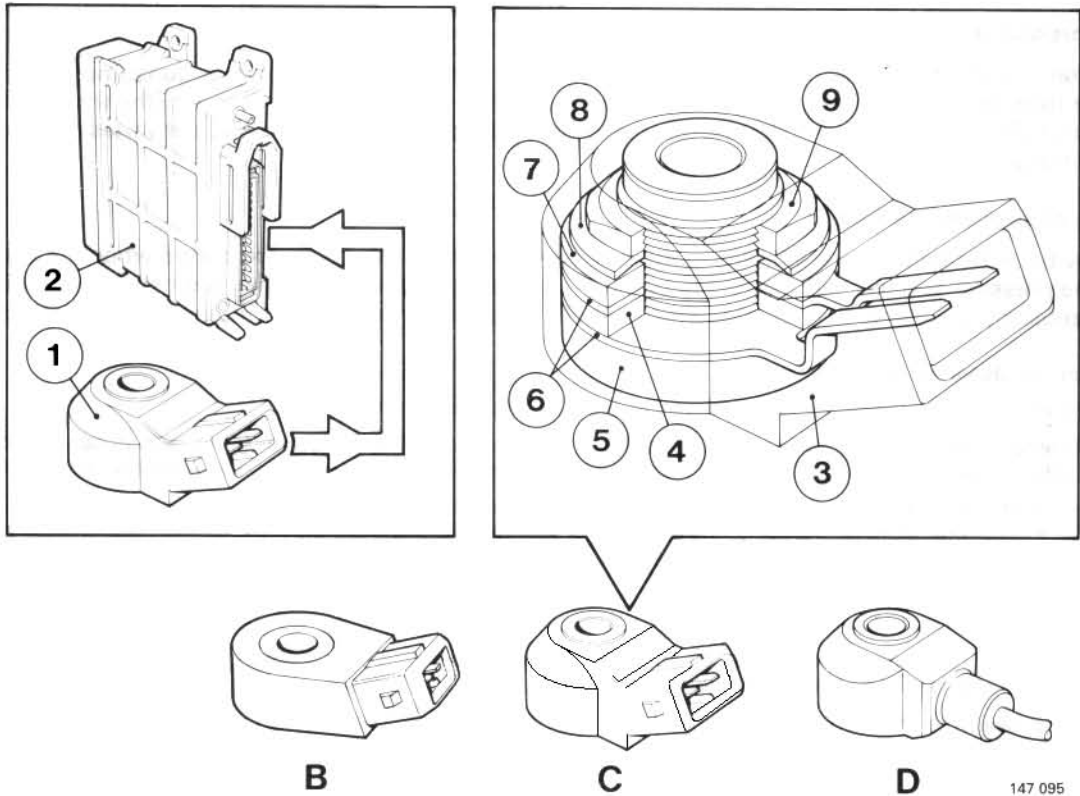
Under certain conditions, however, the combination of high performance and low fuel consumption demands that the engine runs as close as possible to the knock threshold. The closer the timing curve to the threshold, the higher the efficiency of fuel utilization. In other words, the knock threshold is not a fixed limit, but varies depending on running conditions.

Methods of preventing knock

Knock may be prevented by retarding the ignition. Since detonation of the mixture occurs when the piston is closer to TDC, the pressure and temperature in the cylinder are thereby lowered, reducing the risk of detonation. Knock is also prevented by enriching the mixture, which has the effect of reducing the combustion temperature.

* Knock may be caused by the following:

- Use of a fuel with an octane rating which is too low for the compression ratio of the engine.
- Incorrect fuel/air ratio. If the mixture is too lean, the temperature in the combustion chamber will be high despite a constant compression ratio. A lean mixture may be due to a factor such as low fuel pressure or air leakage into the induction system.
- Excessively high combustion temperature. Carbon deposits in the combustion chamber will reduce the rate of heat dissipation, resulting in high temperature (and creating the risk of glow ignition). Deficient cooling (due, for example, to a faulty water pump, radiator or thermostat, or to rust/lime deposits in the cooling passages), will have the same effect.
- Incorrect or worn spark plugs. The risk of detonation will be greatly increased if the plug is of the wrong type (i.e. if the heat rating is incorrect) or is it is fouled.
- Faulty timing. The resistance to knock will be impaired if ignition takes place too early, since the cylinder pressure and temperature will be higher under these conditions.
- A sudden increase in engine speed. What is known as 'transitional' knock will occur if the engine speed and load are suddenly increased. If the engine is running under normal conditions of speed and load (with the timing fairly well advanced), sudden depression of the accelerator will produce an instantaneous increase in the quantity of mixture admitted before the system has time to adjust the timing accordingly. For a brief period, therefore, the timing will be too advanced for the amount of mixture in the cylinders. (One of the functions with which the control unit is programmed limits the scope of timing adjustment to a specified number of degrees per crankshaft revolution.)



Knock sensor

Function

The knock sensor (1) is used to detect engine knock, enabling the control unit (2) to take the appropriate action by retarding the ignition.

Construction

The knock sensor (see picture C) consists of a casing (3) housing a piezoelectric crystal (4) mounted on a threaded sleeve (5) between two connector strips (6). One side of the assembly is fitted with a damping weight (7) and spring washer (8) secured by a nut (9).

Operation

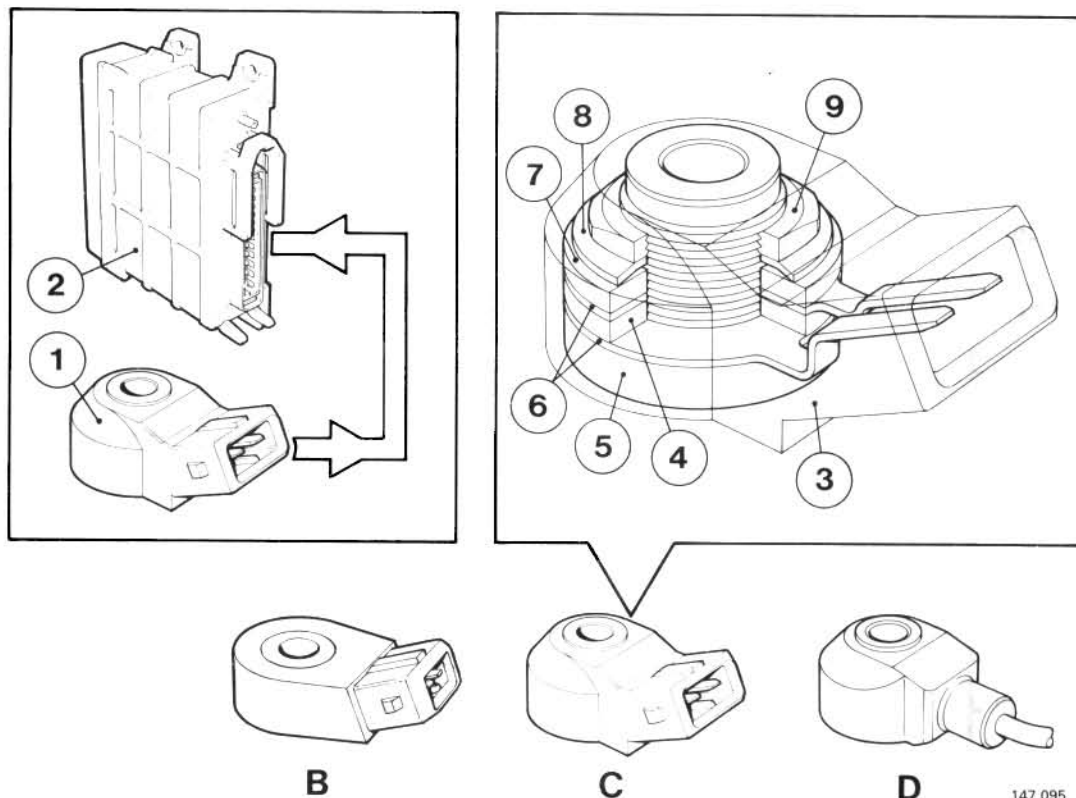
Mounted on the cylinder block, the sensor detects the vibration caused by knock. Since the device employs a piezoelectric crystal (in which a potential gradient is set up when the material is subjected to strain), the sensor develops its 'own' signal. The vibrations caused by knock produce an instantaneous pressure on the bottom of the sensor, which responds by generating an output voltage.

Signal

The signal delivered by the piezoelectric crystal consists of a continuous, variable voltage of a frequency corresponding to the engine vibrations. The signal is fed to the control unit which computes a mean or 'reference' value.

Sensing of signals

The control unit is programmed specifically to detect signals of the frequency generated by knock (approx. 7.5 kHz). The unit is provided with a 'measurement window' – in effect, a specific range of crankshaft angles within which the unit is 'open' to receive signals from the knock sensor (approx. 15° before TDC to approx. 55° after TDC). Immediately on detecting knock in a cylinder, the device generates a signal which deviates significantly from the computed 'reference' signal. This is interpreted by the control unit as confirmation that knock has occurred. After an interval of three ignition pulses (in the case of 4-cylinder engines), the control unit retards the ignition, thereby correcting the condition in the individual cylinder concerned.



147 095

Variants

The three different types of knock sensor used are illustrated above.

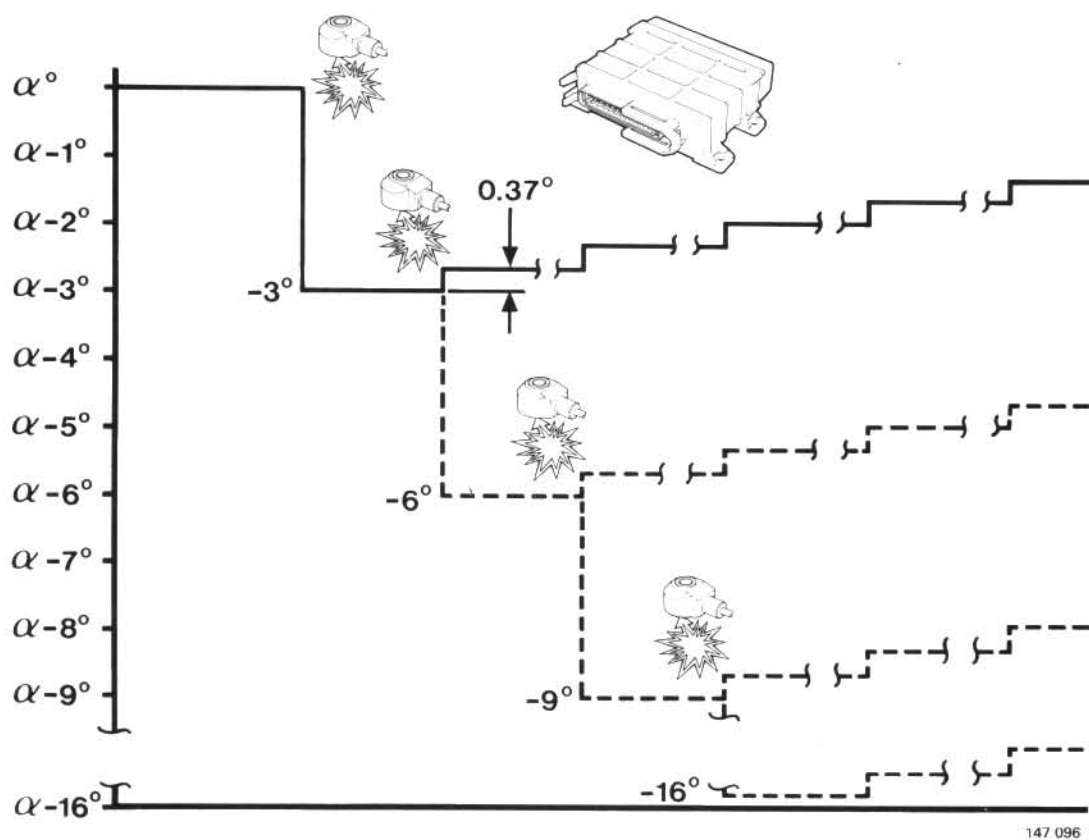
- Type (B) is used on EZ-102K, and on EZ-117K and EZ-118K systems from 1985 to 1986.
- Type (C) is used on EZ-116K systems from 1987 on, as well as on EZ-117K and EZ-118K, and on Rex-I from 1989 on. A refinement of type (B), this variant is fitted with a sleeve (5) which ensures that the mounting force is less easily transmitted to the piezoelectric crystal, making the unit less sensitive to the effect of the tightening torque.
- Type (D) is used on the EZ-115K system on the B 280 engine, which is fitted with a knock sensor for each bank of cylinders. The only difference between this variant and type (C) is that the connection lead is integral with the unit.

* Type (C) and (D) sensors are less sensitive to tightening torque than earlier types. The design permits the torque to vary from 15 to 25 Nm (11–18 ft.lb) without any adverse effect on the performance of the device. Although production of type (B) was discontinued in 1986, it is fully interchangeable with type (C). Particular care must be taken when fitting the older type of sensor; a torque wrench must be used to tighten the device in position.

* Since the ignition may be retarded in each individual cylinder in the event of knock, the timing in each may vary by as much as approx. 10–15°. Apart from the fact that knock control is inherently a major advantage, the facility of eliminating it in an individual cylinder means that fuel utilization can be maximized in relation to the knock threshold in each. This is important since conditions in the various cylinders may differ somewhat in terms of combustion temperature, fuel residue deposits on cylinder walls, injector design, and so on.

* Retardation of the ignition in each individual cylinder is a feature of all systems equipped with knock sensors dealt with in this manual.

* Should the signals from the knock sensor be lost for any reason, most of the control units will retard the ignition by a pre-programmed 'fail-safe' value of approx. 10°.



147 096

Knock control

The knock sensor monitors the combustion process continuously. If knock occurs, the device delivers a special signal to the control unit, which takes corrective action by retarding the ignition in the cylinder affected.

Knock control characteristic

The principle of knock control is more or less the same in the case of all systems equipped with knock sensors. (Although the knock control characteristic shown is that for the EZ-115K system, the description is generally applicable.) The vertical coordinate shows the ignition setting in degrees in relation to the basic timing (indicated here by the angle α), while the horizontal coordinate is the time scale (which normally varies with engine speed).

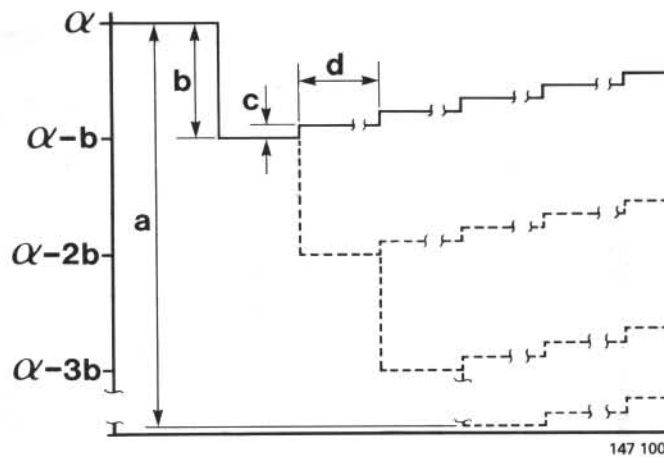
Stepped control

The control unit continuously computes the optimum timing on the basis of the running conditions. On detecting knock, the unit retards the ignition by a step of a few degrees (2–3° depending on the system) in the cylinder affected. If the phenomenon persists, the setting is retarded by a further step, and so on until the condition has been corrected. The maximum retardation in relation to the basic timing is approx. 10–16° in the case of EZ-K systems.

Re-advance following correction of knock

After knock has been eliminated, the control unit maintains the retarded setting for a specified number of engine revolutions, depending on the speed (applies to EZ-K systems), before re-advancing the ignition in small steps (0.1–1°), either until the original characteristic has been restored or until the engine again starts to knock.

* The maximum retardation must not deviate excessively from the basic setting if an excessive rise in exhaust gas temperature is to be avoided. Information on engine speed and/or load is also essential to enable the control unit to impose the maximum retardation, if necessary.

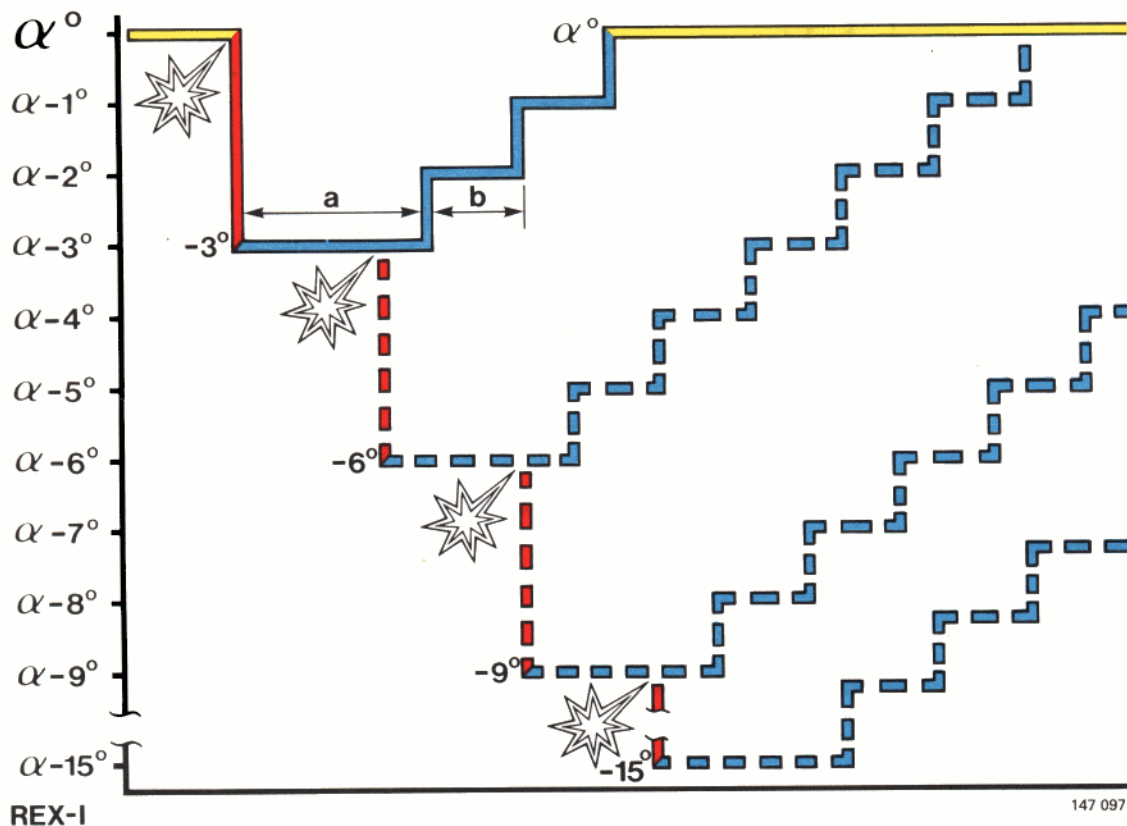


Timing compensation applied by different ignition systems to correct knock

- Fig. 3: α = basic timing as computed
 a = max. knock-controlled retardation
 b = knock retardation step
 c = re-advance step
 d = re-advance interval

The following is a summary of the compensation values applied by the various systems in the event of knock:

EZ-102K:	Max. knock-controlled retardation: Knock retardation step: Re-advance step: Re-advance interval:	9.8° 2.8° 0.35° Specified number of engine revolutions depending on speed
EZ-117K:	Max. knock-controlled retardation: Knock retardation step: Re-advance step: Re-advance interval:	13° (B 230 F); 9.8° (B 230 FT) 2.8° 0.37° Specified number of engine revolutions depending on speed
EZ-118K:	(values for B 230 K, 1985–86; B 230 E and B 200 E respectively) Max. knock-controlled retardation: Knock retardation step: Re-advance step: Re-advance interval:	15°, 16°, 9.8°, 12.6° 2.8°, 2.8°–8.7° (depending on speed), 2.8°, 2.8° 0.35° in all cases Specified number of engine revolutions depending on speed
EZ-115K:	Max. knock-controlled retardation: Knock retardation step: Re-advance step: Re-advance interval:	11–15° depending on variant 3° 0.37° Specified number of engine revolutions depending on speed
EZ-116K:	Max. knock-controlled retardation: Knock retardation step: Re-advance step: Re-advance interval:	14° 2.6° at $n < 4895$ r/min and 2.3° at $n > 4895$ r/min 0.375° Specified number of engine revolutions depending on speed
Rex-I:	Max. knock-controlled retardation: Knock retardation step: Re-advance step: Re-advance interval:	15° –3° at $n > 4895$ r/min 1° Specified number of engine revolutions depending on speed



Rex-I

On the Rex-I system, the program functions which control the tendency of the engine to knock are somewhat different to those in the EZ-K systems. The differences are described in the following pages.

Knock characteristic

The figure shows the 'normal' ignition setting (α) assuming, in this case, that speed and load are constant (hence the extremely simplified 'straight' yellow line). The vertical axis indicates the extent to which the timing has been retarded in relation to the normal setting, α . The horizontal axis indicates the time, as defined by a certain number of engine revolutions. Knock retardation is illustrated by the downward steps (red) and re-advance by the smaller upward steps upwards (blue). The maximum retardation is 15° , here denoted by ' $\alpha - 15^\circ$ '.

Knock-controlled retardation

When the engine is running, the control unit computes the optimum ignition timing on the basis of speed and load signals. The occurrence of knock in a cylinder is detected by the control unit, which retards the ignition by a step of 3° in the cylinder in question. If the phenomenon persists, the control unit retards the ignition by a further step of 3° ($\alpha - 6^\circ$) and so on, until knock is eliminated.

Re-advance at different rates

Re-advance of the ignition to the normal setting (α), or until knock again occurs, takes place at different rates depending on engine speed. However, the steps are equal in magnitude in all cases, representing an advance of 1° at a time. Once the timing has been retarded (to $\alpha - 3^\circ$ or more) (a), the succeeding re-advance steps (b) are performed twice as fast. Thus, the interval 'a' in the figure is twice as long as 'b'.

At high engine speed, the interval 'a' during which the timing is retarded (to $\alpha - 3^\circ$ or more) is relatively long. (The interval is equivalent to approx. 80 revolutions at an engine speed of about 6000 r/min).

At low engine speed, the corresponding interval is about half that at high speed (approx. 35 revolutions at an engine speed of about 1000 r/min).

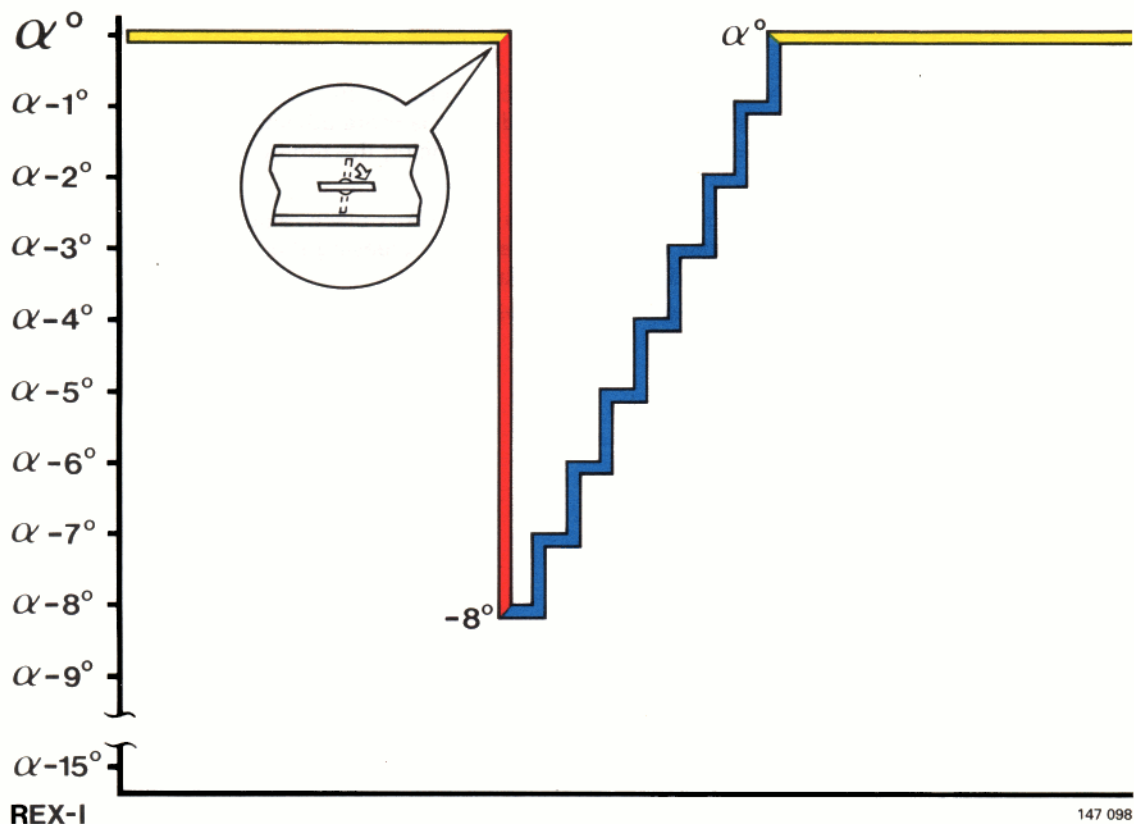
The re-advance rates vary across the speed range, becoming slower as engine speed increases.

Reason for different re-advance rates

'Faster' re-advance rates are possible in the lower speed ranges since ignition then takes place when the piston is closer to TDC and the risk of knock is, consequently, lower. Fast re-advance is more advantageous since it serves to increase the mean value of the timing angle. (As already described, advancing the timing point improves the efficiency of fuel utilization.)

'Slower' re-advance rates are chosen at higher speeds since ignition then takes place relatively early as the piston moves upwards towards TDC (and the attendant risk of knock is greater). Increasing the rate of re-advance under these conditions would greatly increase the likelihood of recurring knock.

* EZ-K systems employ more or less the same method of varying the re-advance rates following knock-controlled retardation.



147 098

Load-controlled retardation

Function

Since a sudden increase in load greatly increases the risk of knock, the control unit incorporates a function which retards the timing sharply for a brief period under these conditions. The function of load-controlled retardation is to reduce the likelihood of knock when the accelerator is suddenly depressed.

Background

High engine load (equivalent to the injection of a large quantity of mixture) is a prerequisite to the occurrence of the more common types of knock. Thus, for example, when the accelerator is suddenly depressed, the control unit may be unable (by virtue of its design) to retard the ignition quickly enough by an amount equivalent to the load increase. For this reason, certain cars may be subject to what is known as 'transitional' knock if driven in too high a gear with the accelerator to the floor.

Sharp retardation

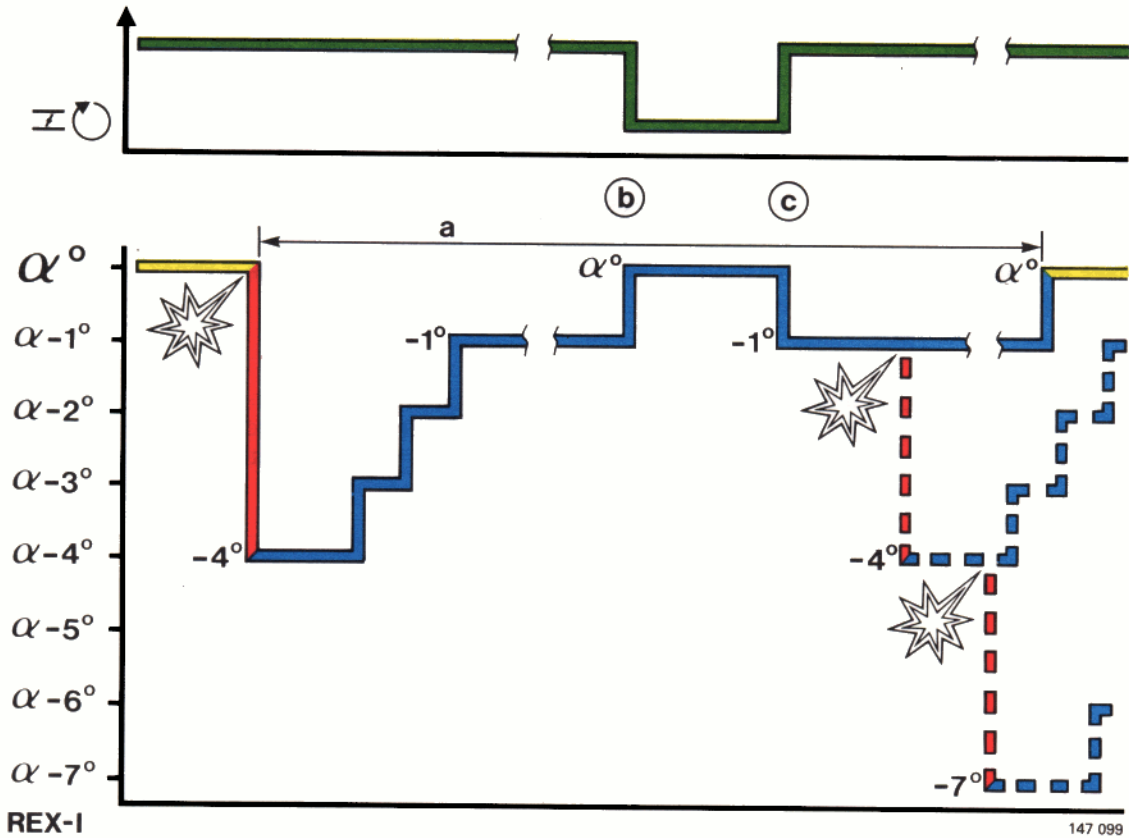
To overcome this problem, the control unit incorporates a program-controlled function which retards the normal timing (α) by 8° in response to a load signal (from the fuel control unit) indicating a sudden pressure drop in the intake manifold.

Rapid re-advance

The control unit then restores the timing very rapidly to the normal value, α . This is carried out in steps of 1° every five engine revolutions (both values approximate), regardless of whether the higher load condition is of longer duration.

Should the rapid pressure drop be followed by full opening of the throttle, the control unit will have sufficient time to again retard the basic timing by a sufficient amount without any significant risk of further knock.

* EZ-K systems are equipped with a similar knock control function.



Adaptive timing retardation

Background/function

If normal engine load is exceeded for longer than usual (for example, when the car is driven up a long incline, is pulling a trailer or is running on low-grade fuel), knock-controlled retardation will intervene more often. The adaptive retardation function, on the other hand, retards the timing by a small amount for a longer period to reduce the risk of knock at specific combinations of engine speed and load.

Meaning roughly 'self-learning', the term 'adaptive' is used to describe the fact that the control unit, after a time, 'learns' that running conditions have changed more or less permanently. The function is applied individually to each cylinder.

Conditions

On the upper curve (green), the upper position on the vertical axis represents a combination of engine speed and load which experience has shown to be particularly susceptible to knock. The horizontal axis is the time scale, calibrated in this case in tens of minutes.

If the control unit detects that the load/speed increase is of a 'permanent' nature (i.e. that it has lasted for a specific time), it will adopt the adaptive retardation mode when knock occurs.

Activation

The lower curve illustrates the practical effect of adaptive timing retardation. Representing a period of approx. 10 minutes during which the function is activated, interval (a) is termed the 'active adaptive zone'.

If the control unit detects that the speed/load increase is of a permanent nature before the adaptive zone is reached, the basic timing will be retarded by 1°. The function is activated in the event of knock i.e. the basic timing is retarded as indicated by the start of interval (a) in the figure.

In this case, the timing is retarded by 4° (to -4°, or 1° more than under 'normal' knock conditions), following which it is re-advanced in the usual manner (at a rate which varies with engine speed) to 1° below 'the basic setting' (α - 1°).

Design and function – Compensation functions

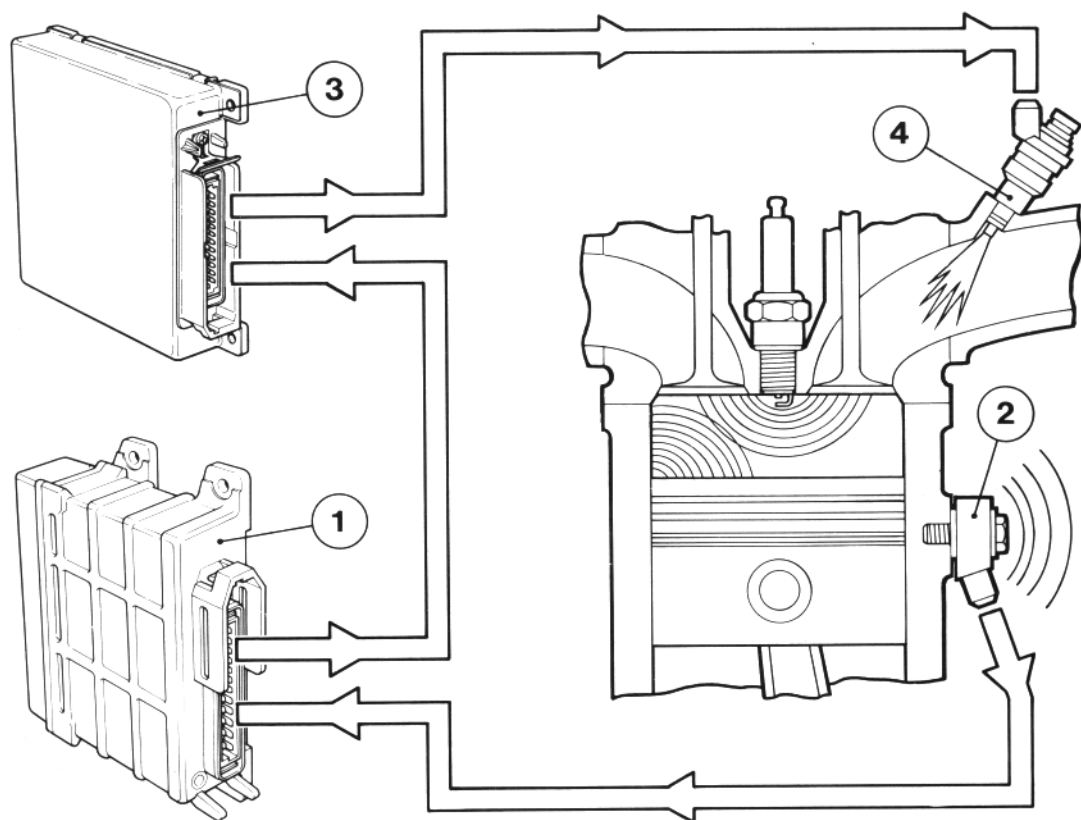
If the load temporarily reverts to normal (b) during the adaptive retardation period (e.g. if the trailer is uncoupled or the road becomes downhill), the timing will be returned to the basic setting (α). If engine speed and load subsequently change (within the 10-minute period) so that conditions once more fall within the knock-sensitive zone (c), the control unit will again automatically retard the timing by 1° without the occurrence of knock.

If knock persists despite the intervention of the adaptive retardation function, the timing will be retarded as usual (as indicated by the dashed downward steps) i.e. by 3° each time knock occurs.

The control unit always leaves the adaptive mode (at the end of interval (a)) after a predetermined interval (approx. 10 min) **regardless of load**. If the load remains high, a new adaptive period will commence if knock recurs and the cycle will be repeated from the start of interval (a).

Advantages

On average, this mode of knock control permits a more advanced timing setting to be used – an advantage in terms of combustion, fuel economy, and so on – due to the fact that fewer knock-controlled retardation operations are required when the function is activated. Stated in simple terms, knock is prevented by detecting the increased risk of the phenomenon.



147 101

Knock-controlled fuel enrichment

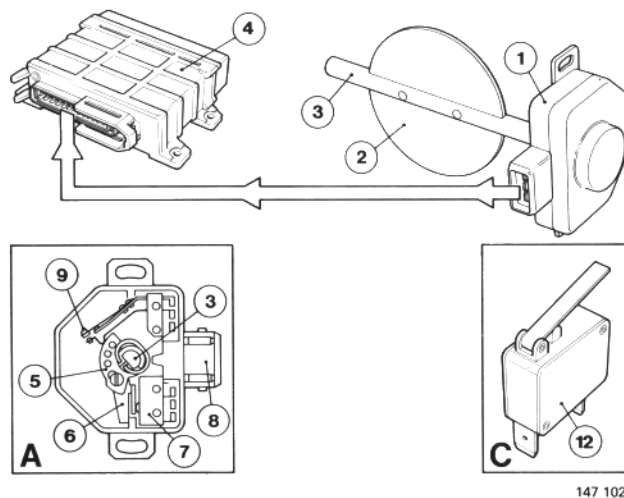
Knock-controlled fuel enrichment means that the injector opening period is extended to enrich the fuel/air mixture, reducing the combustion temperature and bringing the uncontrolled combustion under control. The function is activated if the ignition system control unit detects that knock is occurring in all cylinders above a certain threshold value.

On receiving a signal from the knock sensor (2) and having established that knock is present in all cylinders, the control unit (1) connects a terminal on the fuel injection system control unit (3) to ground, causing the latter to transmit a signal to the injectors (4) to extend the opening period.

Knock-controlled fuel enrichment is a feature of EZ-117K on the B 230 FT engine, and of all variants of EZ-115K and EZ-116K.

* The function is activated only within a certain speed and load range, in addition to which a certain average knock-controlled retardation must already have been applied in all cylinders. The following conditions are required for the intervention of the knock-controlled fuel enrichment function on the various ignition systems/engines:

- EZ-117K on B 230 FT: 6° retardation in all cylinders in response to knock detector signals.
- EZ-115K on B 280 E/F: Retardation of at least 10° in all cylinders in response to knock detector signals at engine speeds above 3800 r/min and above a certain minimum load.
- EZ-116K on B 234 F: Retardation of at least 3–4° in all cylinders in response to knock detector signals at engine speeds above 3800 r/min and above a certain minimum load.



147 102

Throttle switch/idling (air control) switch

Function and location

The throttle switch (1) supplies a signal to the ignition system control unit when the throttle is fully closed. The signal is used to enable the control unit (4) to select a timing setting which is suitable for idling and engine braking conditions. The throttle switch detects the throttle position (2) by measuring the rotation of the spindle (3).

Signal

Throttle closure (for example under idling and engine braking conditions) grounds one of the switch terminals, allowing a current to flow from one of the terminals on the control unit. The ground current is interpreted by the control unit to determine, on the basis of engine speed information, whether the conditions are those of idling or engine braking.

Idling

At speeds close to idling, the signal causes the control unit to adopt a 'fixed' ignition setting in accordance with the idling program. Since the engine is not required to develop a specific power when idling, the timing is determined mainly on the basis of maximum comfort. This means that the setting is well retarded (between approx. 10° and 16° before TDC) to minimize the peak (i.e. maximum) pressure in the combustion chamber during the combustion phase, ensuring smooth, steady running.

Engine braking

Since the speed is higher under engine braking conditions, the control unit timing characteristic is speed-dependent only. In general, the characteristic represents an optimum compromise between the lowest possible emissions and minimum fuel consumption.

(Most of the electronic fuel injection systems used feature a fuel cut-off function which intervenes under engine braking conditions. In this case, the fuel system control unit is also supplied with a fully-closed throttle signal and keeps the injectors fully closed under these conditions.)

Throttle switch types

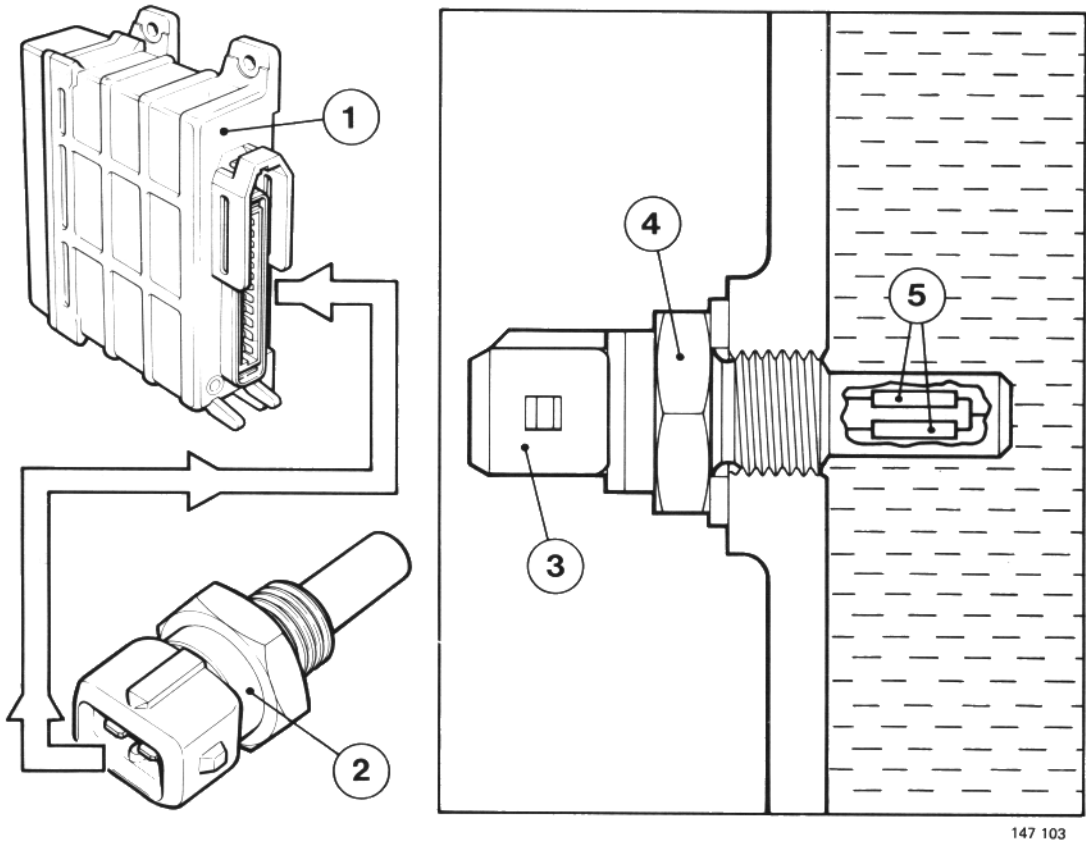
A. Practically all fuel-injected models in the 700 series are fitted with the type of throttle switch illustrated. The switch is mounted on the throttle spindle (3), which actuates a cam plate (5) and an arm (6). The arm operates a microswitch (7) which closes to ground a terminal in the connector (8).

(Apart from supplying a signal to the control unit when the throttle is closed, the type of switch used on some engine variants incorporates a set of full-load contacts (9) which close when the throttle is fully open. In this case, a full-load signal is fed to the fuel system control unit, instructing it to extend the injector opening period. However, this feature is not used on turbocharged engines.)

C. The EZ-118K system employs an idling switch (12) mounted on the throttle cable pulley to indicate when the throttle is fully closed. The control units use the signal to establish a comfortable timing setting when idling and to activate the fuel cut-off function under engine braking conditions. The EZ-118K control unit also uses the signal as a condition for advancing the timing for idling speed compensation when a drive position is selected on an automatic model or the AC compressor is switched in.

* It is extremely important that the throttle switch be correctly adjusted before checking the timing, to ensure that the idling setting is correctly measured.

* Electronic ignition systems not equipped with a throttle switch or idling (air control) switch are supplied with information on idling conditions in the form of a signal representing the vacuum in the intake manifold.



147 103

Temperature sensor

Function and location

The control unit (1) compensates the timing for engine temperature with the aid of the temperature sensor (2). This function is used to adjust the timing at temperatures deviating from the normal operating range (i.e. outside approx. 80°C to 100°C). The temperature sensor is normally mounted in the cylinder head and is completely immersed in the coolant.

Construction

The temperature sensor consists of a connector (3) and a body (4) provided with a male thread and enclosing one or two temperature-sensitive resistors (5) with a negative temperature coefficient (NTC). On most fuel-injected engines, the device is equipped with two resistors, one of which is connected to the fuel system control unit to provide a fuel enrichment signal when the engine is cold and the other to the ignition system control unit. (Twin-resistor temperature sensors are normally grounded to the cylinder block, while the single-resistor type is grounded through the control unit.)

Signal

The resistance of the temperature sensor varies in direct proportion to the coolant temperature, falling as the temperature rises. Since the control unit continuously supplies the sensor with a constant current, the variation in resistance is reflected by the voltage drop across the device, enabling the control unit to determine when the various temperature-dependent timing adjustments must be made.

Before considering the beneficial effects of temperature compensation on the timing, some effort should be made to gain an understanding of the effects of variations in timing on the cylinder, exhaust gas and coolant temperatures.

Theory of temperature-compensated timing advance

Advancing the ignition timing increases the cylinder temperature while reducing the exhaust gas temperature. Under certain conditions, this also yields a reduction in coolant temperature. The higher cylinder temperature is due to the higher pressure of the fuel/air mixture as it is ignited, while the lower exhaust gas temperature is due to the relatively late scavenging of the gases at the end of the combustion process.

The lower coolant temperature achieved by advancing the timing when idling is partly due to the fact that the setting is already well retarded and that a relatively high proportion of the fuel does not, as a result, produce mechanical work, the energy being dissipated in the form of heat losses. Advancing the timing under these conditions greatly improves the efficiency of combustion, increasing the amount of energy converted into mechanical work and reducing the amount of heat discharged to the coolant.

Theory of temperature-compensated timing retardation

Although it reduces the cylinder temperature, retarding the ignition increases the exhaust gas and coolant temperatures. The lower cylinder temperature is due to the reduced pressure of the mixture when it is ignited, while the rise in exhaust gas temperature is due to scavenging of the gases closer to the exhaust valve opening point. The higher coolant temperature is attributable to the fact that less of the energy content of the fuel is converted into mechanical work, a higher proportion being dissipated in the form of thermal losses. As a result, a higher quantity of heat is transferred more quickly to the cylinder wall, exhaust gas port, intake manifold and coolant passages.

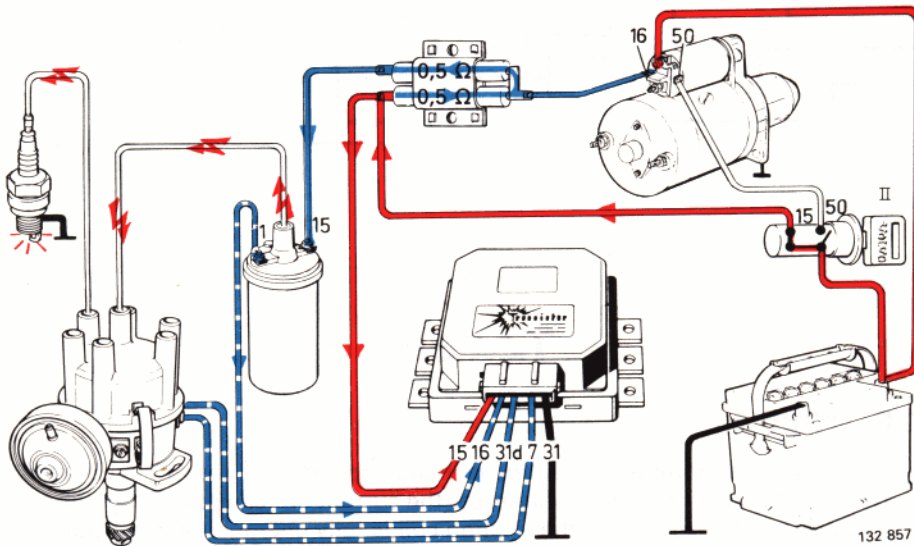
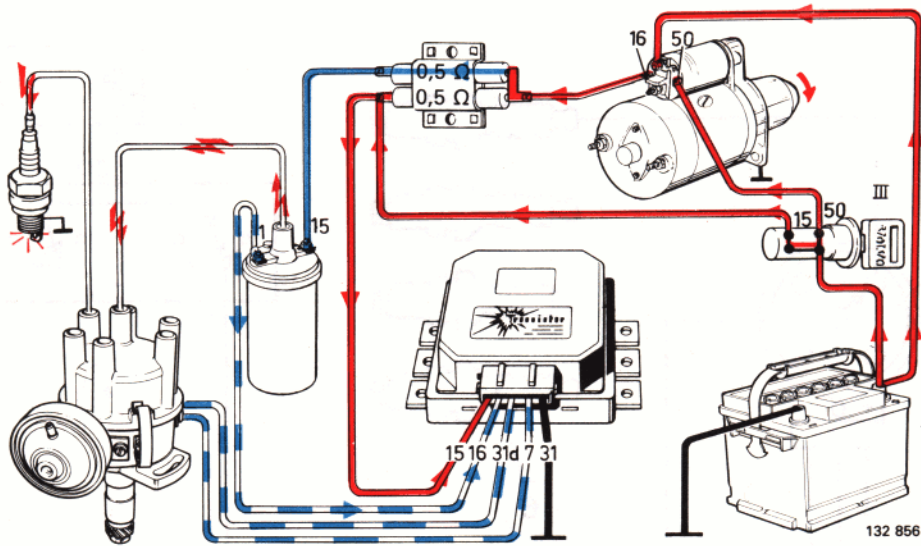
Timing compensation on cold engine

Temperature compensation of the timing on a cold engine usually involves advancing the timing to shorten the warm-up period. However, temperature-controlled functions which retard the timing in a cold engine are also used. One of the effects of this is to bring the catalytic converter up to working temperature more quickly, while another is to increase the coolant temperature, accelerating the defrosting action of the climate control system.

The temperature sensor signals may also be used by the control unit to determine when the knock sensor signal should be switched in. Blocking this signal when the engine is cold ensures that the control unit is unaffected by spurious signals caused by the mechanical noise typically emitted by the engine as it warms up.

Timing compensation on hot engine

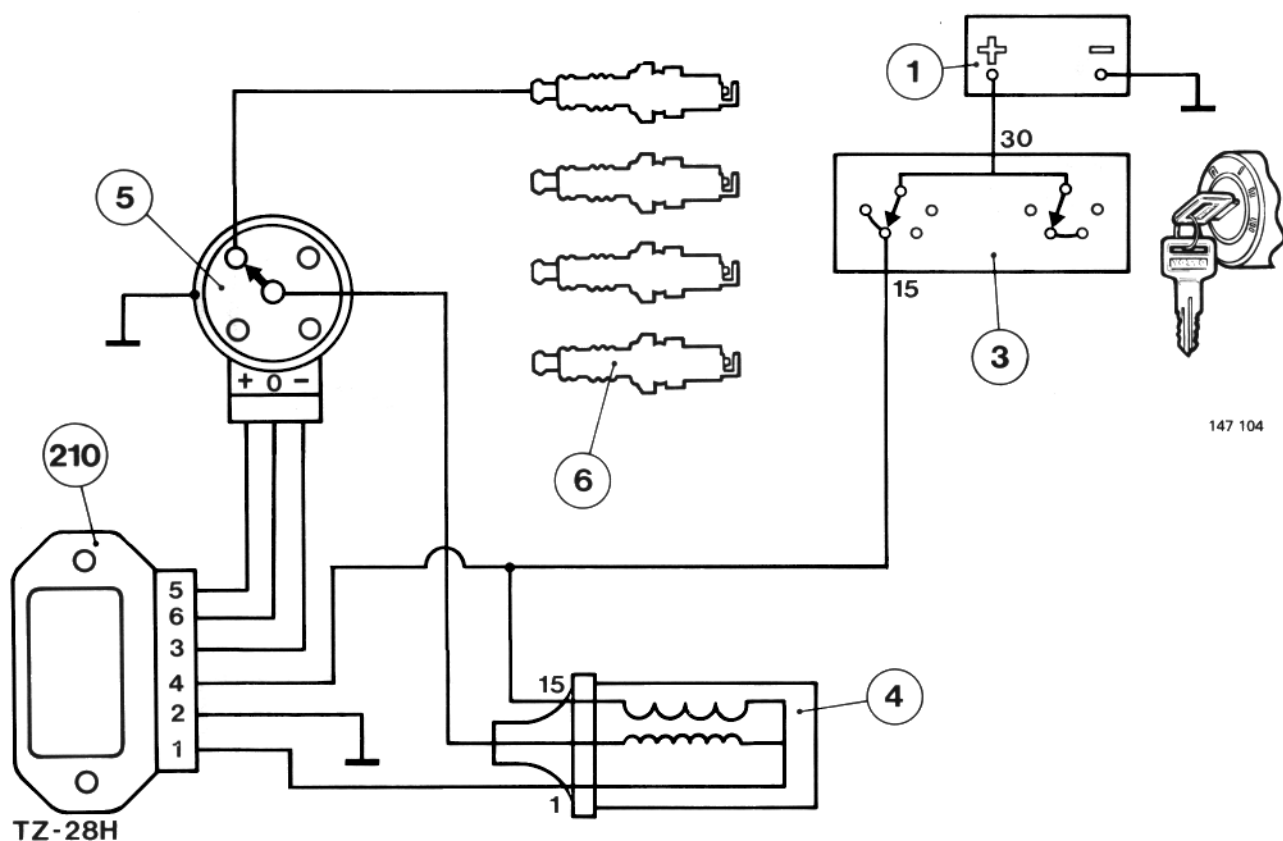
Temperature compensation of the timing on a hot engine means advancing the timing to reduce the coolant temperature. This prevents the engine from boiling (although the cooling water will not begin to boil while the temperature is below approx. 120–125°C, due to the fact that the system is pressurized). The timing advance is normally applied only when idling, since the setting is normally fairly retarded under these conditions.



TSZ

B 28 A/E/F

TSZ is a type of electronic ignition system in which an inductive pulse generator performs the function of the contact points. (Roughly translated, the abbreviation TSZ means 'Transistorized coil ignition'.) The pulse generator transmits information to a 'control unit' which controls the charging period of the ignition coil. The system also incorporates a centrifugal generator and a ballast resistor. The variant used on 6-cylinder engines (B 28 A/E/F) is designated TSZ-4 and is used on 1982–86 700s.



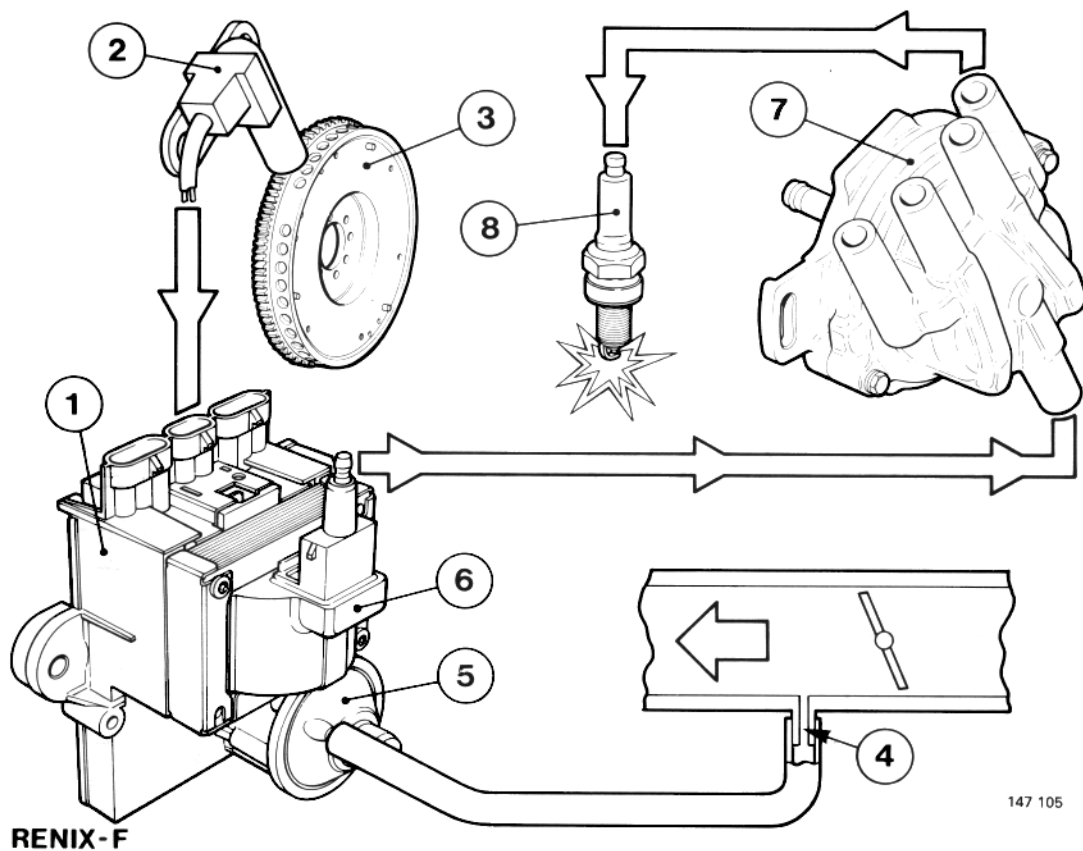
TZ-28H

B 19 E/ET, B 23 E, B 230 A

The 'control unit' (210) consists of a number of electronic circuits operating a power circuit which controls the primary current in the ignition coil. The 'control unit' interrupts the current on receipt of an ignition pulse from the Hall generator in the distributor (5) and ensures that the ignition coil is fully charged between pulses. The 'control unit' also features a standing current cut-off function which prevents overheating of the ignition coil by interrupting the current if no speed signals are present.

'Control unit' connections:

1. Controls ignition coil (4) primary current
2. Ground terminal
3. Hall generator ground terminal
4. Power supply (12 V)
5. Hall generator power supply (12 V)
6. Receives engine speed and crankshaft position signals from Hall generator



147 105

RENIX-F

RENIX-F

B 200 K

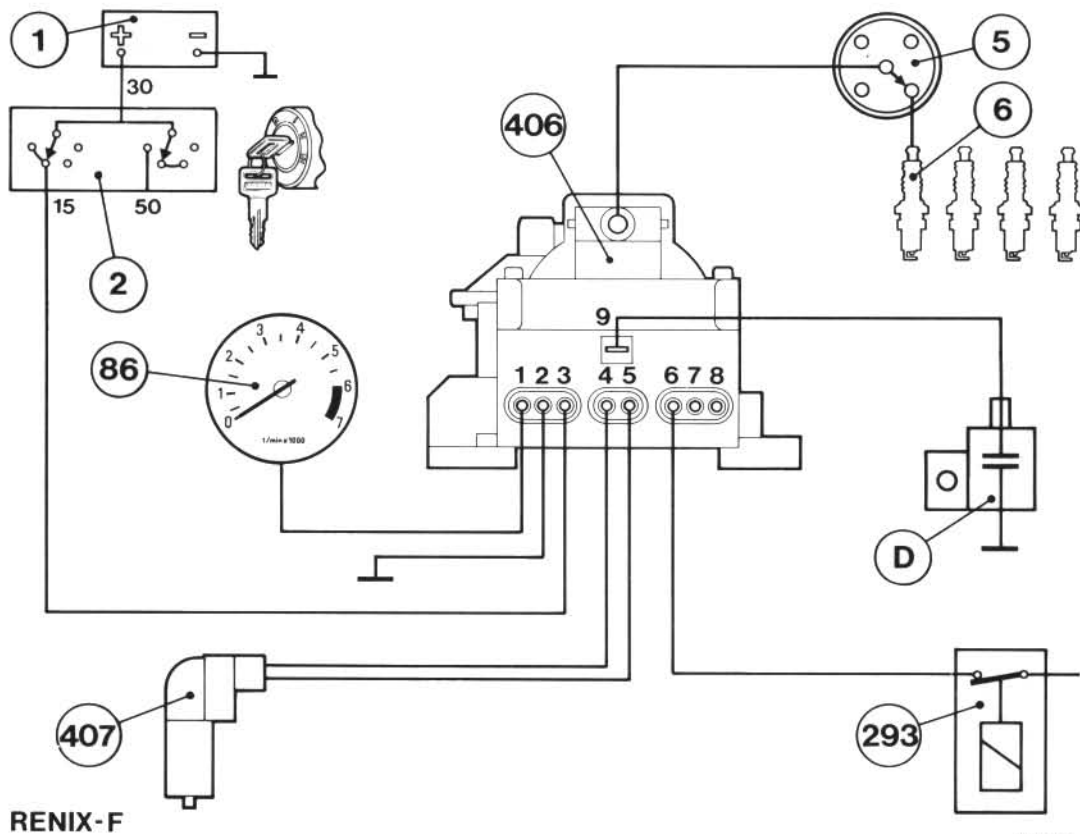
(The above illustration and the following text are based on the B 200 K engine used in the 740)

The system consists of an electronic control unit (1) which is supplied with engine speed and crankshaft position signals by an inductive speed/position pick-up (2). The pick-up detects the passage of a number of 'teeth' on the flywheel (3). The control unit is also supplied with information on engine load through a vacuum line (4) connected to the intake manifold, the pressure in which actuates a vacuum advance unit (5) integral with the unit.

The speed and load signals are processed by the control unit electronics and compared with the timing settings stored in the memory. Having used the information to compute the optimum timing, the unit transmits control signals to an integral power stage which makes and breaks the current in the primary winding of the ignition coil (6) at the correct instant, generating a high-tension current in the secondary. The HT pulse is fed to the distributor (7) for delivery to the appropriate spark plug (8).

Apart from the rotor, the distributor contains no mechanical or electronic components, its sole function being to distribute the high-tension current to the correct plug.

* At idling speeds of less than 1000 r/min, the control unit advances the timing by 5° to prevent a drop in speed when the AC system is switched on or when a drive position is selected on an automatic model.

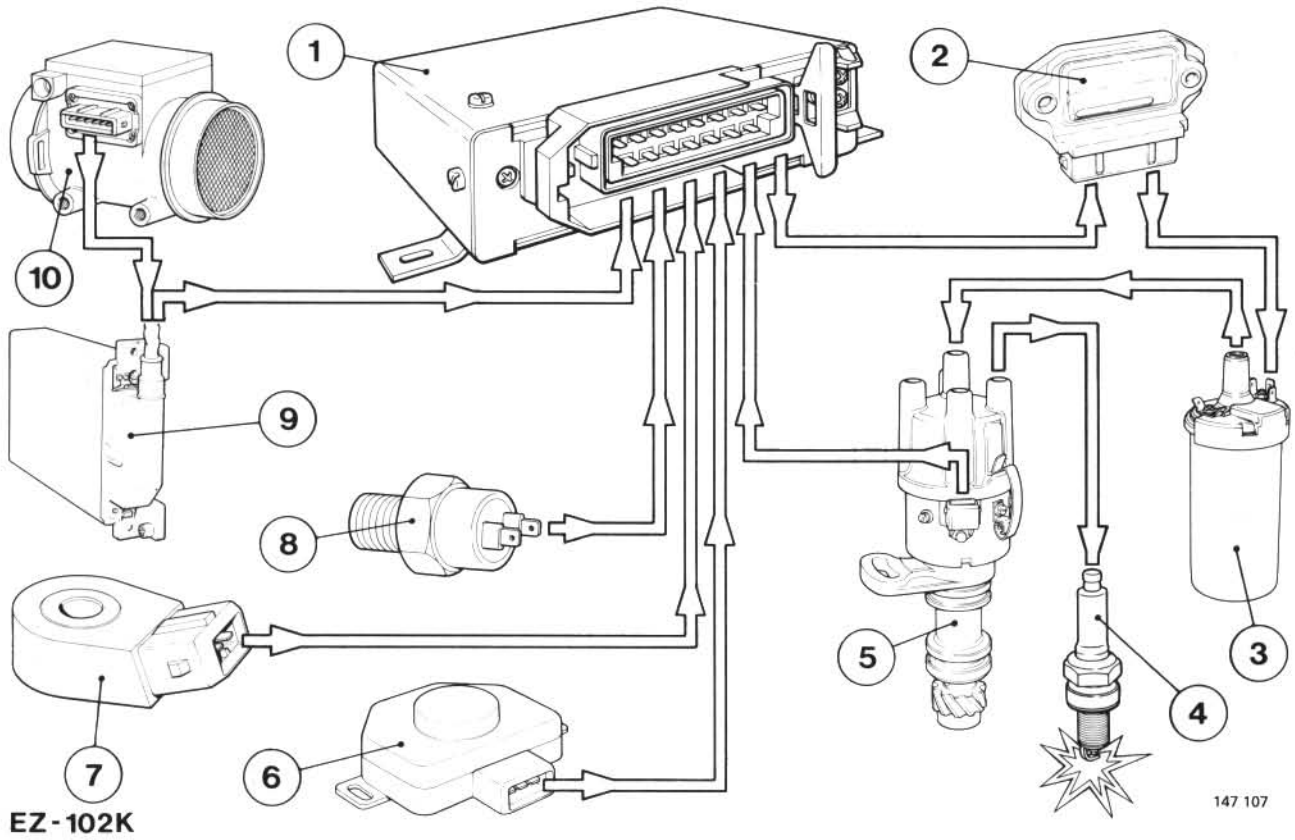


REXIX-F

147 106

Control unit connections

1. Supplies speed signals to rev counter (86).
2. Connects control unit (406) to ground.
3. Receives supply from battery (1) via ignition switch (2).
4. Receives engine speed and crankshaft position signals from speed/position pick-up (407).
5. Receives engine speed and crankshaft position signals from speed/position pick-up (407).
6. Receives signal from idling advance relay (293) on cars with automatic transmission and/or AC.
7. Spare.
8. Spare.
9. Connected to radio interference suppression capacitor (D).



147 107

EZ-102K

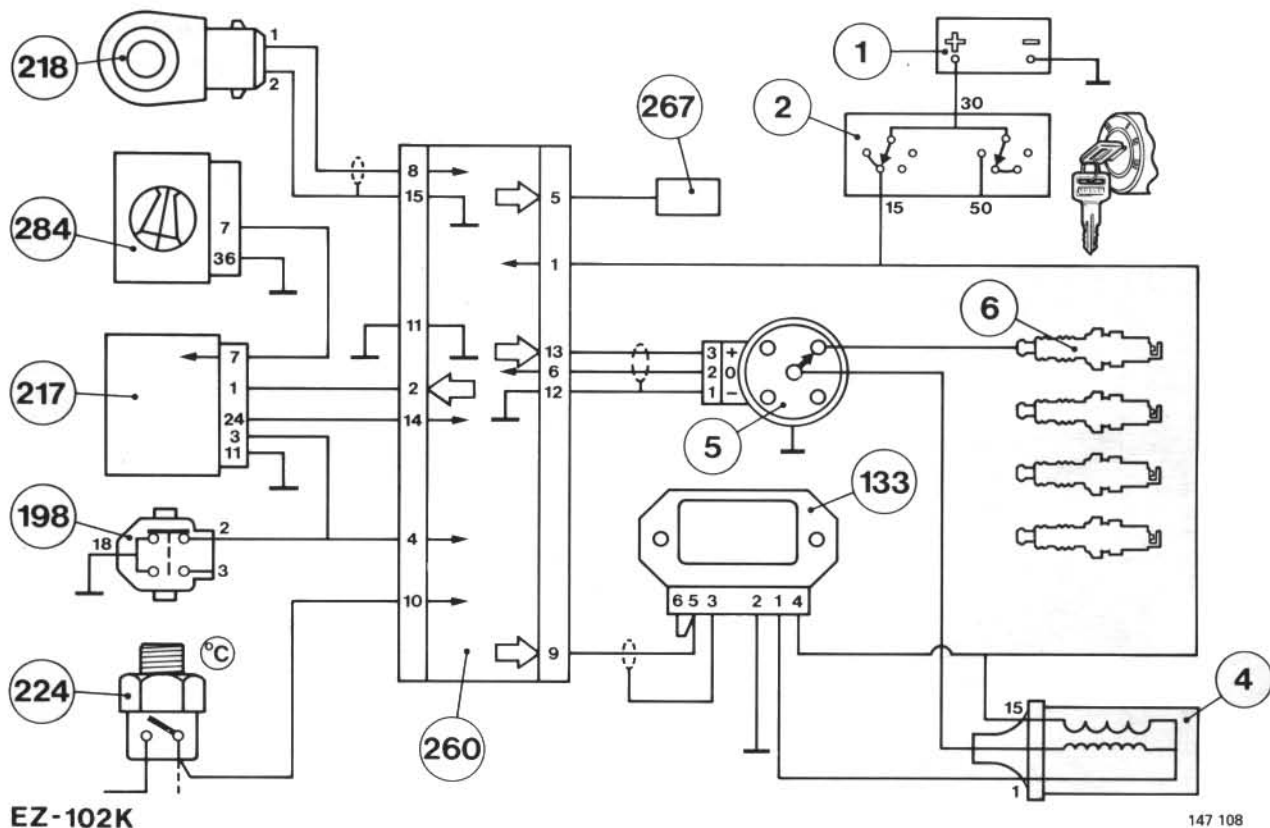
B23 FT

(760, 1984 with B 23 FT)

The sensors supply the control unit (1) with a series of signals which describe the engine running conditions. The control unit uses the signals to compute the optimum timing and transmits the necessary ignition pulses to the power stage (2), which makes and breaks the current in the primary winding of the ignition coil (3). The high-tension current thereby induced in the secondary winding is delivered to the appropriate spark plug (4) by the distributor (5).

The timing is computed by the control unit on the basis of the following information:

- The Hall generator in the distributor (5) supplies a signal indicating the engine speed and crankshaft position.
- The engine load signal is supplied by the LH-2.1 injection system control unit (9) which, in turn, is supplied with a load signal by the air mass meter (10).
- Any tendency of the engine to run hot is indicated by a thermostat (8). (The throttle must be closed and the engine temperature must be above 103°C before the control unit advances the timing. Under these conditions, the thermostat will close, and the control unit will both advance the setting by 13° and switch in the electric radiator fan.)
- Engine knock is indicated by the knock sensor (7).
- Throttle closure is indicated by the throttle switch (6).

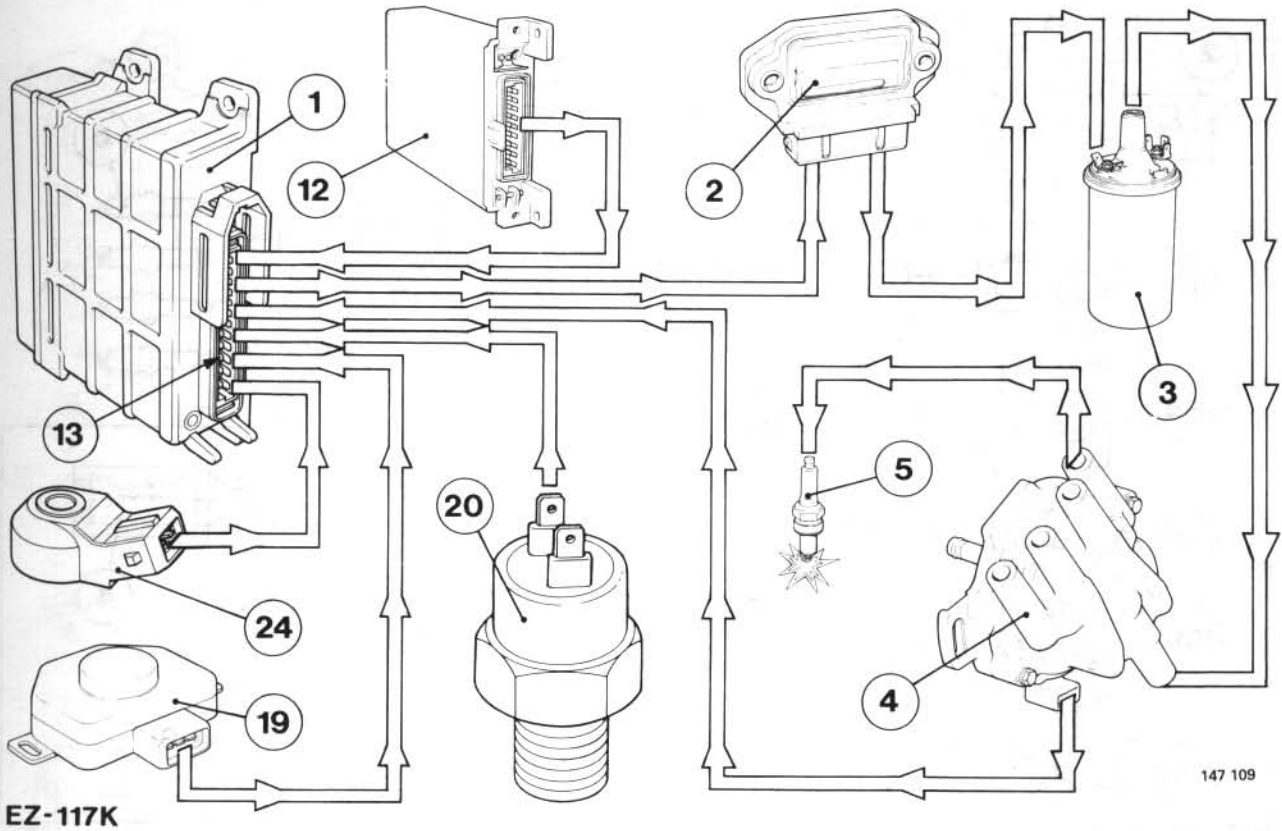


Control unit connections

1. Receives power from battery (1) through ignition switch (2).
2. Transmits speed signal to fuel system control unit (217)
4. Connected to ground by throttle switch (198) when throttle is closed.
5. Transmits fault signals to test terminal (267) when fault tracing with test diode.
6. Receives engine speed and crankshaft position signal from Hall generator in distributor (5).
8. Receives signal from knock sensor (218).
9. Transmits ignition pulses to power stage (133).
10. Receives 12 V supply on closure of thermostat (224).
11. Grounds control unit (260).
12. Grounds screen of lead from Hall generator in distributor (5).
13. Supplies power to Hall generator in distributor (5).
14. Receives load signal from fuel system control unit (217).
15. Grounds screen of knock sensor (218) lead.

Power stage connections

1. Controls current in ignition coil (4) primary winding.
2. Grounded.
3. Grounds screen of lead connected to terminal 5.
4. Receives power from battery (1) across ignition switch (2).
5. Receives ignition pulses from control unit (260).



EZ-117K

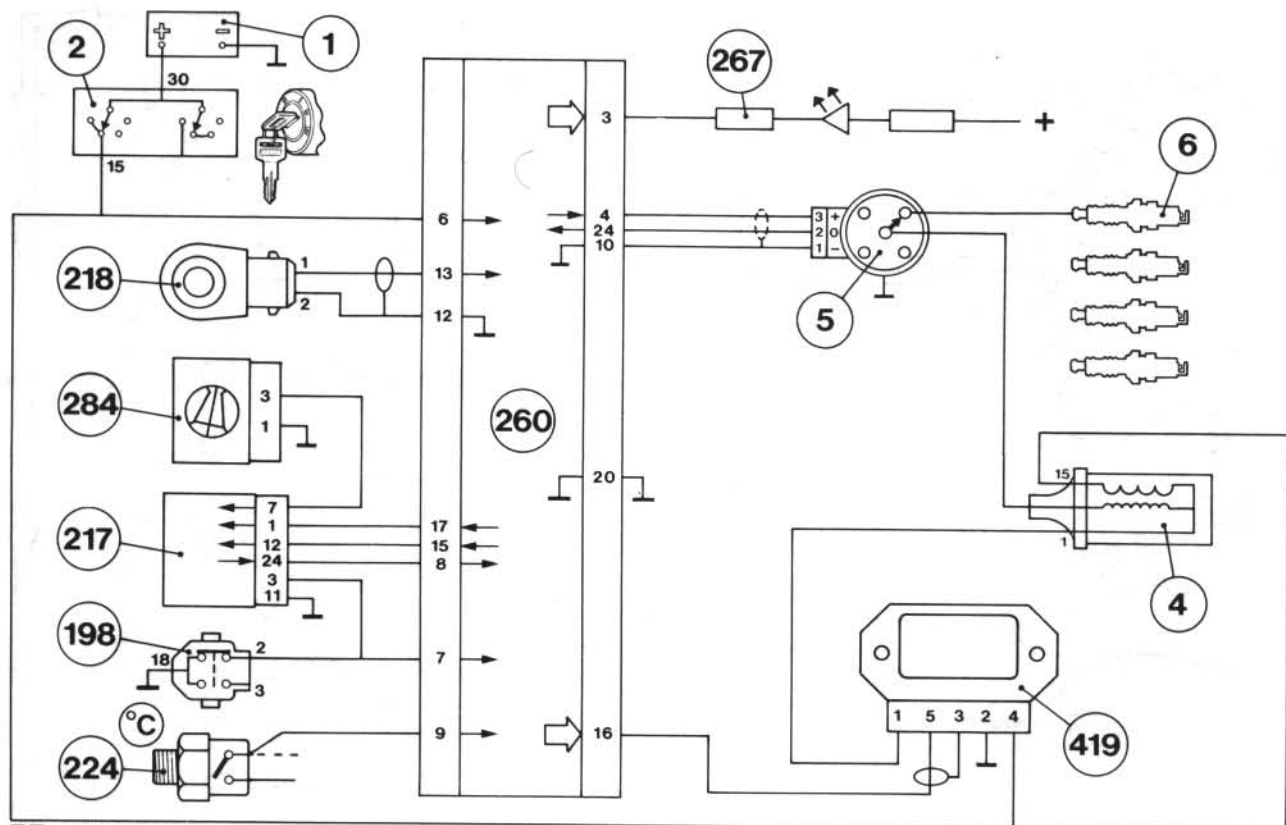
B 230 F/FT

(740: B 230 F/FT; 760: B 230 FT)

The control unit (1) computes the optimum timing based on signals from the various sensors and transmits ignition pulses to the power stage (2) at exactly the right instant. At this point, the power stage interrupts the current in the primary winding of the ignition coil (3). The high-tension current induced in the secondary is delivered to the appropriate spark plug (5) by the distributor (4).

The timing is computed by the control unit on the basis of the following information:

- The engine load signal is supplied by the fuel injection system (LH-2.2) control unit (12) which, in turn, is supplied with load signals by the air mass meter.
- A Hall generator in the distributor (4) supplies an engine speed and crankshaft position signal.
- Knock is indicated by the knock sensor (24).
- Closure of the throttle is indicated by the throttle switch (19).
- Any tendency of the engine to overheat is indicated by a thermostat (20). In this event, the control unit advances the timing by 13° if the throttle is closed. (This applies only to B 230 FT variants.)



EZ-117K

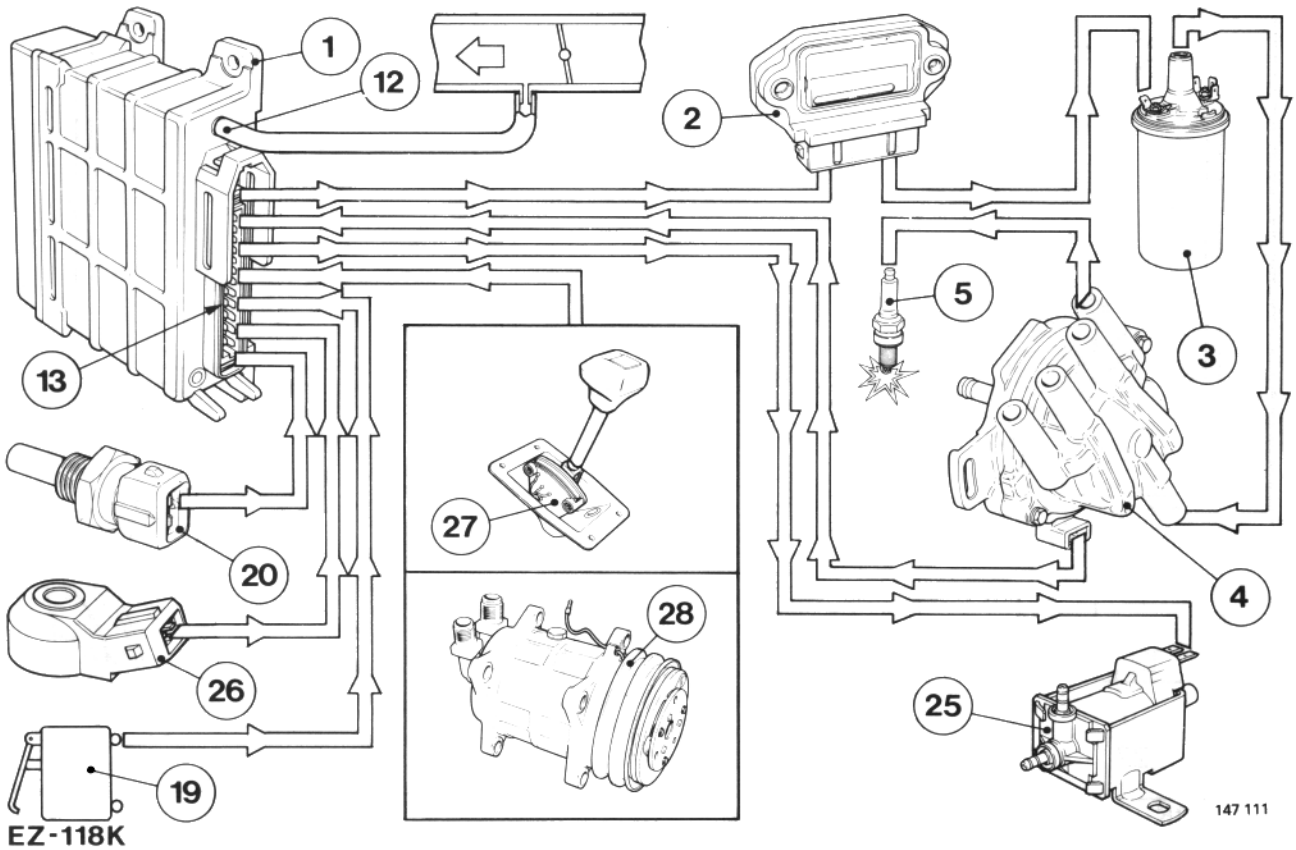
147 110

Control unit connections

- 3. Supplies fault indication signals to test terminal (267) when test diode is connected.
- 4. Supplies power to Hall generator in distributor (5).
- 6. Receives supply from battery (1) across ignition switch (2).
- 7. Grounded by throttle switch (198) when throttle is closed.
- 8. Receives load signal from fuel system (LH-2.2) control unit (217).
- 9. Receives 12 V supply when thermostat (224) closes (B 230 FT only).
- 10. Grounds screen of lead from Hall generator in distributor (5).
- 12. Grounds screen of lead from knock sensor (218).
- 13. Receives signal from knock sensor (218).
- 15. Transmits knock-controlled fuel enrichment signal to injection system control unit (217) (B 230 FT only).
- 16. Transmits ignition pulses to power stage (419).
- 17. Transmits speed signal to fuel system (LH-2.2) control unit (217).
- 20. Grounds control unit (260).
- 24. Receives engine speed/crankshaft position signal from Hall generator in distributor (5).

Power stage connections

- 1. Controls current in ignition coil (4) primary winding.
- 2. Grounded.
- 3. Grounds screen of lead connected to terminal 5.
- 4. Receives power from battery (1) across ignition switch (2).
- 5. Receives ignition pulses from control unit (260).



EZ-118K

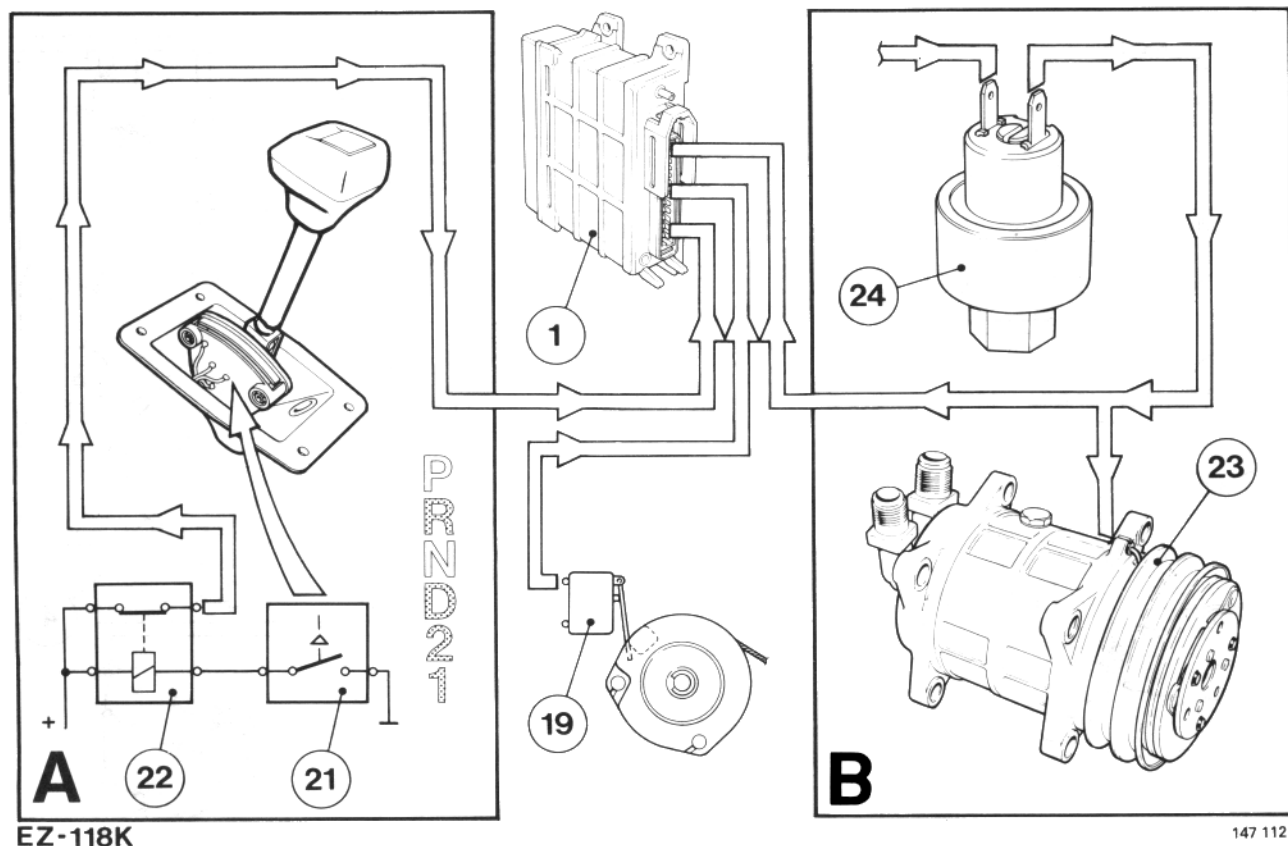
B 200 E, B 230 E and B 230 K

The control unit (1) computes the optimum timing on the basis of information from the various sensors and transmits the necessary ignition pulses to the power stage (2), which controls the current in the primary winding of the ignition coil (3). The high-tension current induced in the secondary winding by interruption of the primary is fed to the distributor (4) for delivery to the appropriate spark plug (5).

Variants for the B 230 K engine also supply signals to a solenoid valve (25) controlling the fuel cut-off function under engine braking conditions.

The timing setting computed by the control unit is based on the following information:

- An engine load signal is supplied by a vacuum line (12) between the control unit and the intake manifold.
- A Hall generator in the distributor (4) supplies an engine speed/crankshaft position signal.
- Engine knock is indicated by a knock sensor (26).
- Closure of the throttle is indicated by a throttle switch (19) mounted on the throttle cable pulley.
- On models equipped with AC, operation of the compressor (28) is indicated by a signal from the electromagnetic clutch.
- The selection of a drive position on automatic models is indicated by a signal from the starting interlock switch (27) via a relay.
- Engine temperature is measured by a temperature sensor (20) in the cylinder head (B 230 K only).



EZ-118K

147 112

EZ-118K – Idling compensation

EZ-118K may be provided with one or two idling compensation functions if the car is equipped with automatic transmission and/or air conditioning. If either function is activated, the control unit will advance the timing at idling by 8° to compensate for the higher engine load.

- A.** Certain models equipped with automatic transmission are provided with a function which advances the timing when a drive position is selected, to compensate for the increased load imposed by the torque converter.

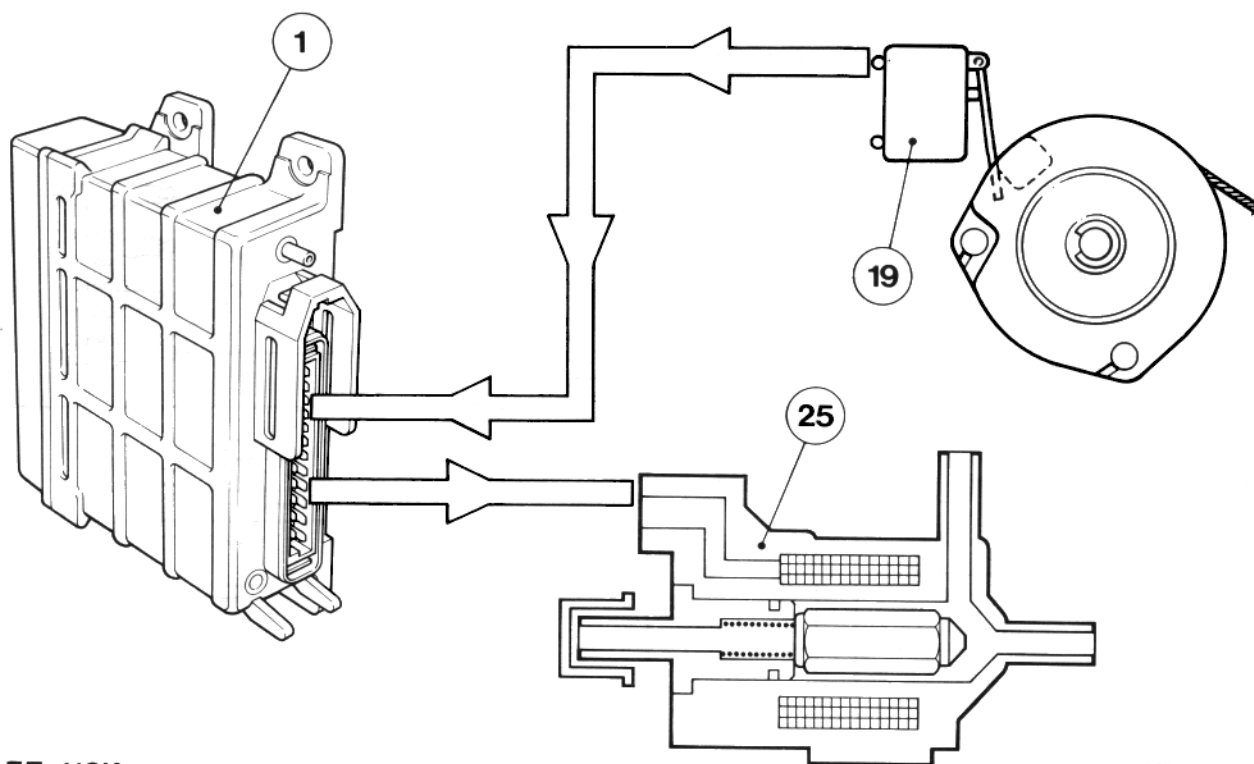
The starting interlock switch (21) opens the relay coil (22) ground connection when the gear selector is moved to position R, D, 2 or 1. This closes the relay contacts, supplying 12 V to the timing advance terminal on the control unit (1). The control unit will advance the timing if the idling (air control) switch (19) also indicates that the engine is idling.

- B.** Certain models equipped with air conditioning are provided with a function which advances the timing when the AC compressor is switched in, thereby preventing a fall in idling speed while maintaining the capacity of the AC system.

The timing advance terminal on the control unit (1) is connected to the electromagnetic clutch circuit on the compressor (23), and receives a 12 V supply when the pressure switch (24) closes to energize the clutch. The control unit then advances the timing if the idling switch (19) also indicates that the engine is idling.

On the B 230 K engine, the above compensation functions intervene only if the engine temperature exceeds 75°C on 1985–86 variants or 85°C on 1987 and later variants.

* Idling compensation operated by the ignition system control unit is not required on engines on which the idling valve is connected to the fuel system control unit (CIS system) or to a special CIS control unit. On engines of this type, the CIS valve ensures that extra air, as well as additional fuel, is supplied to the engine to compensate for the increased load.



EZ-118K

147 113

EZ-118K – Fuel cut-off

(B 230 K variants only)

The control unit (1) supplies a signal to the solenoid valve (25) under engine braking conditions (when the engine speed is high) provided that the idling switch (19) simultaneously indicates that the throttle is closed. The solenoid valve operates to cut off the supply of fuel with the aid of a vacuum valve mounted on the carburettor.

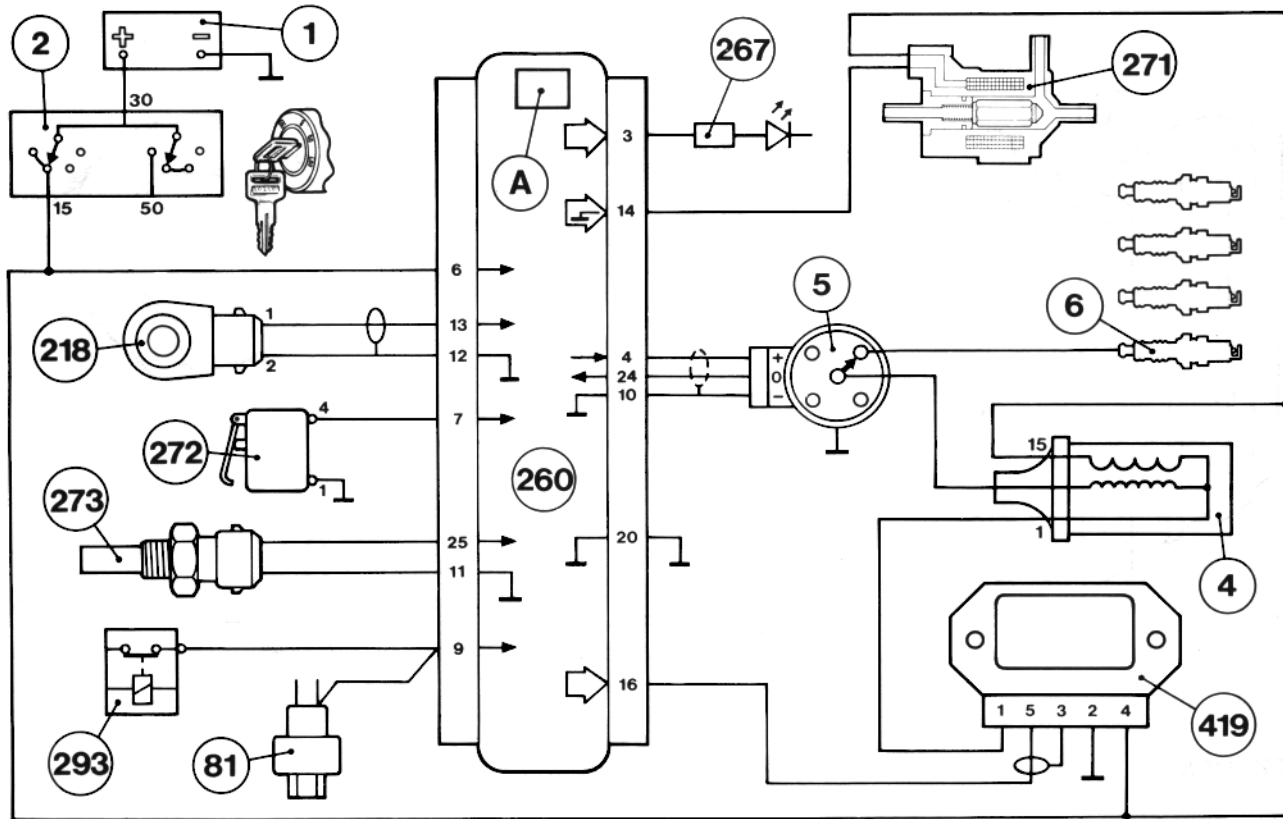
The control unit grounds the solenoid valve, thereby activating the fuel cut-off function when the engine speed is higher than approx. 1650 r/min (1610 r/min on 1985–86 models and 1700 r/min on 1987 and later models) and the idling switch is closed.

The ground connection is opened and the fuel supply is restored when the engine speed has fallen to approx. 1550 r/min or when the accelerator is depressed.

The fuel cut-off function operates only if the engine temperature is higher than approx. 85°C.

* The fuel cut-off function reduces the fuel consumption and, as a result, the volume of exhaust gases.

* The idling switch was transferred from the accelerator pedal to the throttle pulley in 1987, the same year in which the EZ-118K control unit for the B 230 K engine was programmed with new timing curves as part of the redesign of the combustion chamber. On its introduction, the new engine was designated B 230 KH, the H standing for 'Heron'. In the service literature, K engines are now identified by stating the year, for example B 230 K, 1987–.



EZ-118K

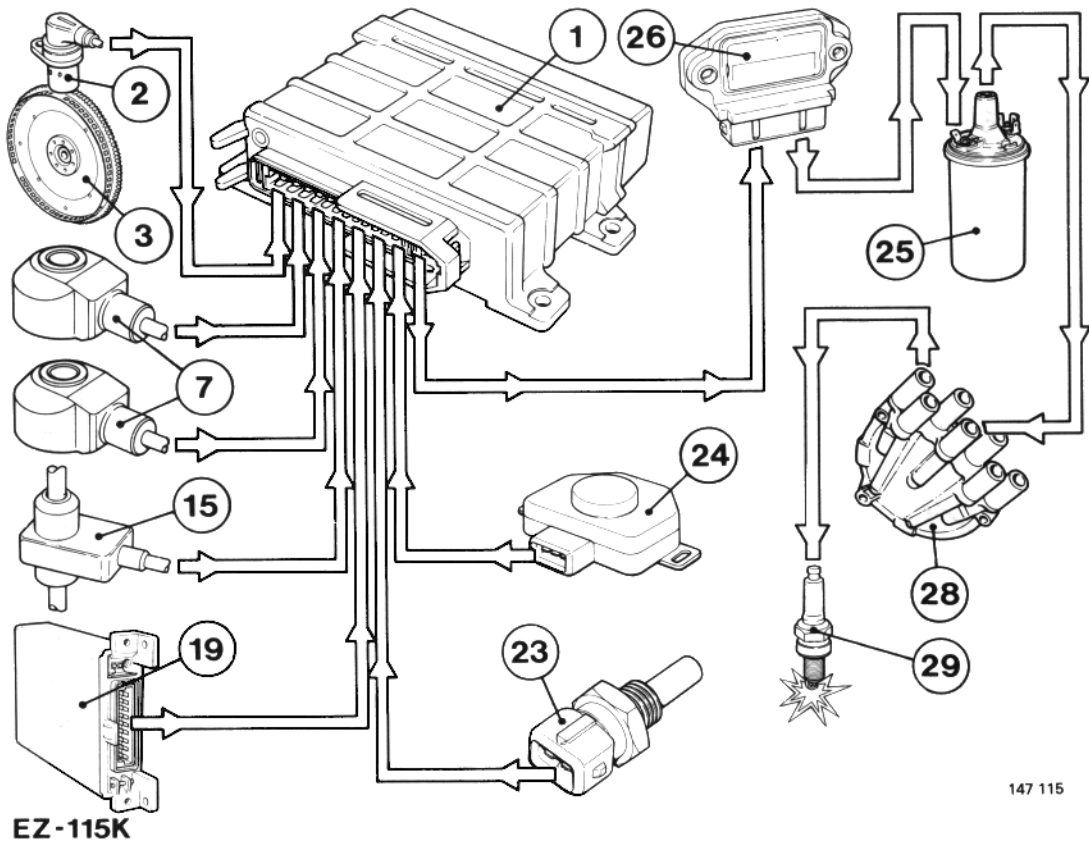
147 114

Control unit connections

3. Supplies fault indication signals to test terminal (267) when test diode is connected.
4. Supplies power to Hall generator in distributor (5).
6. Receives supply from battery (1) across ignition switch (2).
7. Grounded by idling switch (272) when throttle is closed.
9. Receives 12 V supply from AC pressure switch (81) and/or idling compensation relay (293).
10. Grounds Hall generator in distributor (5).
11. Grounds temperature sensor (273) (B 230 K only).
12. Grounds knock sensor (218) terminal 2.
13. Receives signals from knock sensor (218).
14. Grounds fuel cut-off solenoid valve (271) (B 230 K only).
16. Supplies ignition pulses to power stage (419) terminal 5.
20. Grounds control unit (260).
24. Receives engine speed/crankshaft position signal from Hall generator in distributor (5).
25. Receives engine temperature signal from temperature sensor (273).

Power stage connections

1. Controls current in ignition coil (4) primary winding.
2. Grounded.
3. Grounds screen of lead connected to terminal 5.
4. Receives power from battery (1) across ignition switch (2).
5. Receives ignition pulses from control unit (260).



EZ-115K

B 280 E/F

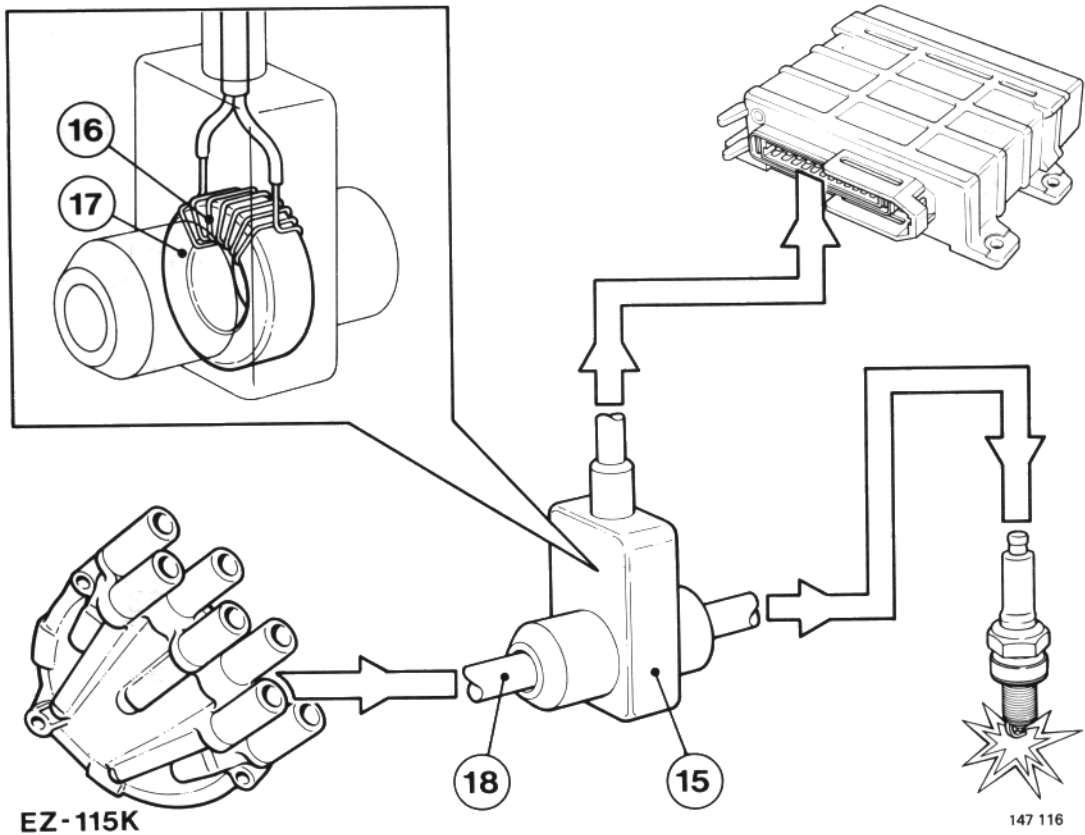
The control unit (1) computes the optimum timing on the basis of information from the various sensors and delivers an ignition pulse at exactly the correct instant to the power stage (26), which responds by making and breaking the current in the primary winding of the ignition coil (25). The high-tension current induced in the secondary winding by interruption of the primary current is fed to the distributor (28) for delivery to the appropriate spark plug (29).

The control unit computes the timing on the basis of the following information:

- Engine speed and crankshaft position signals are supplied by the speed/position pick-up (2).
- Engine knock is detected by the knock sensors (7).
- Ignition in No. 1 cylinder is indicated by the No. 1 cylinder detector (15).
- Engine load signals are supplied by the fuel injection system control unit (19).
- Engine temperature is indicated by the temperature sensor (23).
- Closure of the throttle is indicated by the throttle switch (24).

* The ignition pulse is interrupted by the control unit at a speed of approx. 6300 r/min.

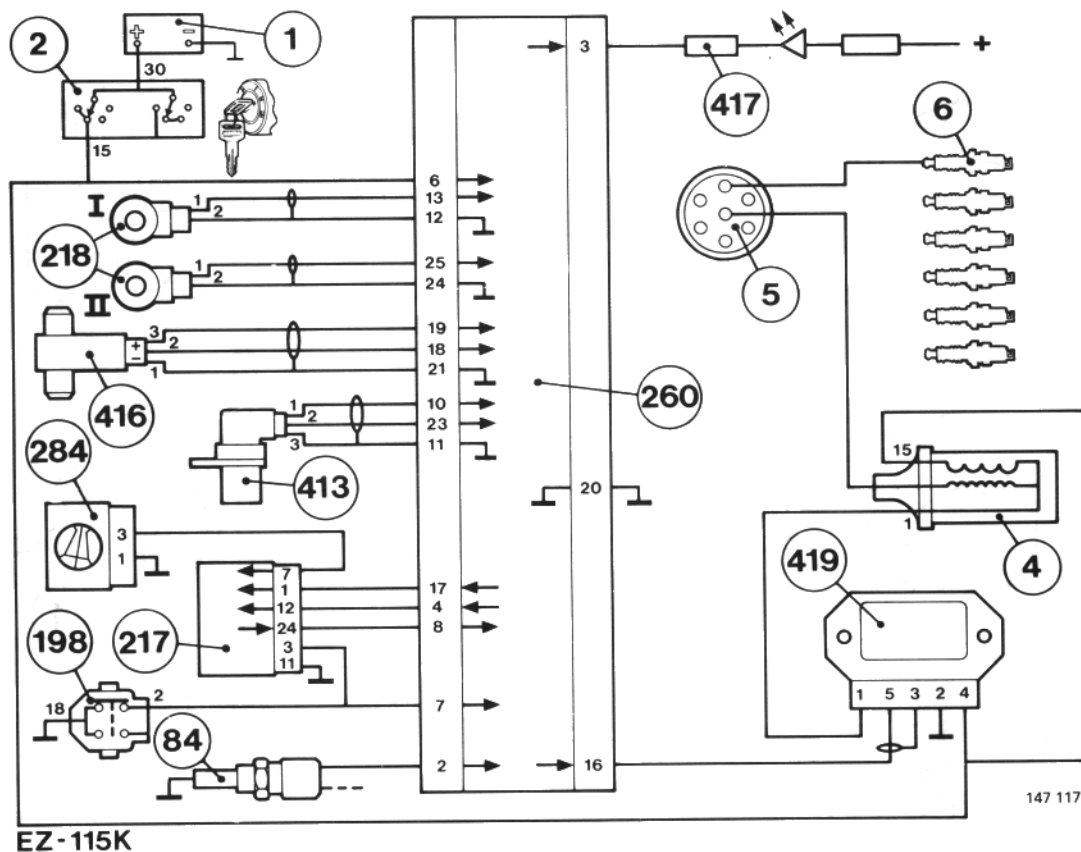
* The control unit can vary the timing from approx. 60° before TDC to approx. 11° after TDC.



EZ-115K – No. 1 cylinder detector

Since the B 280 engine is equipped with twin knock sensors (one for each bank of cylinders), the control unit must be able to distinguish between the two in order to determine which cylinder is knocking. For this purpose, the high-tension lead to No. 1 cylinder is fitted with an inductive detector (15).

The device consists of a coil (16) wound on a core (17) surrounding the ignition lead (18). The current pulse induced in the coil by the HT current in the lead as the cylinder fires is the signal used by the control unit to maintain the correct firing order at all times. The signal is also used to identify an individual cylinder affected by knock, enabling the control unit to retard the ignition in the cylinder affected.

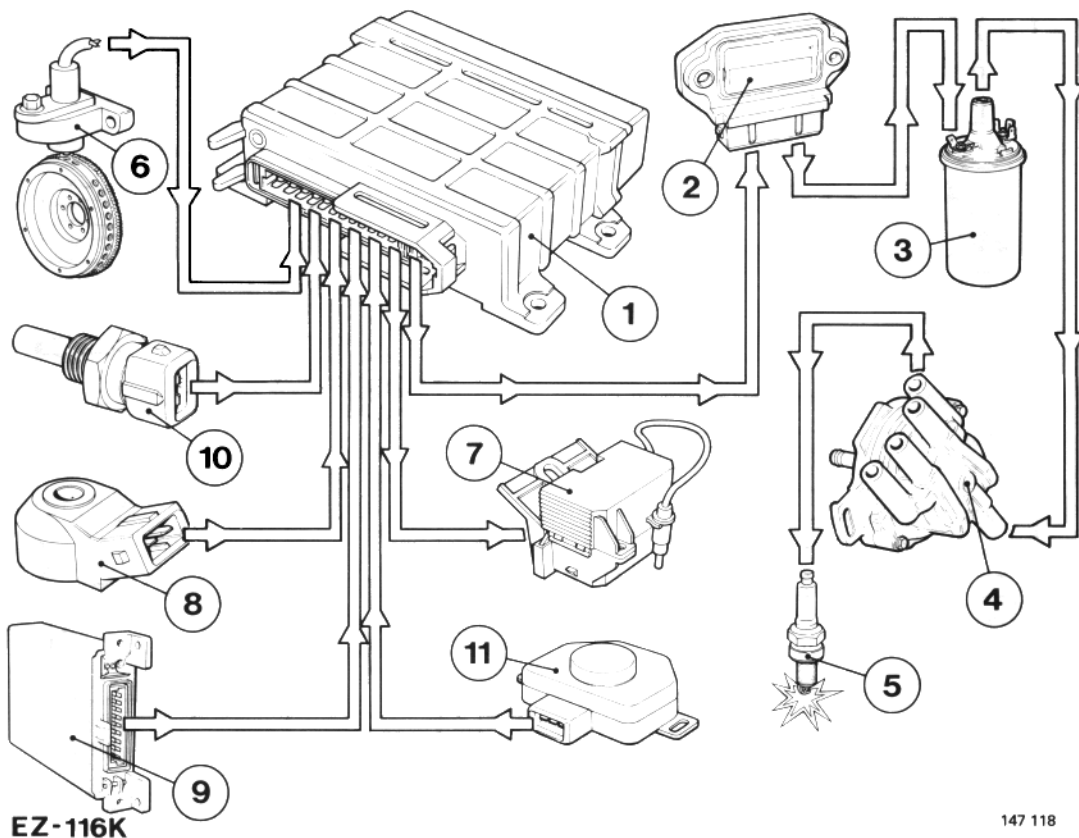


Control unit connections

2. Receives signal from temperature sensor (84) (7/16).
3. Transmits fault signals to test terminal (417) (17/4) when test diode is connected.
4. Transmits knock-controlled fuel enrichment signal to fuel system control unit (217) (4/8).
6. Receives supply from battery (1) (1/1) across ignition switch (2) (3/1).
7. Receives idling signal from throttle switch (198) (3/49).
8. Receives load signal from air mass meter (284) (7/17) via fuel system control unit (217) (4/8).
10. Receives signals from speed/position pick-up (413) (7/25).
11. Grounds screen of lead from speed/position pick-up (413) (7/25).
12. Grounds screen of lead from knock sensor I (LH) (218) (7/23).
13. Receives signal from knock sensor I (LH) (218) (7/23).
16. Transmits ignition pulses to power stage (419) (4/15).
17. Transmits speed information to fuel system control unit (217) (4/8).
18. Receives signal from No. 1 cylinder detector (416) (7/26).
19. Receives signal from No. 1 cylinder detector (416) (7/26).
20. Grounds control unit (260) (4/10).
21. Grounds screen of lead from No. 1 cylinder detector (416) (7/26).
23. Receives signals from speed/position pick-up (413) (7/25).
24. Grounds screen of lead from knock sensor II (RH) (218) (7/24).
25. Receives signal from knock sensor II (RH) (218) (7/24).

Power stage connections

1. Controls current in ignition coil (4) (21/1) primary winding.
2. Grounds power stage (419) (4/15).
3. Grounds screen of lead from control unit (260) (4/10) terminal 16.
4. Receives supply from battery (1) (1/1) across ignition switch (2) (3/1).
5. Receives ignition pulses from control unit (260) (4/10).



EZ-116K

B 234 F, B 204 E and B 230 F

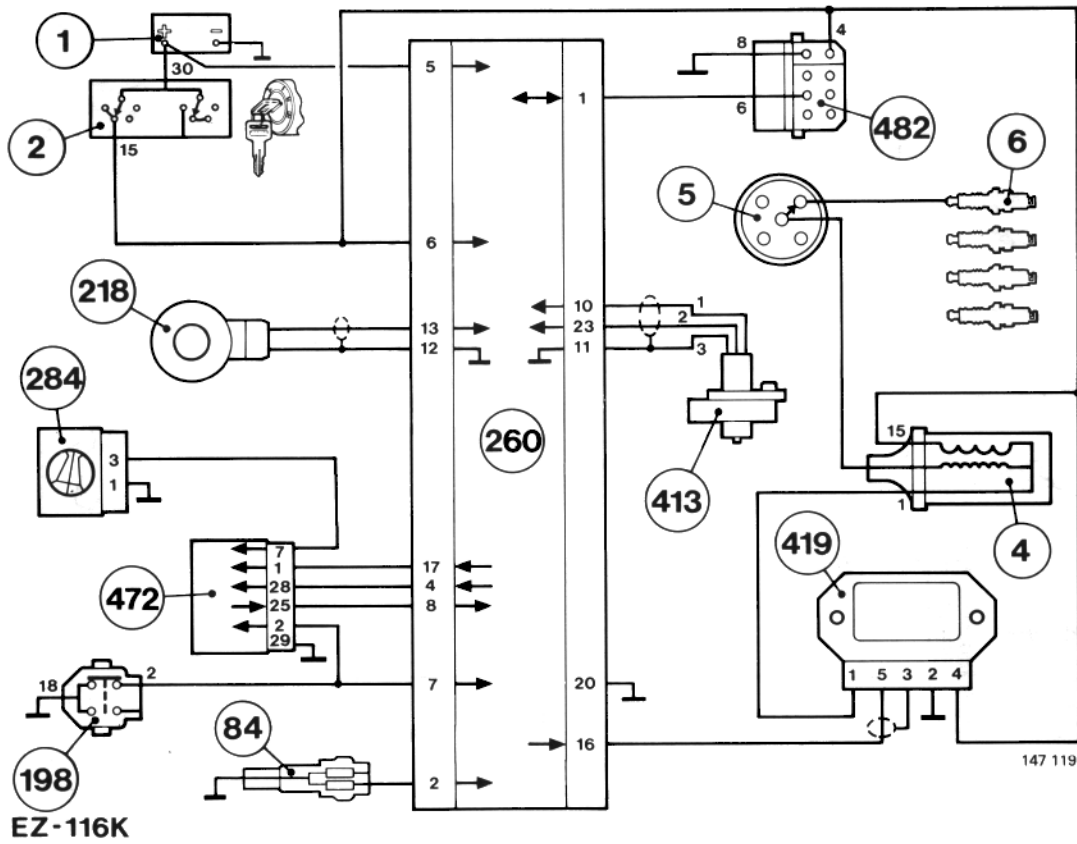
The control unit (1) computes the optimum timing on the basis of information from the various sensors. The power stage (2) makes and breaks the current in the primary winding of the ignition coil (3) in response to ignition pulses from the control unit. The high-tension current thereby induced in the secondary is supplied to the appropriate spark plug (5) by the distributor (4).

The control unit also supplies signals to the diagnostic unit (7) used for fault tracing and monitoring purposes.

The ignition setting computed by the control unit is based on the following information:

- Engine speed and crankshaft position are indicated by the speed/position pick-up (6).
- Engine knock is detected by the knock sensor (8).
- The fuel injection system (LH-2.4) control unit (9) transmits engine load signals from the air mass meter.
- Engine temperature is indicated by the temperature sensor (10).
- Closure of the throttle is indicated by the throttle switch (11).

* The control unit can vary the timing from approx. 55° before TDC to approx. 5° after TDC.

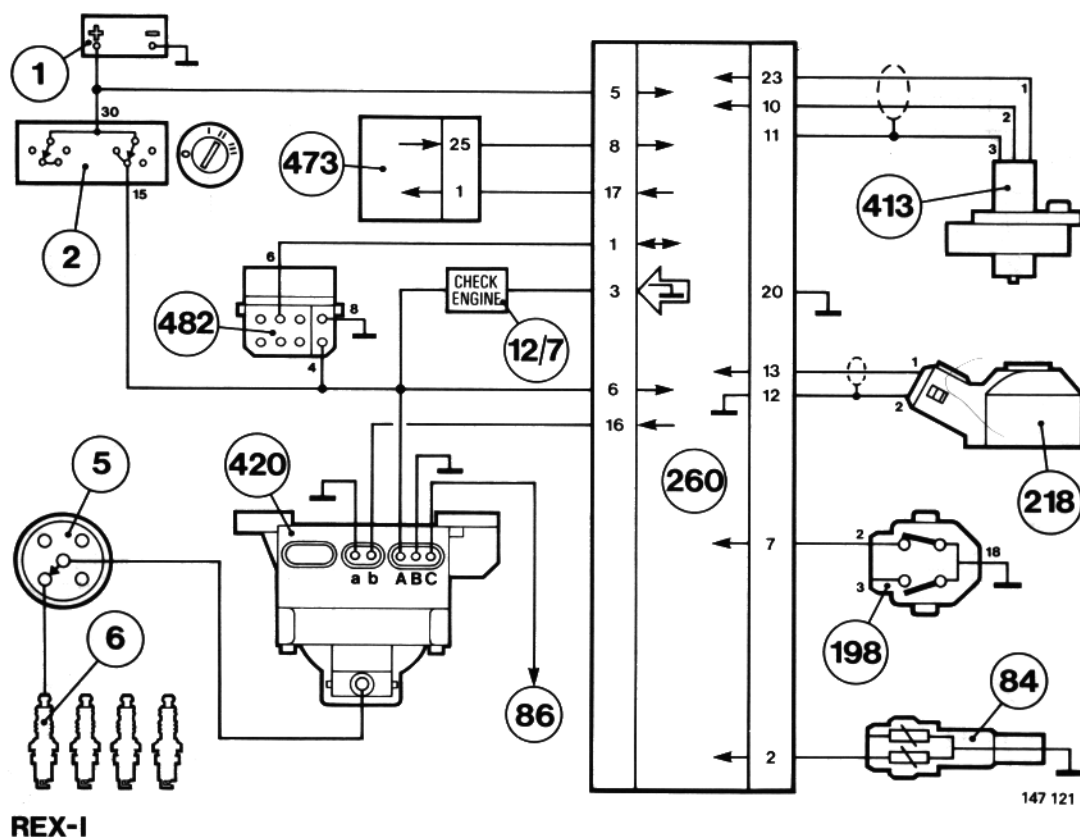


Control unit connections

1. Transmits signals to diagnostic unit (482) during fault tracing.
2. Receives analogue engine temperature signal from temperature sensor (84).
4. Transmits knock-controlled fuel enrichment signal to fuel system control unit (472).
5. Receives power directly from battery (1).
6. Receives power from battery (1) across ignition switch (2) terminal 15.
7. Receives signal from throttle switch (198) when throttle is closed.
8. Receives engine load signal from air mass meter (284) via fuel system control unit (472).
10. Receives engine speed and crankshaft position signal from speed/position pick-up (413).
11. Grounds screen of lead from speed/position pick-up (413).
12. Grounds screen of lead from knock sensor (218).
13. Receives signals from knock sensor (218).
16. Transmits ignition pulses to power stage (419).
17. Transmits speed information to fuel system control unit (472).
20. Grounds control unit (260).
23. Receives engine speed and crankshaft position signals from speed/position pick-up (413).

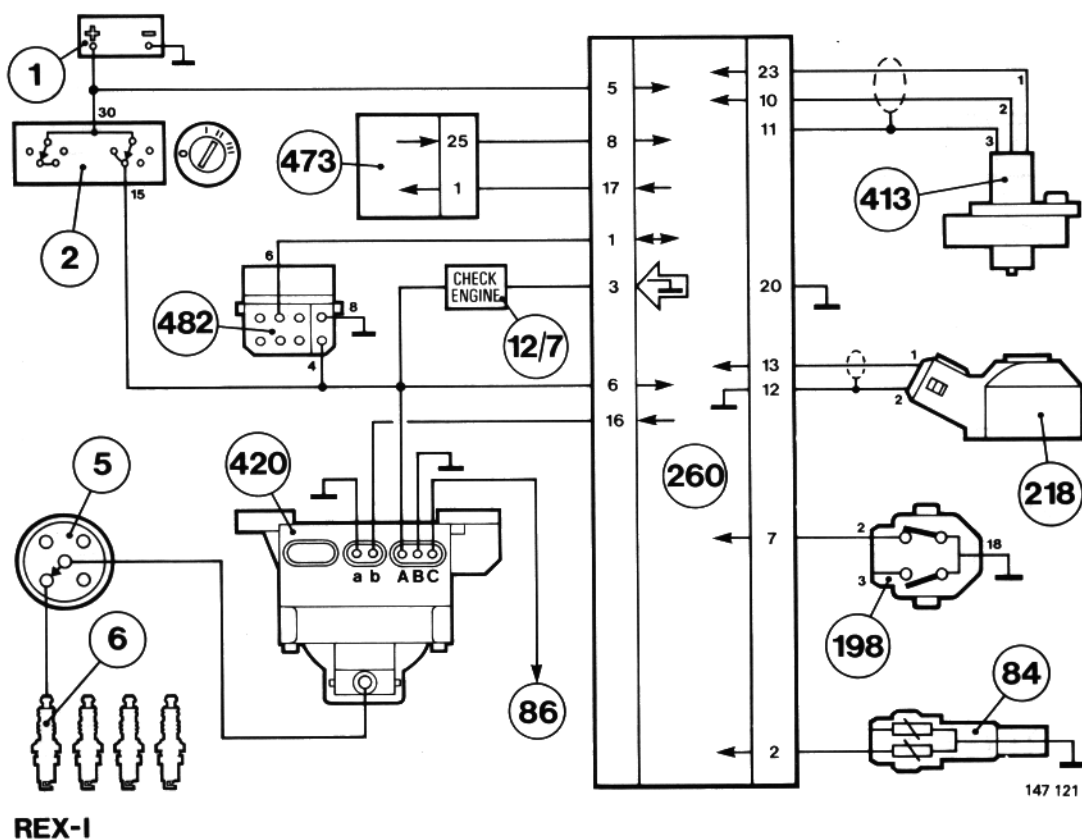
Power stage connections

1. Controls primary current in ignition coil (4).
2. Grounds power stage (419).
3. Grounds screen of lead from control unit (260) terminal 16.
4. Receives power from battery (1) across ignition switch (2).
5. Receives ignition pulses from control unit (260).



Control unit connections

1. Transmits signals to diagnostic unit (482) when fault tracing. Signals are transmitted by diagnostic unit when appropriate diagnostic functions are selected.
2. Receives engine temperature signal from temperature sensor (84) for timing compensation, if required. Control unit supplies one of NTC resistors in sensor with constant voltage and measures resulting voltage level internally.
3. Grounds connection when certain types of fault are present in system. Grounding closes circuit to combined instrument, illuminating 'Check engine' warning lamp (12/7).
4. Spare.
5. Receives supply from battery (1) for self-diagnostic program memory.
6. Receives supply from battery (1) across ignition switch (2) terminal 15.
7. Receives signal from throttle switch (198) when throttle is fully closed. Control unit respond by selecting timing curve which is speed-dependent only.
8. Receives engine load signal from Regina control unit (473) for computation of timing.
10. Receives engine speed and crankshaft position signals from speed/position pick-up (413) for computation of timing.
11. Connection for screen of lead from speed/position pick-up (413).
12. Grounds screen of lead from knock sensor (218).
13. Receives signal from knock sensor (218) for retardation of timing in cylinder affected by knock.
14. Spare.
15. Spare.



REX-I

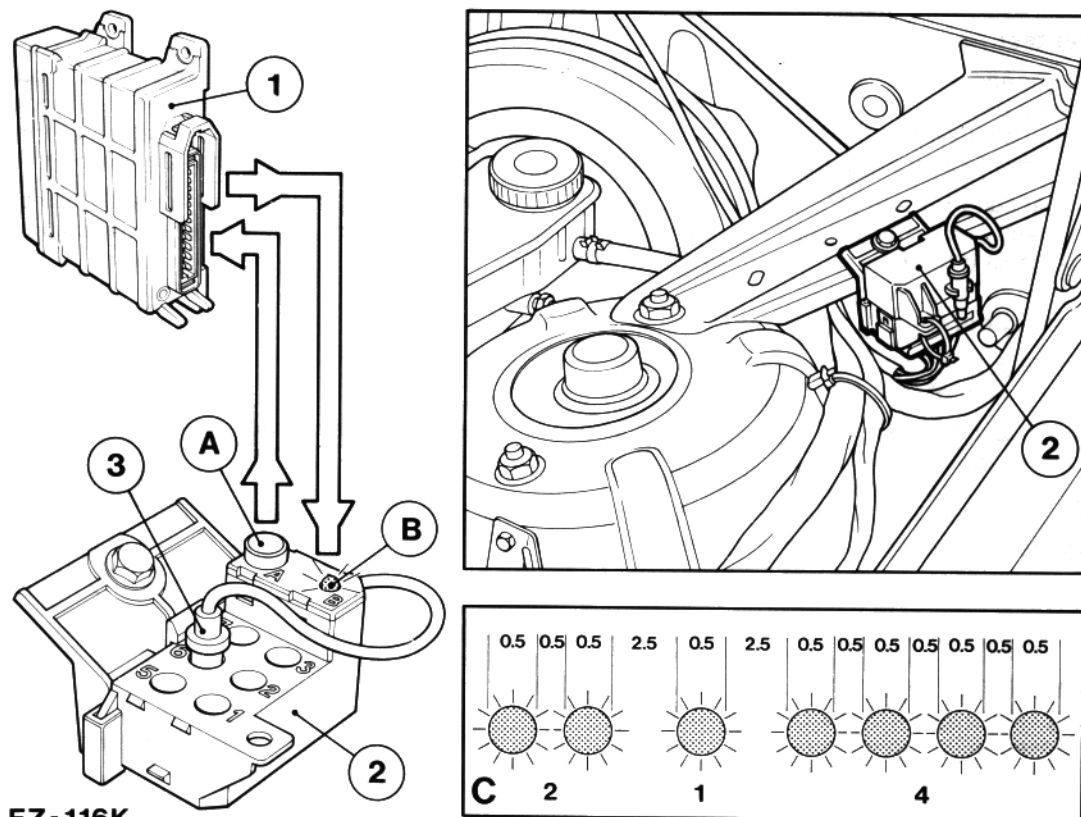
147 121

- | | |
|--------------------------------|-------------------------------|
| 1 Battery | 198 Throttle switch |
| 2 Ignition switch | 218 Knock sensor |
| 5 Distributor | 260 Rex-I control unit |
| 6 Spark plug | 413 Speed/position pick-up |
| 12/7 Check engine warning lamp | 420 Power stage/ignition coil |
| 84 Coolant temperature sensor | 473 Regina control unit |
| 86 Speedometer | 482 Diagnostic unit |

16. Transmits ignition pulses to power stage/ignition coil (420). Power stage interrupts supply to coil when signal goes low (0 V).
17. Transmits engine speed signals to Regina control unit (473) terminal 1.
18. Spare.
19. Spare.
20. Grounds control unit (260).
21. Spare.
22. Spare.
23. Receives engine speed and crankshaft position signals from speed/position pick-up (413) for computation of timing.
24. Spare.
25. Spare.

Power stage/ignition coil connections

- a Grounds power stage/ignition coil (420) (signal ground).
- b Receives ignition pulses from control unit (260) terminal 16. Control unit permits charging of coil through power stage while signal remains high (5 V). Power stage opens terminal B ground connection when signal goes low (0 V). Resultant high tension generated in ignition coil is distributed by distributor (5) to appropriate spark plug (6).
- A Receives supply from battery (1) across ignition switch (2).
- B Grounded (supply ground).
- C Transmits signals corresponding to number of ignition pulses to speedometer (86) in combined instrument.



EZ-116K

147 122

EZ-116K and Rex-I – Diagnostic system

The EZ-116K/Rex-I control unit (1) incorporates a diagnostic circuit which greatly facilitates fault tracing and monitoring of the system. The system features two separate test functions – a self-diagnostic function whereby the diagnostic circuit continuously monitors the operation of the ignition system, and a functional test program which enables the operation of certain switches to be tested. A diagnostic unit (2), mounted beside the left-hand suspension strut housing in the engine compartment, is used to communicate with the diagnostic circuit in the control unit.

Diagnostic unit

The diagnostic unit is provided with a coding cable (3), which is used to select the system (ignition or fuel injection) to be tested by inserting the plug in the appropriate socket under the cover (4). The sockets are numbered from 1 to 7, the ignition system being tested using socket No. 6. The pushbutton (A) on top of the unit is used to select the desired test function.

Display codes

A red LED (B) is located on the diagnostic unit beside the pushbutton. The LED displays a series of flashing codes to indicate any faults which may be present in the system when the appropriate test function has been activated. The code 2-1-4 is illustrated in Fig. C above. As the illustration shows, the code consists of a 3-digit number, each digit of which is indicated by flashing of the LED in rapid succession (at intervals of approx. 0.5 seconds). The interval between each series of flashes which comprises an individual digit is approx. 2.5 seconds.

NOTE: Once the self-diagnostic function has been selected, a fault code will be displayed if a system component or its wiring is faulty. On the other hand, when the functional test program is selected, the LED will display a code confirming that the switch and wiring under test are fault-free.

Self-diagnostic function

The self-diagnostic function monitors the same types of fault as those stored in the control unit memory. (The control unit continuously monitors a number of the components and circuits connected to it, detecting and storing any faults which may occur.) The memory accommodates a total of three different faults, although the LED on the diagnostic unit can display up to seven 3-digit fault codes.

NOTE: The memory will be erased and the fault codes cancelled if the battery is disconnected!

Functional test program

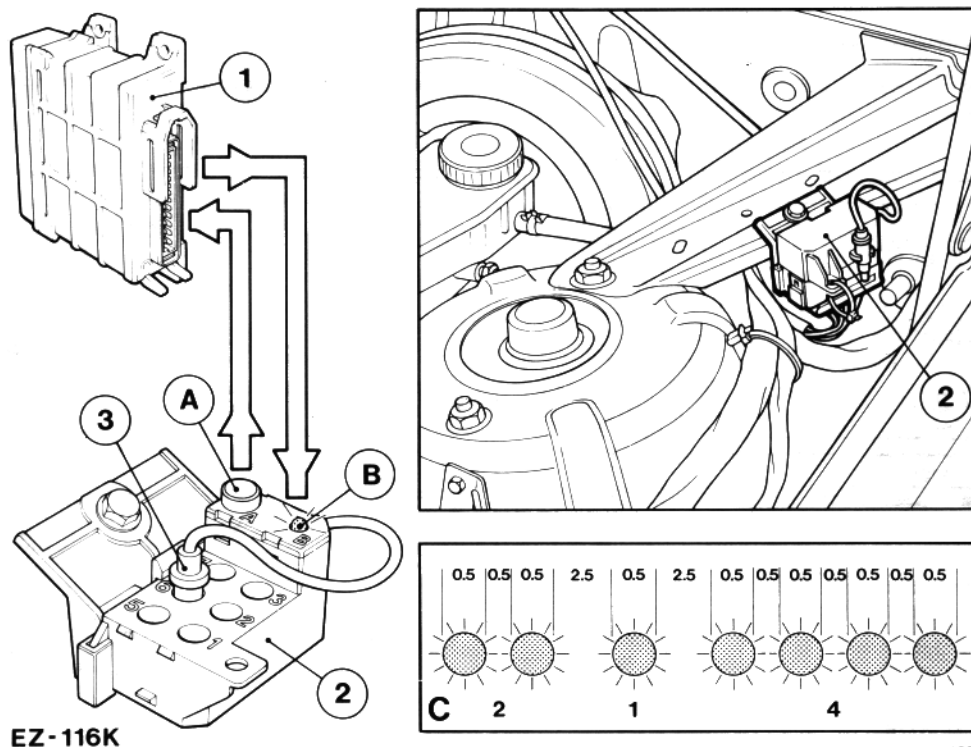
The system monitors the operation of certain components and switches by operation of the items in question. When the component or switch is operated in accordance with a set procedure, the LED displays a 3-digit code in confirmation. Failure to display a code indicates that the control unit has failed to detect operation of the component/switch. In this event, the fault may lie either in the item itself, or in the associated wiring and connections.

The functional test program provides an ideal means of checking that the switches are correctly wired e.g. on completion of repair work on the engine. As an example, it may be used to check whether the speed/position pick-up and/or wiring is intact if the engine fails to start.

Some major differences

The EZ-116K/Rex-I diagnostic system differs from other EZ-K systems in the following respects when used to perform the same type of fault tracing:

- The use of a test diode is unnecessary. This has been superseded by the diagnostic unit which, in effect, is an extension of the ignition system.
- The engine must be switched off during fault tracing.
- Since the diagnostic system can display a greater number of fault codes, it covers a wider range of potential faults, enabling them to be identified more quickly.
- The system includes a 'fault-free' code.
- All fault codes are of the 3-digit type.
- The technician decides when the next fault code is to be displayed.
- The system includes a functional test program, providing a fast and reliable means of checking that certain switches have been reconnected correctly following repair work on the engine.
- Switching off the ignition and stopping the engine is not sufficient to erase the memory. In this case, the memory can be erased on completion of work only by operating the pushbutton in a predetermined sequence.



EZ-116K

147 122

The following preliminary steps must be carried out to ensure that the LED displays the codes:

- The coding cable must be connected to socket 6.
- The ignition must be switched on without starting the engine (i.e. the key must be turned to switch position II).

Pushbutton A must then be pushed once or twice* for not longer than 3 seconds. One operation activates the self-diagnostic function and two operations the functional test program.

The following fault codes are displayed when the self-diagnostic function is selected:

- 1-1-1 No faults.
- 1-4-2 Internal control unit fault; engine runs with timing retarded to 'fail-safe' setting.
- 1-4-3 Faulty knock sensor; engine runs with timing retarded to 'fail-safe' setting.
- 1-4-4 No load signal from fuel system control unit.
- 2-1-4 Faulty speed/position pick-up signal.
- 2-2-4 Faulty temperature sensor signal (engine runs as though hot).
- 2-3-4 Faulty throttle switch signal; engine runs with timing retarded to 'fail-safe' setting.

Once a fault code has been displayed, the pushbutton must be operated again to display the next code. In this case, a repeat of the previous code indicates that only one fault is stored in the memory. The memory function must be erased when any faults present have been corrected. Since the memory accommodates a maximum of three faults, further faults, if any, cannot be displayed until the first three have been corrected and the memory erased. This is carried out as follows:

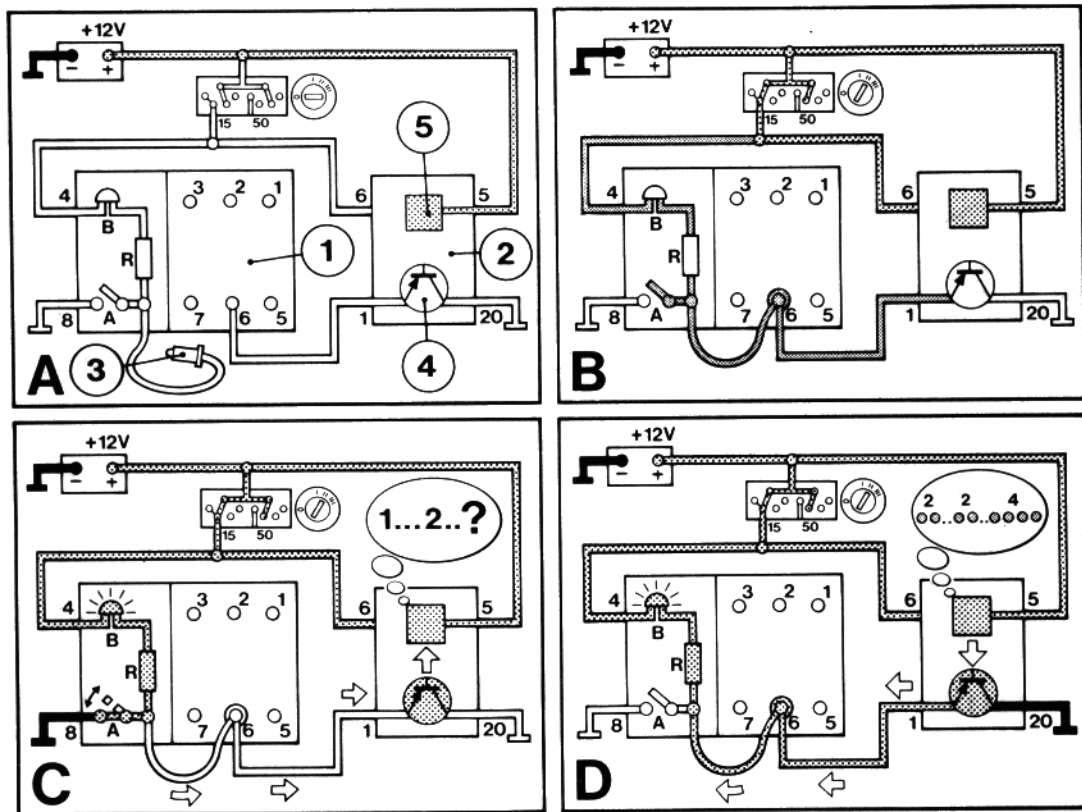
- Switch on the ignition without starting the engine (i.e. turn key to position II).
- Depress pushbutton A for at least 5 seconds.
- Wait for the LED to light (approx. 4–5 seconds).
- Operate pushbutton A once more for at least 5 seconds.

Start and run the engine up to normal working temperature. Stop the engine, switch on the ignition and operate pushbutton A to check that no further faults are present in the memory. The LED should display the code 1-1-1.

The functional test program is selected by operating pushbutton A twice after the preliminary steps have been carried out. The LED will flash continuously at a frequency of approx. 6 flashes per second, indicating that the control unit is in the functional test mode. The following acknowledgement codes may then be displayed:

- 3-3-4 Throttle switch
- 1-4-1 Speed/position pick-up

The acknowledgement code indicating that the throttle switch and its wiring/connections are intact is displayed by pressing the accelerator to the floor. The speed/position pick-up acknowledgement code is then displayed by releasing the accelerator and starting the engine.



147 123

Diagnostic unit – Construction and signals

The above figures illustrate the construction of the diagnostic unit (1), its connections, and the sequence of events which occurs in the course of communication between the unit and the ignition system control unit (2) during fault tracing.

Construction and connections (Picture A)

The diagnostic unit consists of an LED (B), a resistor (R) and a normally-open switch (pushbutton A). Terminal 8 is connected to ground when the switch is closed. A connection point for the coding cable (3) is provided between the resistor and switch. Socket No. 6 is connected to terminal 1 on the ignition system control unit.

Grounding of terminal 1 is monitored by a signal transistor (4) (actually a transistor network, although symbolized by a single component in the figures) which alternately opens and closes the ground connection across control unit terminal 20. The signal transistor is controlled by the diagnostic circuit (5) in the control unit.

The battery supplies power to control unit terminal 5 and to the diagnostic circuit in the control unit. This ensures that the memory is not erased when the ignition is switched off.

Preliminary steps (Picture B)

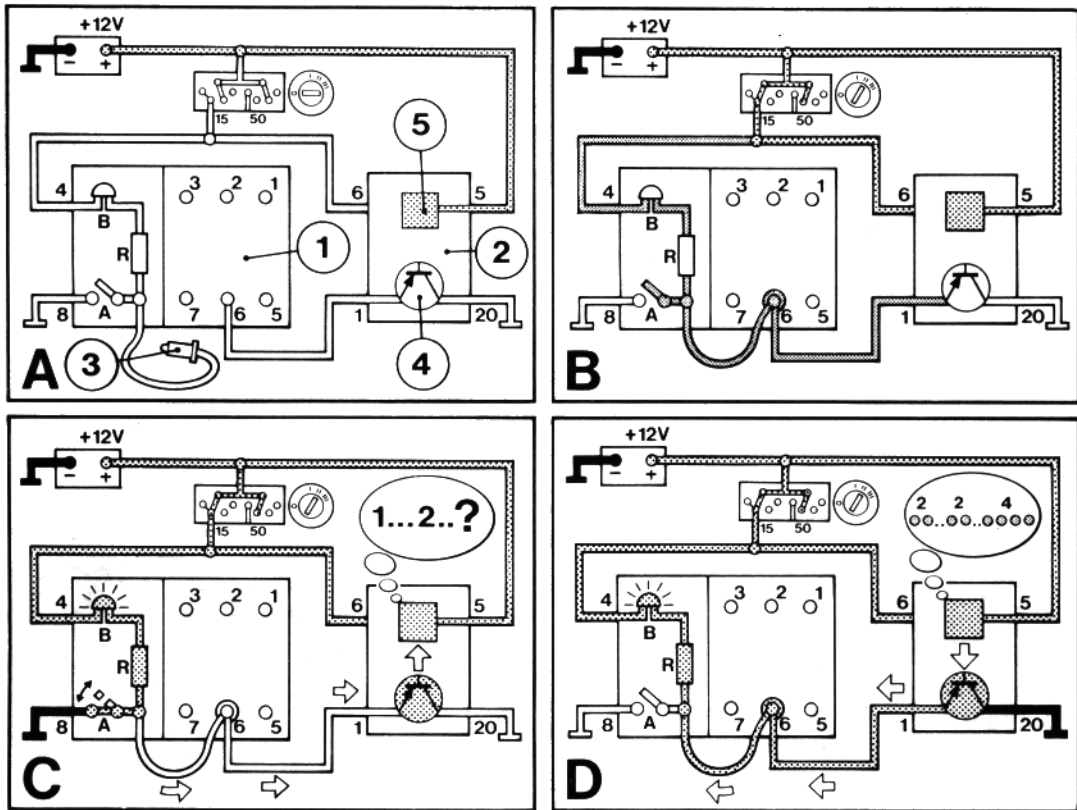
Power is supplied to control unit terminal 6 across ignition switch terminal 15 when the key is turned to position II. Voltage is present at terminal 1 on the control unit when the coding cable is inserted in socket No. 6 on the diagnostic unit.

Signal from diagnostic unit (Picture C)

The control unit must be supplied with some type of signal indicating which of the test functions is to be activated. This information is supplied across the normally-open switch (pushbutton A).

(The direction of the arrows in this picture shows that the signal flows from the diagnostic unit to the control unit.)

The switch is closed by depressing the pushbutton, grounding terminal 8 on the diagnostic unit. Current then flows from the battery, across ignition switch terminal 15, through the diagnostic unit and finally to ground across terminal 8. This causes the LED to light, while the voltage normally present at control unit terminal 1 falls to 0 V. The control unit determines whether the self-diagnostic function or functional test program has been selected by detecting whether the voltage at terminal 1 has fallen to zero once or twice.



147 123

Signals to diagnostic unit (Picture D)

In this mode, the diagnostic circuit in the control unit reads the selected test function program and determines, as appropriate, which fault/acknowledgement code is to be displayed by the LED to report a fault stored in the memory or confirm operation of a switch.

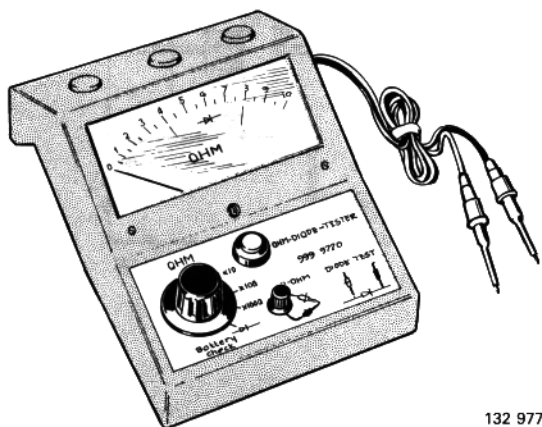
(The arrows in this picture indicate that the direction of signal flow is from the control unit to the diagnostic unit.)

The diagnostic circuit controls the operation of the signal transistor. To produce a flash, the circuit activates the transistor, connecting terminal 1 on the control unit to ground across terminal 20. Current then flows through the ignition switch and diagnostic unit to control unit terminal 1 and to ground across terminal 20, causing the LED to light (i.e. to produce one flash of the particular digit). Immediately after this, when the LED has been extinguished, the signal transistor opens the terminal 1 ground connection and the cycle is repeated until the three-digit code for the particular fault or acknowledgement code has been completed.

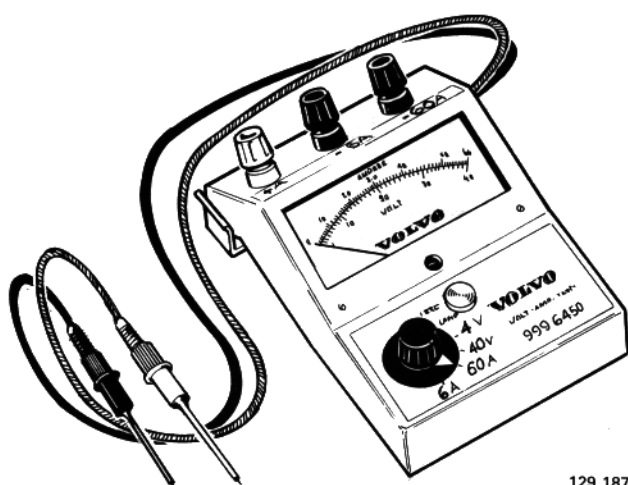
If the self-diagnostic function has been selected, the diagnostic circuit must be supplied with information on when the next fault code is to be displayed. The control unit receives this information in the form of the new signal which is initiated when the voltage at terminal 1 falls to zero as pushbutton A is again depressed.

Test equipment

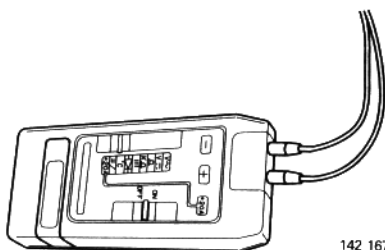
999	Description - application
5280	Test diode – for connection to diagnostic unit to indicate certain types of fault
6450	Voltmeter/ammeter – for voltage and current measurement
6525	Multimeter – for voltage, current and resistance measurement
9724	Ohmmeter/diode tester – for resistance measurement
9921	Volvo Mono-Tester – for measurement of timing angle
9940	Stroboscope – for checking timing
998 8860	Plain text reader – for displaying fault codes in plain text



132 977

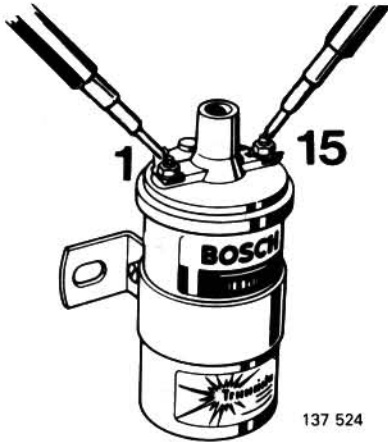


129 187



142 167

Instructions for work on ignition systems



137 524

Resistance measurement

All leads must be disconnected from the terminals of items to be tested.

Specified values apply at approx. 20°C (68°F).

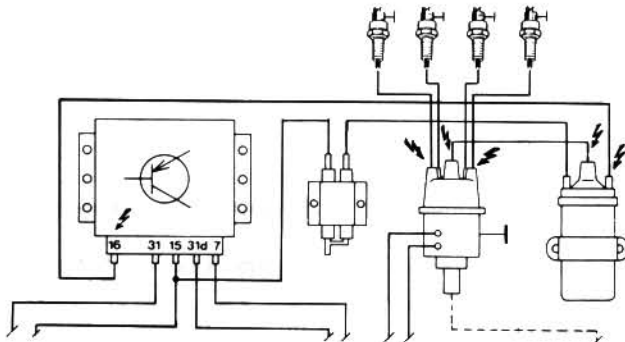
NOTE: The expansion plug on a vertically installed ignition coil must be provided with a plastic cap.

Electronic ignition systems

WARNING!

Electronic ignition systems operate at voltages in excess of 30 000 V. In addition, the power developed is such that contact with live components may be potentially fatal.

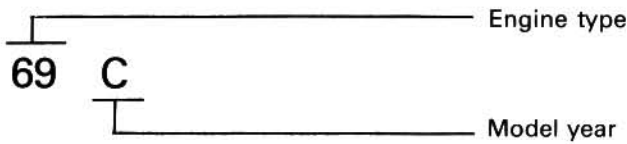
The presence of a dangerous voltage is indicated by the symbol ⚡



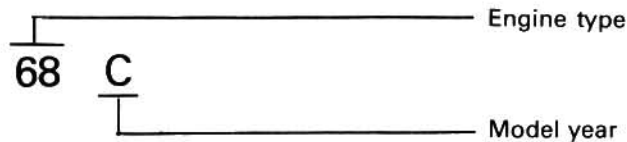
136 453

The engine variant and model year are included in the type designation

Identification No., USA/Canada



Identification No., other markets



Engine type

- 23 = B 200 K
- 24 = B 19 E, B 200 E
- 26 = B 19 ET, B 200 ET
- 62 = B 28 A
- 68 = B 28 E, B 280 E
- 69 = B 28 F, B 280 F
- 75 = D 24 TIC
- 76 = D 24 T
- 77 = D 24

Model year

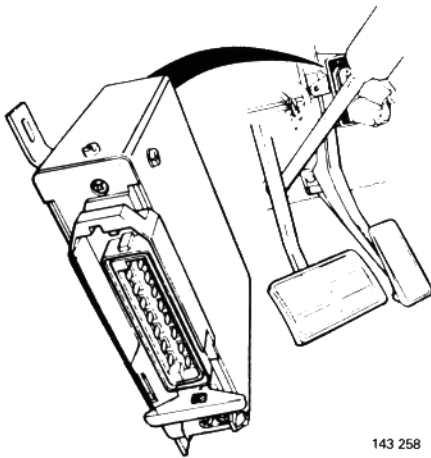
- C = 1982
- D = 1983
- E = 1984
- F = 1985
- G = 1986
- H = 1987
- J = 1988
- K = 1989
- L = 1990

YV1 744 68 2 C 1 0 0 1 2 3 4

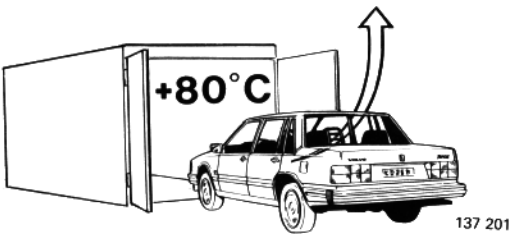
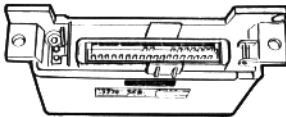
Important



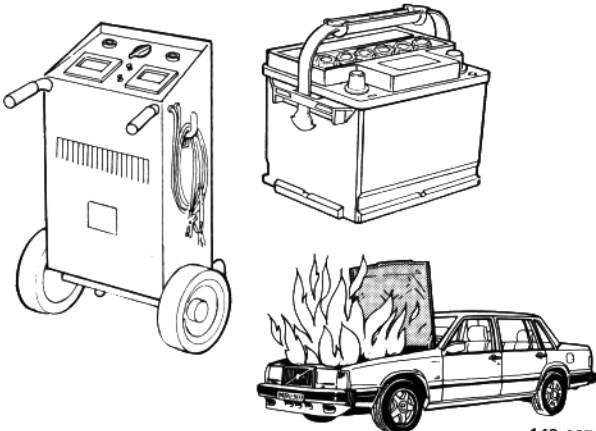
143 094



143 258



137 201



143 107

Warning!

The ignition system operates at high power and dangerous voltage levels in both the low and high-tension circuits.

Dangerous voltages are present at all points of the system, including connectors etc.

Switch off the ignition:

- when connecting and disconnecting test instruments
- when disconnecting and reconnecting the control unit connector
- when disconnecting and reconnecting the ignition coil and spark plug leads.

Battery

- Do not disconnect the leads when the engine is running.
- Disconnect the leads when using a boost charger.
- Do not use a boost charger or a voltage source higher than 16 V when jump starting.

Control unit

- Remove the control unit e.g. when carrying out a stoving operation. The unit must not be heated above +80°C.
- Disconnect the control unit connector when carrying out electric-arc welding.
- Remove the control unit when carrying out electric-arc welding in its vicinity.
- Do not replace the control unit without checking all wiring and components, otherwise the replacement unit may suffer the same damage.

Battery

It is essential that the battery voltage be normal (i.e. not too low) when testing the various components. A battery charger may be connected, as required, during testing. Max. permissible charging current/voltage: **12 A and 16 V.**

NOTE: Do not use a boost charger.

Group 28 Ignition system

Type..... Breakerless
 Firing order: B 28, B 280..... 1-6-3-5-2-4
 Other engines 1-3-4-2

Ignition timing (BTDC with vacuum advance unit disconnected)		
Engine type	12.5 r/s 750 r/min	41.7 r/s 2500 r/min
B 19 E B 19 ET B 23 E	10° 15° 10°	28–33° 23–26° 28–33°
B 23 ET B 23 FT B 200 K	10 ^{o1)} 12 ^{o2)} 15°	– – 22–26°
B 200 E B 200 ET B 204	12 ^{o2)} 14 ^{o2), 6)} 15 ^{o6)}	23–27° –
B 230 A B 230 K B 230 E	7° 15 ^{o3)} 12 ^{o2)}	17–23° 27–31° 23–27°
B 230 ET B 230 F B 230 F B 230 FT	10 ^{o2), 6)} 12 ^{o4)} 10 ^{o7)} 12 ^{o4)}	– – – 20–40 ^{o5)}
B 234 F B 28 A B 28 E	15 ^{o6)} 10° 10 ^{o2)}	– 25–29° 25–29°
B 28 F B 280 E B 280 F	– 10 ^{o6)} 16 ^{o6)}	23° – –

¹⁾ At idling = 14.1 r/s (850 r/min)

²⁾ At 15 r/s (900 r/min)

³⁾ At 13.3 r/s (800 r/min)

⁴⁾ At 15 r/s (900 r/min) for Japan

⁵⁾ AC system disconnected

⁶⁾ Not adjustable

⁷⁾ Rex-I

Specifications

Ignition coil

Primary winding resistance (across terminals 1 and 15)

B 19 E, B 19 ET, B 23 E, B 23 FT, B 230 A	0,6–0,9 Ω
B 23 ET	0,5 Ω
B 28	0,5 Ω
B 200 E, B 200 K, B 230 E, B 230 F, B 230 K, B 230 FT, B 280, B 204 E, B 234 F	0,6–0,9 Ω
B 200 ET, B 230 ET	0,5 Ω
B 230 F (Rex I)	0,35–0,65 Ω

Secondary winding resistance (across terminal 1 and HT terminal)

B 19 E, B 19 ET, B 23 E, B 23 FT, B 230 A	6,5–8,5 kΩ
B 23 ET	6,0 kΩ
B 28	9,5 kΩ
B 200 E, B 200 K, B 230 E, B 230 F, B 230 K, B 230 FT, B 280, B 204 E, B 234 F	6,5–9,0 kΩ
B 200 ET, B 230 ET	6,0 kΩ
B 230 F (Rex I)	4–6 kΩ

Spark plugs

Engine type	Designation	Part No.	Kit No.
B 19 E	W6DC	1 306 604-8	273 596-7
B 19 ET	W6DC	1 306 604-8	273 596-7
B 23 E	W6DC	1 306 604-8	273 596-7
B 23 ET	W7DC	1 306 605-5	273 597-5
B 23 FT	WR7DC	1 346 541-4	271 409-5
B 28 A	HR6DC	1 269 915-3	273 599-1
B 28 E	HR6DC	1 269 915-3	273 599-1
B 28 F	HR6DC	1 269 915-3	273 599-1
B 200 K	WR7DC	1 367 528-5	270 746-1
B 200 E	WR7DC	1 367 529-3	270 747-9
B 200 ET	WR7DC	1 367 528-5	270 746-1
B 204 –1989	WR6DC	1 367 529-3	270 747-9
B 230 A	WR7DC	1 367 528-5	270 746-1
B 230 K –1986	W7DC	1 306 605-5	273 597-5
B 230 K 1987–	W6DC	1 306 604-8	273 596-7
B 230 E	WR6DC	1 367 529-3	270 747-9
B 230 ET	WR7DC	1 367 528-5	270 746-1
B 230 F	WR7DC	1 367 528-5	270 746-1
B 230 FT Eur	WR6DC	1 367 529-3	270 747-9
other	WR7DC	1 367 528-5	270 746-1
B 234 F –1988	WR6DC	1 367 529-3	270 747-9
B 280 E Nor	HR6DC	1 269 915-3	273 599-1
other	HR5DC	1 389 896-0	270 590-3
B 280 F	HR6DC	1 269 915-3	273 599-1

Spark plug gap: B 19, B 23, B 200, B 230, B 234 F, B 204..... 0.7-0.8 mm (.028-.032)
 B 28, B 280..... 0.6-0.7 mm (.024-.028)

Tightening torque (unoiled plug):

B 19, B 23, B 200, B 230, B 234 F, B 204..... 25±5 Nm (18 ± 3.5 ft. lb)
 B 28, B 280..... 12±2 Nm (9 ± 1.5 ft. lb)

Distributor

Engine	Ignition system	Distributor	
		Volvo part No.	Bosch part No.
B 19 E, B 23 E	TZ-28 H ²⁾	1 336 689	0 237 020 075
B 19 ET	TZ-28 H	1 336 694	0 237 020 031
B 23 ET	Motronic ¹⁾	1 317 298	0 237 501 003
B 23 FT	EZ-K ¹⁾	1 332 587	0 237 506 001
B 200 E, B 230 K	EZ-K ¹⁾	1 336 087	0 237 502 001
B 230 F	Rex-I, EZ-K ¹⁾	1 336 132	0 237 502 002
B 230 E, B 230 F, B 230 FT	EZ-K ¹⁾	1 336 087	0 237 502 001
B 200 K	Renix ¹⁾	1 336 132	0 237 502 002
B 200 ET, B 230 ET	Motronic ¹⁾	1 336 132	0 237 502 002
B 230 A	TZ-28 H	1 336 690	0 237 024 013
B 28 A, B 28 E	TSZ-4	1 269 191	0 237 402 013
B 28 F	TSZ-4	1 269 380	0 237 402 017
B 280	EZ-K ¹⁾	—	—
B 204, B 234 F	EZ-K ¹⁾	1 367 197-9	0 237 502 003

¹⁾ Microprocessor-controlled. System is not equipped with centrifugal or vacuum advance unit. See test values below for other distributors.

²⁾ Modified distributors have same values as 1 336 690 (B 230 A)

B 19 E, B 23 E

Bosch part No	0 237 020 075
Volvo part No.....	1 336 689
Direction of rotation.....	Clockwise
Pulse generator coil resistance, ohm	—
Air gap, rotor–stator, min.....	—

B 19 ET

Bosch part No	0 237 020 031
Volvo part No.....	1 336 694
Direction of rotation.....	Clockwise
Pulse generator coil resistance, ohm	—
Air gap, rotor–stator, min.....	—

B 28 A/E

Bosch part No	0 237 402 013
Volvo part No.....	1 269 191
Direction of rotation.....	Clockwise
Pulse generator coil resistance, ohm	540–660
Air gap, rotor–stator, min.....	0.3 mm (.01")

B 28 F

Bosch part No	0 237 402 017
Volvo part No.....	1 269 380
Direction of rotation.....	Clockwise
Pulse generator coil resistance, ohm	540–660
Air gap, rotor–stator, min.....	0.3 mm (.01")

B 230 A

Bosch part No	0 237 024 013
Volvo part No.....	1 336 690
Direction of rotation.....	Clockwise
Pulse generator coil resistance, ohm	—
Air gap, rotor–stator, min.....	—

Specifications

Centrifugal advance unit**B 19 E, B 23 E**

Total advance, distributor degrees	12.5±1.5
Advance commences at distributor speed, r/s	6.7–9.2
(r/min)	(400–500)

Settings

5° at distributor speed, r/s	20–26
(r/min)	(1200–1560)
10° at distributor speed, r/s	33.3–39
(r/min)	(2000–2340)
Max. advance at distributor speed, r/s	26.7
(r/min)	(1600)

B 19 ET

Total advance, distributor degrees	12.5±1.5
Advance commences at distributor speed, r/s	6.7–11.7
(r/min)	(400–700)

Settings

5° at distributor speed, r/s	12.8–16
(r/min)	(770–960)
10° at distributor speed, r/s	17.5–22.3
(r/min)	(1050–1340)
Max. advance at distributor speed, r/s	40
(r/min)	(2400)

B 28 A/E

Total advance, distributor degrees	13±1
Advance commences at distributor speed, r/s	7.5–9.6
(r/min)	(450–575)

Settings

5° at distributor speed, r/s	12.15–15.4
(r/min)	(750–925)
10° at distributor speed, r/s	23.3–32.5
(r/min)	(1400–1950)
Max. advance at distributor speed, r/s	40
(r/min)	(2400)

B 28 F

Total advance, distributor degrees	11±1
Advance commences at distributor speed, r/s	8.5–10
(r/min)	(500–600)

Settings

5° at distributor speed, r/s	12.4–15.3
(r/min)	(740–920)
10° at distributor speed, r/s	30–50
(r/min)	(1800–3000)
Max. advance at distributor speed, r/s	33.3
(r/min)	(2000)

B 230 A

Total advance, distributor degrees	12.5±1.5
Advance commences at distributor speed, r/s	7.5–10.5
(r/min)	(450–630)

Settings

5° at distributor speed, r/s	16.5–20.5
(r/min)	(1000–1250)
10° at distributor speed, r/s	25–29
(r/min)	(1500–1750)
Max. advance at distributor speed, r/s	31.7
(r/min)	(1900)

Vacuum advance unit**B 19 E, B 23 E**

Direction of advance	Positive
Total advance	7.5±1
Advance commences at vacuum, mm Hg	105-140 (2.03-2.70 in Hg)
Settings: 5° at vacuum, mm Hg	175-215 (3.38-4.15 in Hg)
2° at vacuum, mm Hg	–
Max. advance at vacuum, mm Hg	235 (4.54 in Hg)
Direction of advance	–
Total advance, distributor degrees	–
Advance commences at vacuum, mm Hg	–
Settings: 1° at vacuum, mm Hg	–
Max. advance at vacuum, mm Hg	–

B 19 ET

Direction of advance	Positive
Total advance	7.5±1
Advance commences at vacuum, mm Hg	105-140 (2.03-2.70 in Hg)
Settings: 5° at vacuum, mm Hg	175-215 (3.38-4.15 in Hg)
2° at vacuum, mm Hg	–
Max. advance at vacuum, mm Hg	250 (4.83 in Hg)
Direction of advance	Negative
Total advance, distributor degrees	2.5±1
Advance commences at vacuum, mm Hg	105-180 (2.03-3.47 in Hg)
Settings: 1° at vacuum, mm Hg	135-210 (2.61-4.05 in Hg)
Max. advance at vacuum, mm Hg	225 (4.34 in Hg)

B 28 A/E

Direction of advance	Positive
Total advance	7.5±1
Advance commences at vacuum, mm Hg	160-210 (3.09-4.05 in Hg)
Settings: 5° at vacuum, mm Hg	–
2° at vacuum, mm Hg	200-240 (3.86-4.63 in Hg)
Max. advance at vacuum, mm Hg	300 (5.79 in Hg)
Direction of advance	–
Total advance, distributor degrees	–
Advance commences at vacuum, mm Hg	–
Settings: 1° at vacuum, mm Hg	–
Max. advance at vacuum, mm Hg	–

B 28 F

Direction of advance	Positive
Total advance	10±1
Advance commences at vacuum, mm Hg	105-135 (2.03-2.61 in Hg)
Settings: 5° at vacuum, mm Hg	–
2° at vacuum, mm Hg	115-145 (2.22-2.80 in Hg)
Max. advance at vacuum, mm Hg	210 (4.05 in Hg)
Direction of advance	–
Total advance, distributor degrees	–
Advance commences at vacuum, mm Hg	–
Settings: 1° at vacuum, mm Hg	–
Max. advance at vacuum, mm Hg	–

Timing curves

B 230 A

Direction of advance

Total advance

Advance commences at vacuum, mm Hg

Settings: 5° at vacuum, mm Hg

2° at vacuum, mm Hg

Max. advance at vacuum, mm Hg

Direction of advance

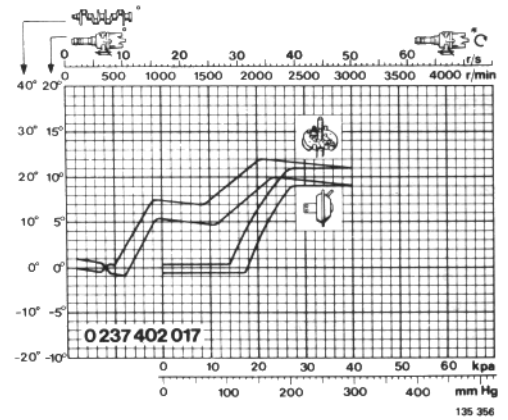
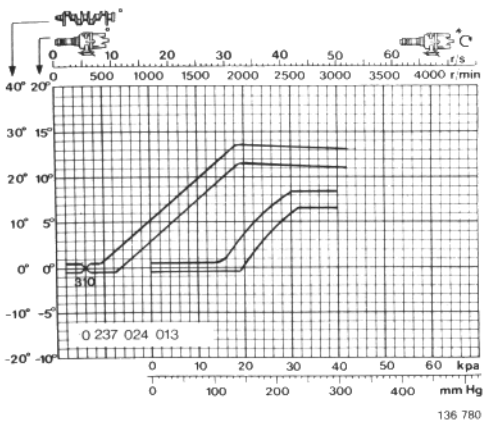
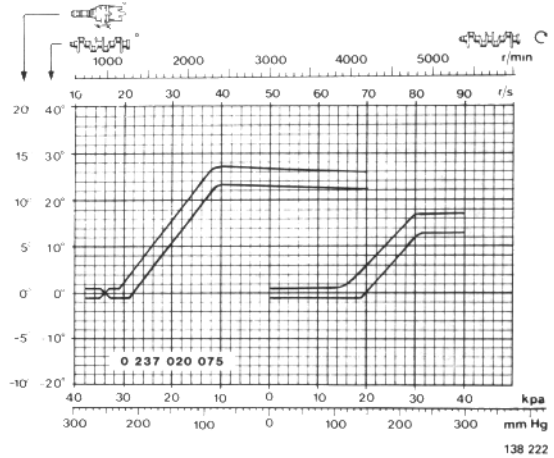
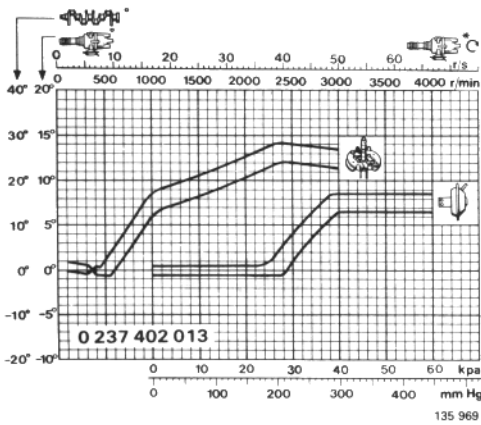
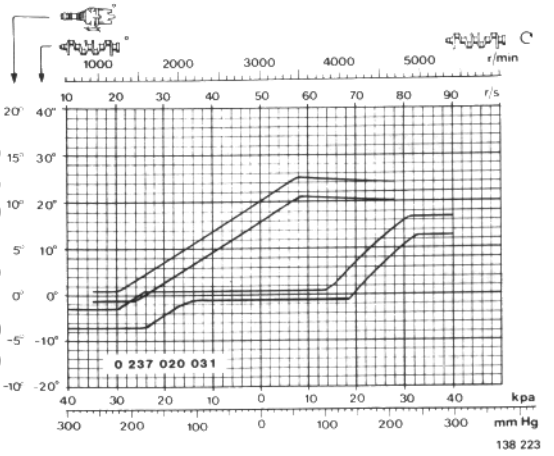
Total advance, distributor degrees

Advance commences at vacuum, mm Hg

Settings: 1° at vacuum, mm Hg

Max. advance at vacuum, mm Hg

Positive
7.5±1
105-145
(2.03-2.80
in Hg)
165-210
(3.18-4.05
in Hg)
-
240
(4.63 in Hg)



Ignition leads

Engine	Kit No.
B 19 E	275 690-6 (1984)
B 19 ET	270 479-9 (1984)
B 23 E	275 690-6 (1984)
B 23 ET	270 479-9 (1984)
B 23 FT	270 479-9 (1984)
B 28 A	275 688-0 (1984), 270 560-6 (1985-87)
B 28 E	275 689-8 (1984), 270 561-4 (1985-87)
B 28 F	275 689-8 (1984), 270 561-4 (1985-87)
B 200 K	270 748-7 (1985-87), 270 896-4 (1988-)
B 200 E	270 748-7 (1985-)
B 200 ET	270 749-5 (1985-87), 270 897-2 (1988-)
B 204	270 880-8 (1988-)
B 230 A	270 478-7 (1985-)
B 230 K	270 748-7 (1985-87), 270 896-4 (1988-)
B 230 E	270 748-7 (1985-87), 270 896-4 (1988-)
B 230 ET	270 749-5 (1985-87), 270 897-2 (1988-)
B 230 F	270 748-7 (1985-87), 270 896-4 (1988-)
B 230 FT	270 749-5 (1985-87), 270 897-2 (1988-)
B 234 F	270 880-8 (1988-)
B 280 E	270 525-9 (1985-)
B 280 F	270 525-9 (1985-)

Renix-F

Engine	B 200 K -1986	B 200 K 1987-
Control unit	1 367 072-4	1 389 533-9
Speed/position pick-up	1 336 660-4	1 336 660-4

TZ-28H

Engine	B 19 E	B 19 ET	B 23 E	B 230 A
Control unit	1 389 939-8	1 389 939-8	1 389 939-8	1 389 939-8

EZ-102K

Engine	B 23 FT
Control unit	1 332 580-8
Power stage	1 332 584-0
Knock sensor	1 326 658-0
Throttle switch	1 306 939-0

Specifications

EZ-115K

Engine	B 280 E	B 280 E Scandinavia	B 280 F
Control unit	1 274 827-3	1 389 597-4	1 274 828-1
Power stage	1 332 584-0	1 332 584-0	1 332 584-0
Knock sensors	1 367 643-2	1 367 643-2	1 367 643-2
Temperature sensor	1 346 030-8	1 346 030-8	1 346 030-8
Throttle switch	1 306 938-0	1 306 938-0	1 306 938-0
Speed/position pick-up	1 367 645-7	1 367 645-7	1 367 645-7
No.1 cylinder detector	1 367 188-8	1 367 188-8	1 367 188-8

EZ-117K

Engine	B 230 F	B 230 FT
Control unit	1 336 505-1	1 346 469-8
Power stage	1 332 584-0	1 332 584-0
Knock sensor	1 367 644-0	1 367 644-0
Throttle switch	1 306 938-0	1 306 938-0

EZ-118K

Engine	B 200 E	B 230 E	B 230 K -1986	B 230 K 1987-
Control unit	1 336 800-6	1 336 503-6	1 336 506-9	1 35 196-3
Power stage	1 332 584-0	1 332 584-0	1 332 584-0	1 332 584-0
Knock sensor	1 367 644-0	1 367 644-0	1 367 644-0	1 367 644-0
Temperature sensor	-	-	1 332 396-0	1 332 396-9
Microswitch	1 357 943-8	1 357 943-8	1 367 734-9	1 367 734-9

EZ-116K

Engine	B 230 F	B 204 E	B 234 F
Control unit	3 501 688-0 (Calif) 3 517 402-8 (USA, Fed)	1 367 178-9	3 517 608-8 USA/EU
Power stage	3 501 921-5	3 501 921-5	3 501 921-5
Knock sensors	1 367 644-0	1 367 644-0	1 367 644-0
Temperature sensor	1 346 030-8	1 346 030-8	1 346 030-8
Throttle switch	3 517 068-7	3 517 068-7	3 517 068-7
Speed/position pick-up	1 389 399-7	1 389 399-7	1 389 399-7
Diagnostic unit	1 398 703-7	1 398 703-7	1 398 703-7

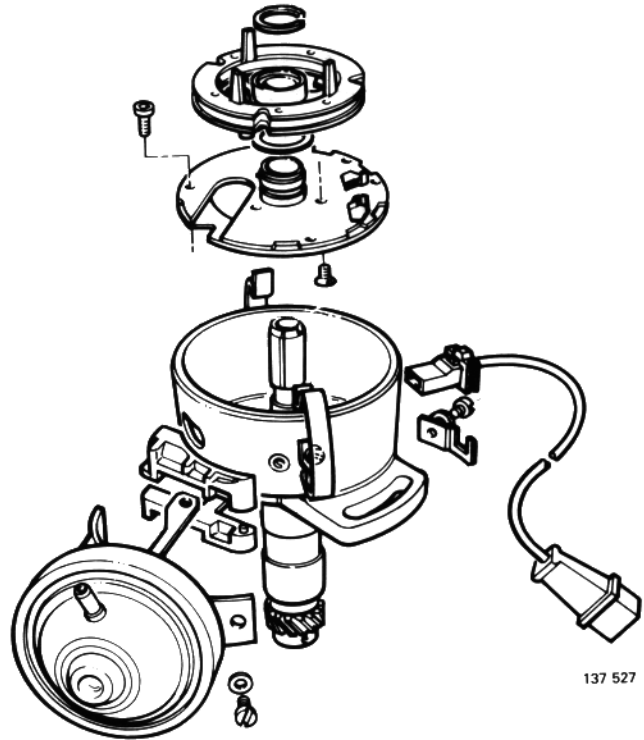
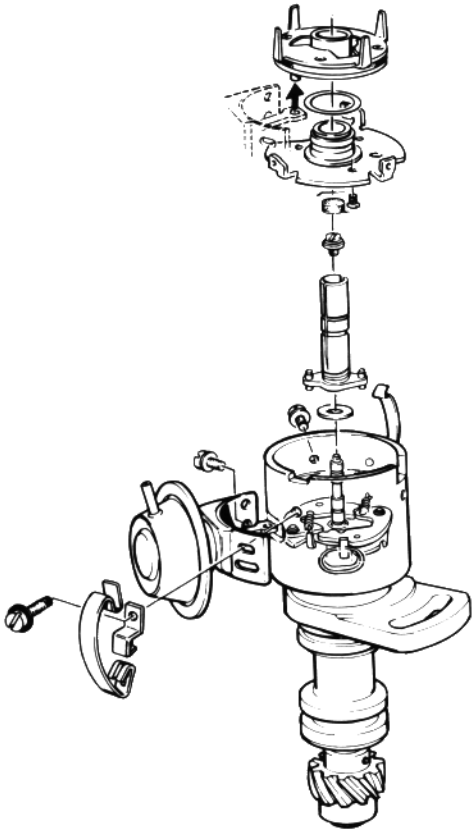
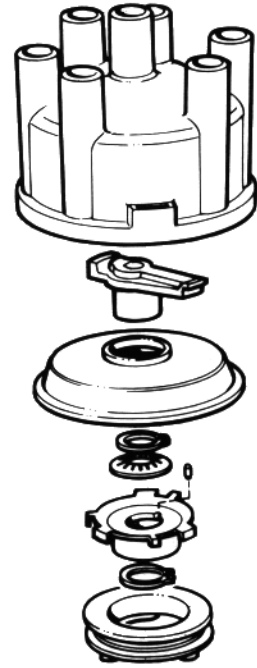
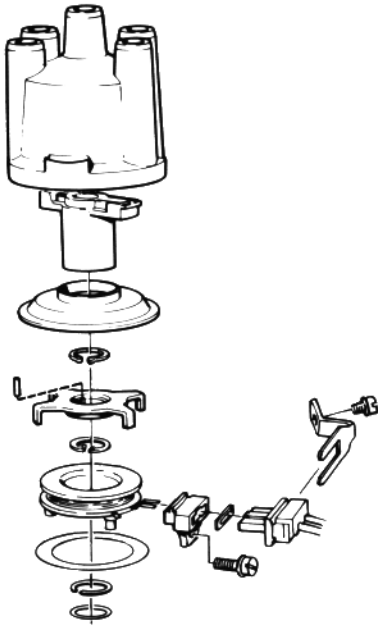
Rex-I

Engine	B 230 F
Control unit	1 389 567-7
Power stage	1 367 438-7
Knock sensor	1 367 644-0
Temperature sensor	1 346 030-8
Speed/position pick-up	1 389 399-7
Throttle switch	1 389 558-6
Diagnostic unit	1 398 703-7

Breakerless ignition systems

Contents

	Procedure	Page
Ignition coil and ignition leads	A1-A3	81
Distributor – general	B1-B11	82-86
Distributor cap and rotor arm	B3-B4	82
Timing advance	B5-B11	83-86
Static timing	B5	83
Centrifugal advance	B6	83
Ignition timing (table)		84
Vacuum advance	B7-B10	85
Timing retardation	B11	86
Distributor – overhaul	C1-C28	87-97
Replacement of vacuum advance unit	C1-C2	87
Replacement of distributor, B 19, B 23	C3-C4	87
Replacement of pulse generator coil B 19, B 23	C5-C11	88-89
Replacement of distributor, B 28	C12-C21	90-92
Replacement of pulse generator coil, B 28	C22-C27	92-94
Checking air gap	C28	94
Lubrication	C29	95
Control unit replacement	C30	95
Distributor testing	C31-C34	96-97
Replacement of Hall generator		
B 200/230, B 280	D1-D9	98-100
B 19 E, B 23 E, B 230 A	D10-D16	100-102
Wiring diagrams		103
Fault-tracing chart, TSZ-4		104

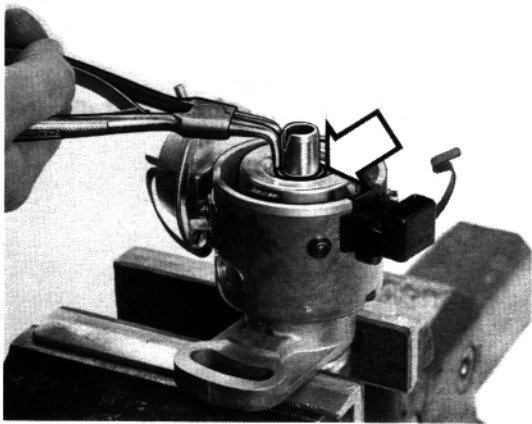


137 526

137 527

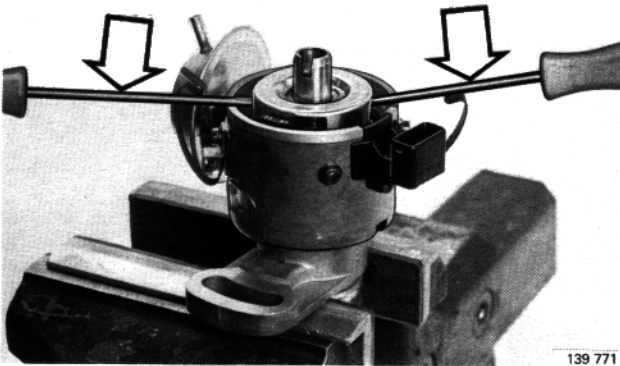
4-cylinder

6-cylinder (B 28)



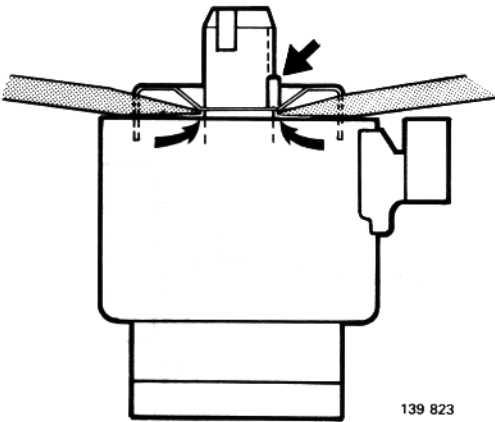
Place distributor into a soft jaw vice.
Remove rotor arm.

Remove trigger rotor circlip.



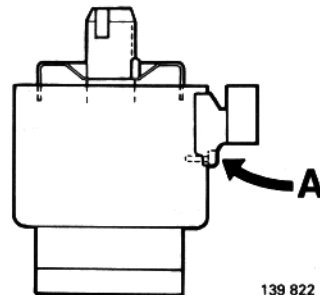
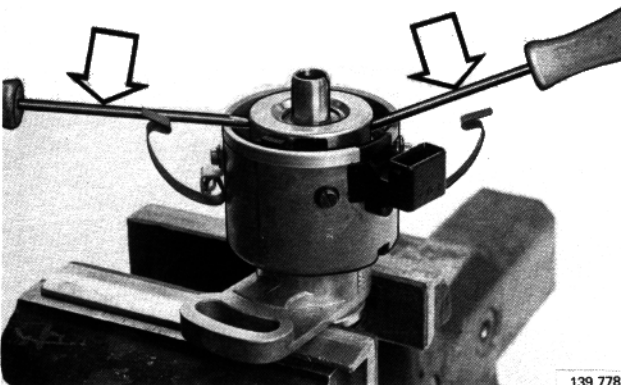
Remove trigger rotor using two round-bladed screwdrivers (dia. approx. 5 mm/.20").
Place screwdriver tips under rotor hub and prise carefully upwards.

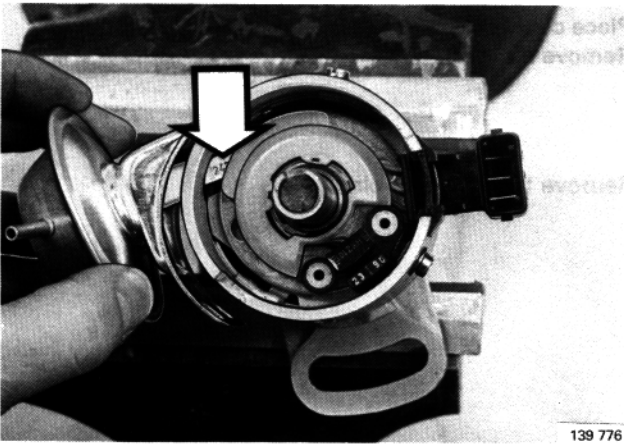
NOTE: Do not press against rotor vanes or damage may result.
Take care to ensure that locking pin does not fall into distributor.



Remove:

- circlip
- Hall generator retaining screws
- plastic pin (A) securing connector.

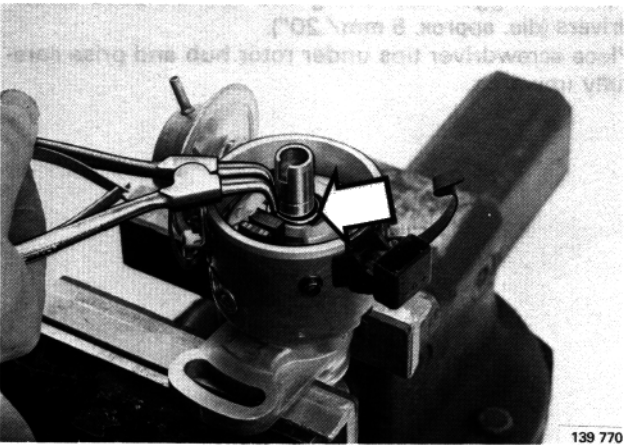




Turn Hall generator counterclockwise as far as possible.

Release and remove vacuum advance unit.

Lift Hall generator unit and connector out of distributor.



Reassemble distributor

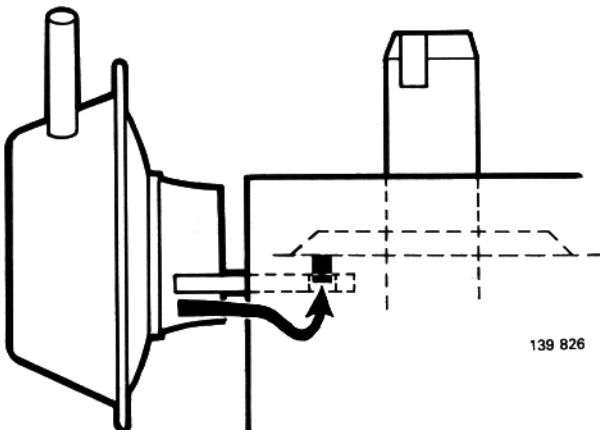
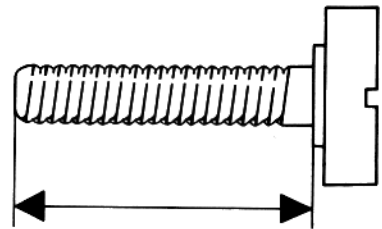
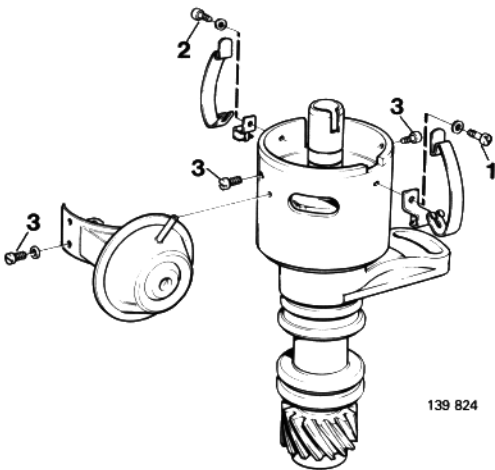
Install Hall generator unit and connector in distributor and secure loosely with two screws. Mount circlip.

Screws are of different lengths:

1 = 8 mm/.31"

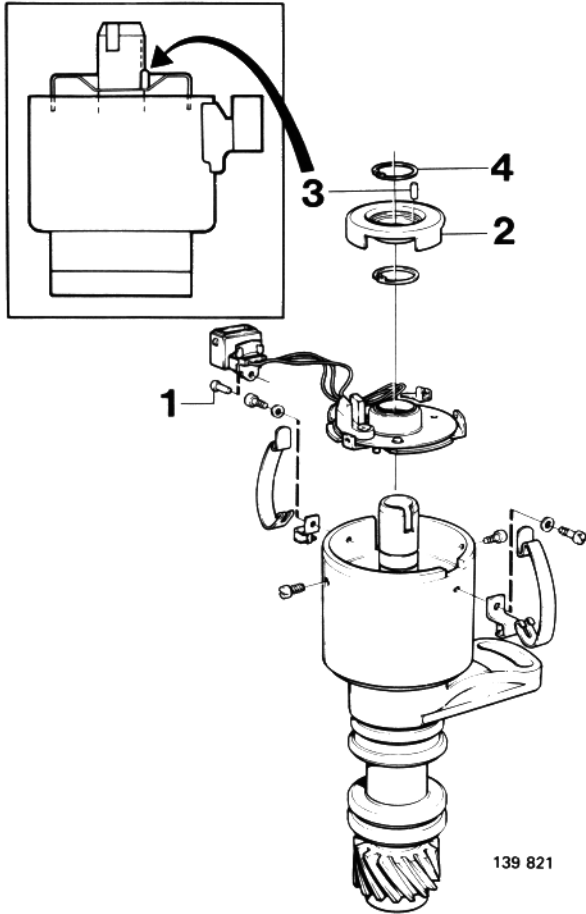
2 = 6 mm/.24"

3 = 5 mm/.20"



Turn generator element counterclockwise.

Hook vacuum advance unit rod over spigot on Hall generator plate.

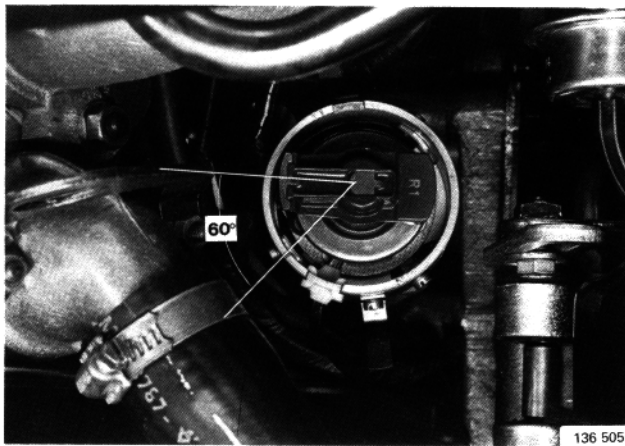


Insert and tighten all screws.

Insert connector securing pin (1).

Install:

- trigger rotor (2)
- locking pin (3)
- circlip (4).



Install distributor

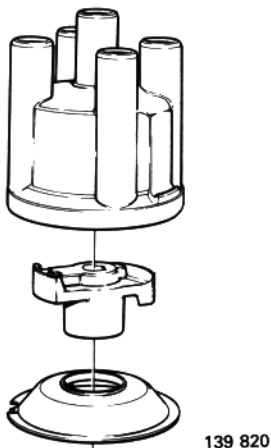
Ensure that No. 1 cylinder is at TDC.

Turn rotor arm clockwise about 60° from mark on distributor housing.

Place distributor in position.

Rotor arm should now be aligned with mark on distributor housing.

Remove rotor arm.



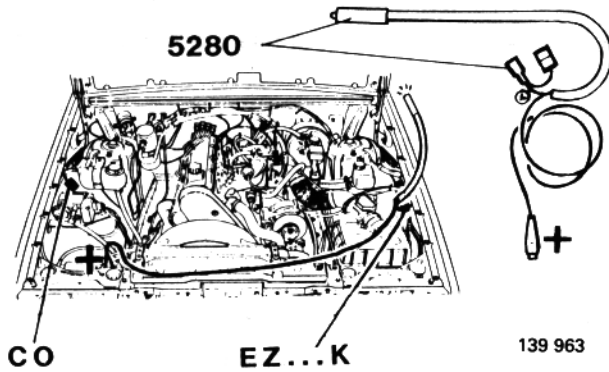
Install:

- moisture shield (plastic cover)
- rotor arm
- distributor cap.

H. Fault tracing – EZ-102K

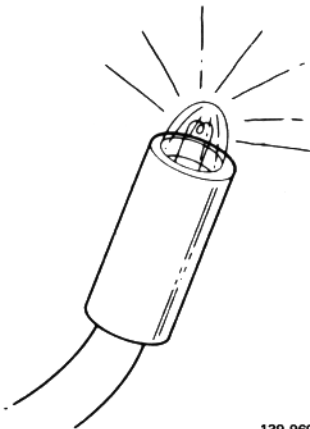
The following procedure provides a systematic check and inspection of the complete ignition system. If the engine can be started, commence fault tracing with the test diode to establish the source of the fault. Otherwise, proceed to page 136.

Fault tracing with test diode



Connect test diode (special tool 5280) to test terminal on left-hand wheel housing (yellow/red lead). Connect red lead to battery positive terminal.

Switch on ignition. Diode should light. Start engine, increase speed to above 3000 r/min and reduce to approx. 1000 r/min. This will initiate **internal diagnostics**.



139 969

One flash: Max. timing retardation 9.8°.

Two flashes: Low battery voltage.

Three flashes: Fault in control unit knock sensor circuit. Replace control unit.

Four flashes: Fault in knock sensor or wiring. See H19 (page 146).

Five flashes: Faulty load signal from fuel system control unit.

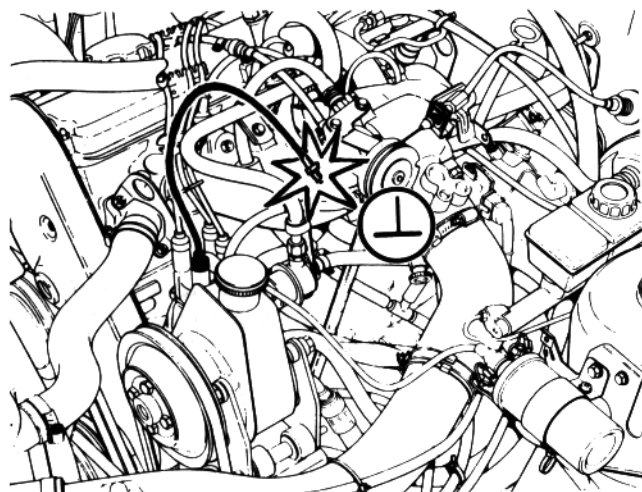
Symptom: Engine does not start

Fault tracing

First check **whether or not** the fault is in the ignition system by checking for a spark at one of the plugs.

Disconnect a plug lead, connect it to a spare plug and operate the starter motor.

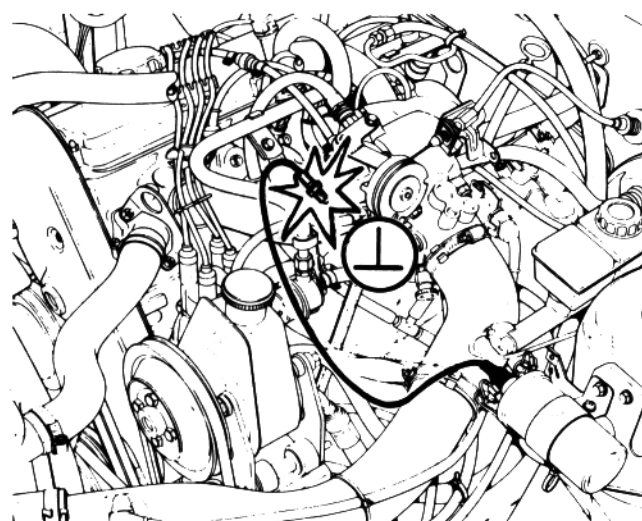
N.B. Ensure sparking does not take place in vicinity of other wiring!



139 817

Spark present?

- Yes Engine or fuel system fault.
- No Check for spark at ignition coil:
 - Connect an ignition lead and plug directly to the coil. Ground the plug and operate the starter motor.



139 818

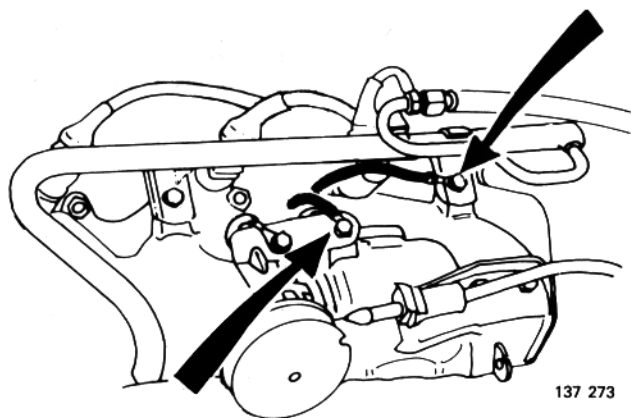
Spark at ignition coil?

- Yes Check rotor, distributor cap and HT leads. Correct faults as required.
- No Ignition system fault. Switch off ignition.

Fault tracing, EZ-102K

H1

Check security of ground leads at terminals on intake manifold (twin black leads).



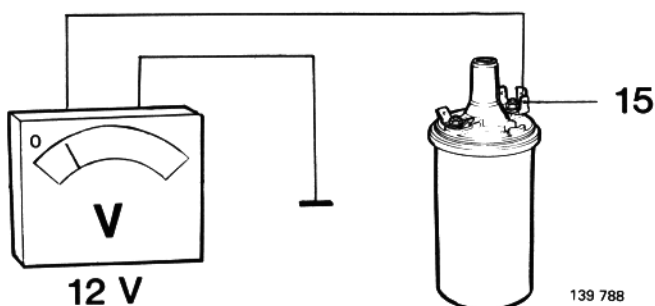
H2

Check LT supply to ignition coil and power stage

Switch on ignition. Measure voltage between ignition coil terminal 15 and ground. Voltmeter reading should be approx. 12 V.

If voltage = 0 V:

Open-circuit in lead from central electrical unit. (See wiring diagram.)

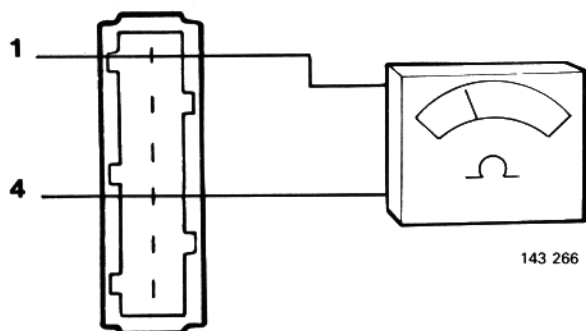


H3

Disconnect power stage connector

Pull back connector sleeve and connect instrument to **rear** of connector. Measurement from front may damage terminals, resulting in looseness and poor contact.

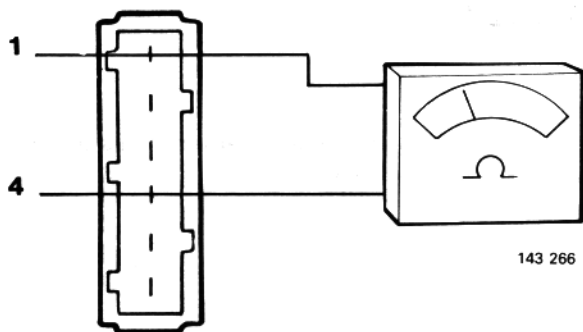
Check that voltage across each of connector terminals 1 and 4 and ground is approx. 12 V. Measure individually between each terminal and ground.



If voltage = 0 V:

Open-circuit in lead from central electrical unit. (See wiring diagram.)

Switch off ignition.



Check ignition coil primary winding and leads

Measure resistance between terminals 1 and 4 in power unit connector. (This is equivalent of measuring resistance across ignition coil terminals 1 and 15, including leads.)
(See wiring diagram.)

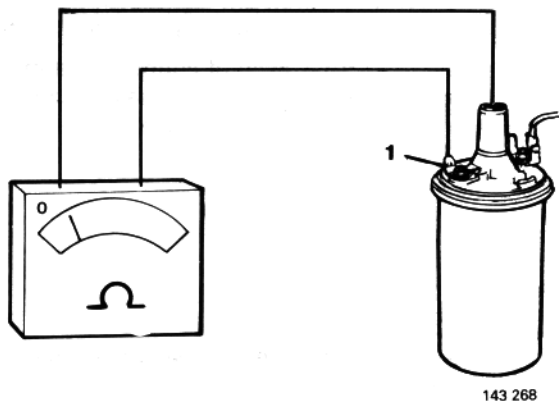
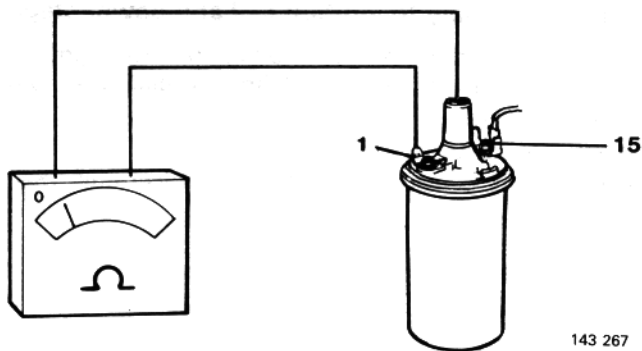
Reading should be **0.6–0.9 ohm**.

Other reading: Ignition coil faulty or short-circuit in leads.

Measure resistance **directly** between **ignition coil** terminals 1 and 15.

If resistance is correct (0.6–0.9 ohm): Fault in lead between ignition coil and connector.

If resistance is incorrect: Replace ignition coil.



Check ignition coil secondary winding

Measure resistance between HT terminal and terminal 1 on ignition coil.

Resistance should be **6.5–8.5 kohm**.

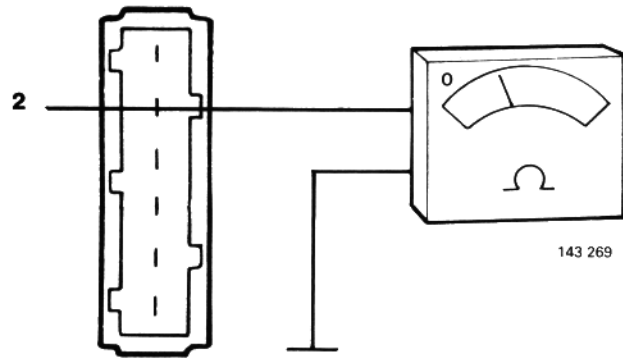
Other reading: Ignition coil faulty. Replace coil.

H6

Check power stage ground lead

Measure resistance between connector terminal 2 and ground. Resistance should be 0 ohm.

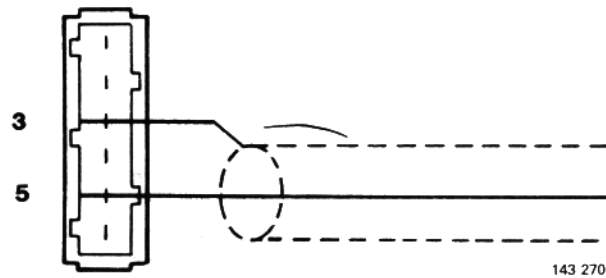
If reading is different: Check lead (see wiring diagram). Ground terminal is on intake manifold.



H7

Check screen connections

Check that screen of lead to terminal 5 is connected to terminal 3.



H8

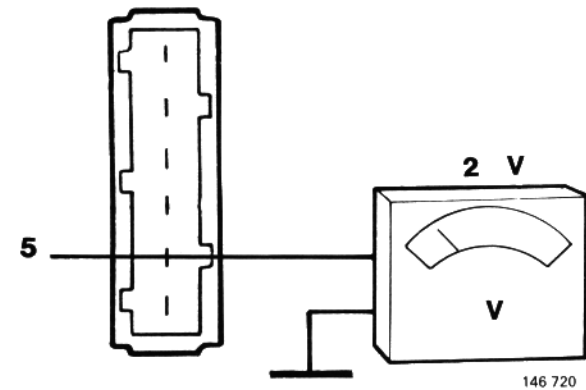
Check signal from control unit to power stage

Disconnect leads from ignition coil terminal 1 (red/white) and 15 (blue).

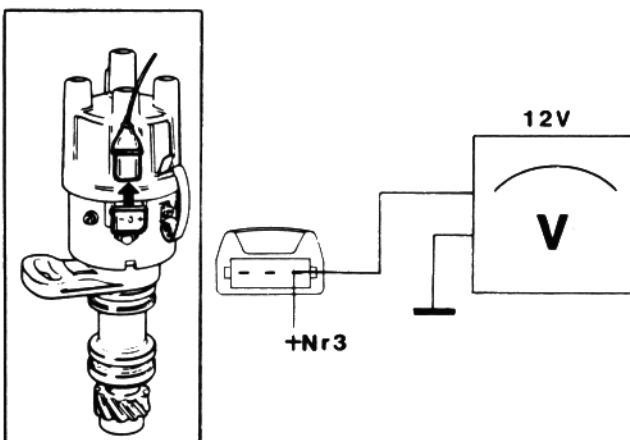
Measure voltage between terminal 5 or 6 in power stage connector and ground. Operate starter motor. Voltmeter should indicate approx. 2 V.

No reading: See top of page 146. Reconnect coil leads.

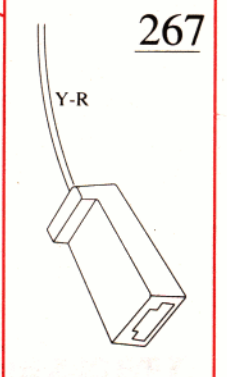
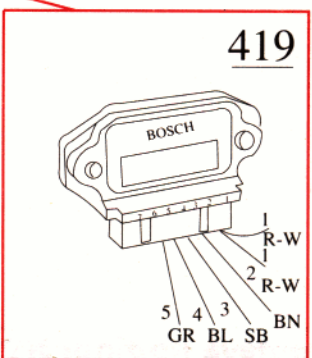
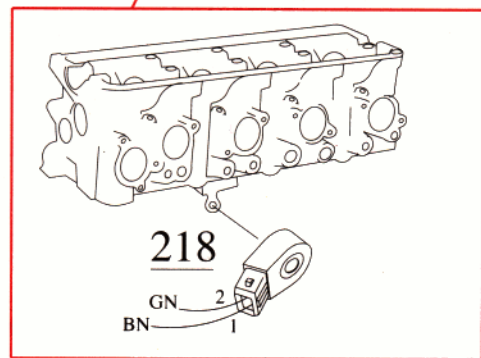
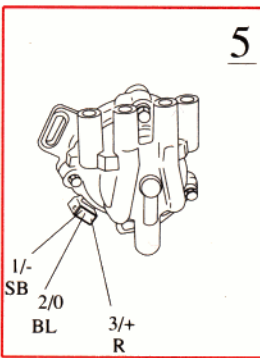
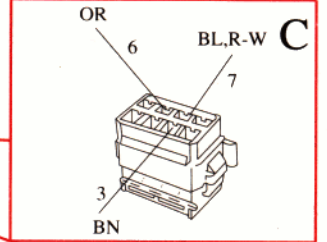
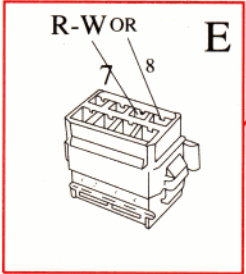
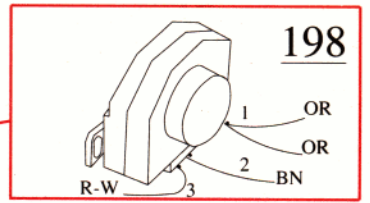
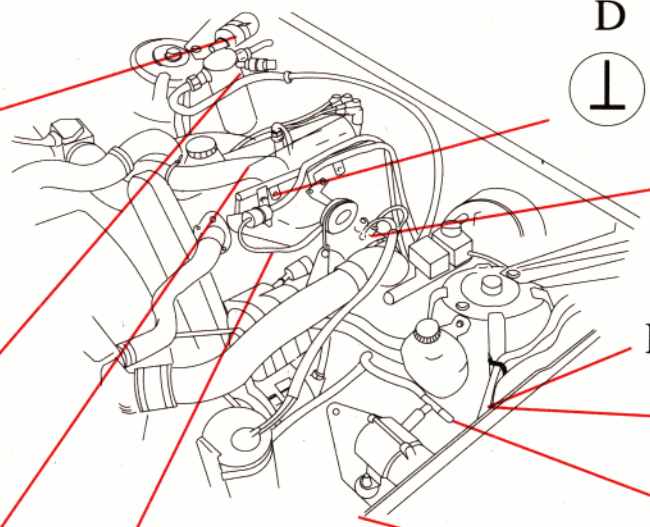
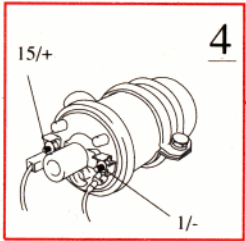
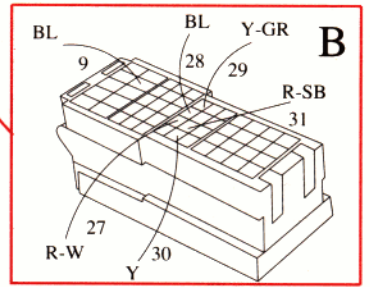
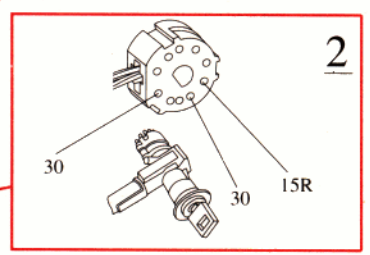
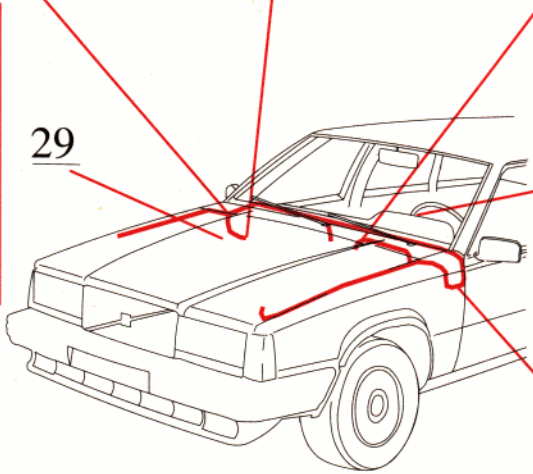
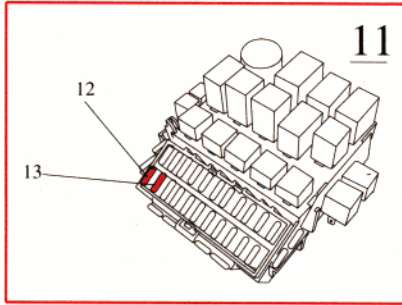
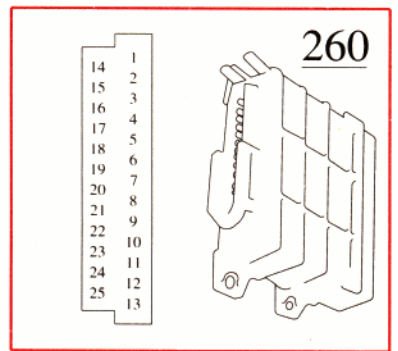
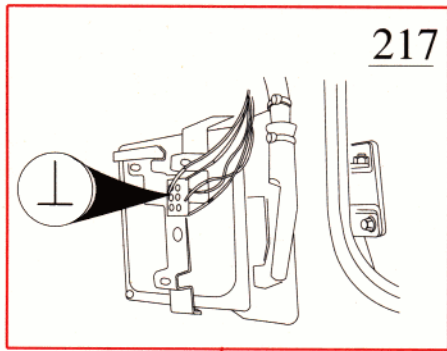
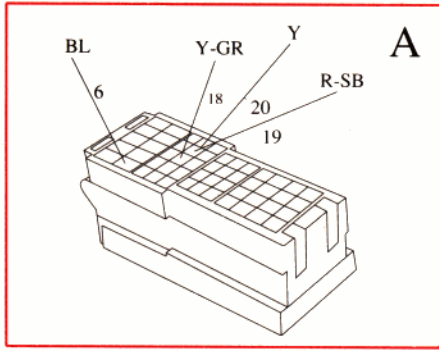
Reconnect power stage connector.



Undo distributor connector. Switch on ignition. Measure voltage between positive terminal (red lead) and ground. Reading should be approx. 12 V.



EZ-117K Ignition system (B 230 F/FT)

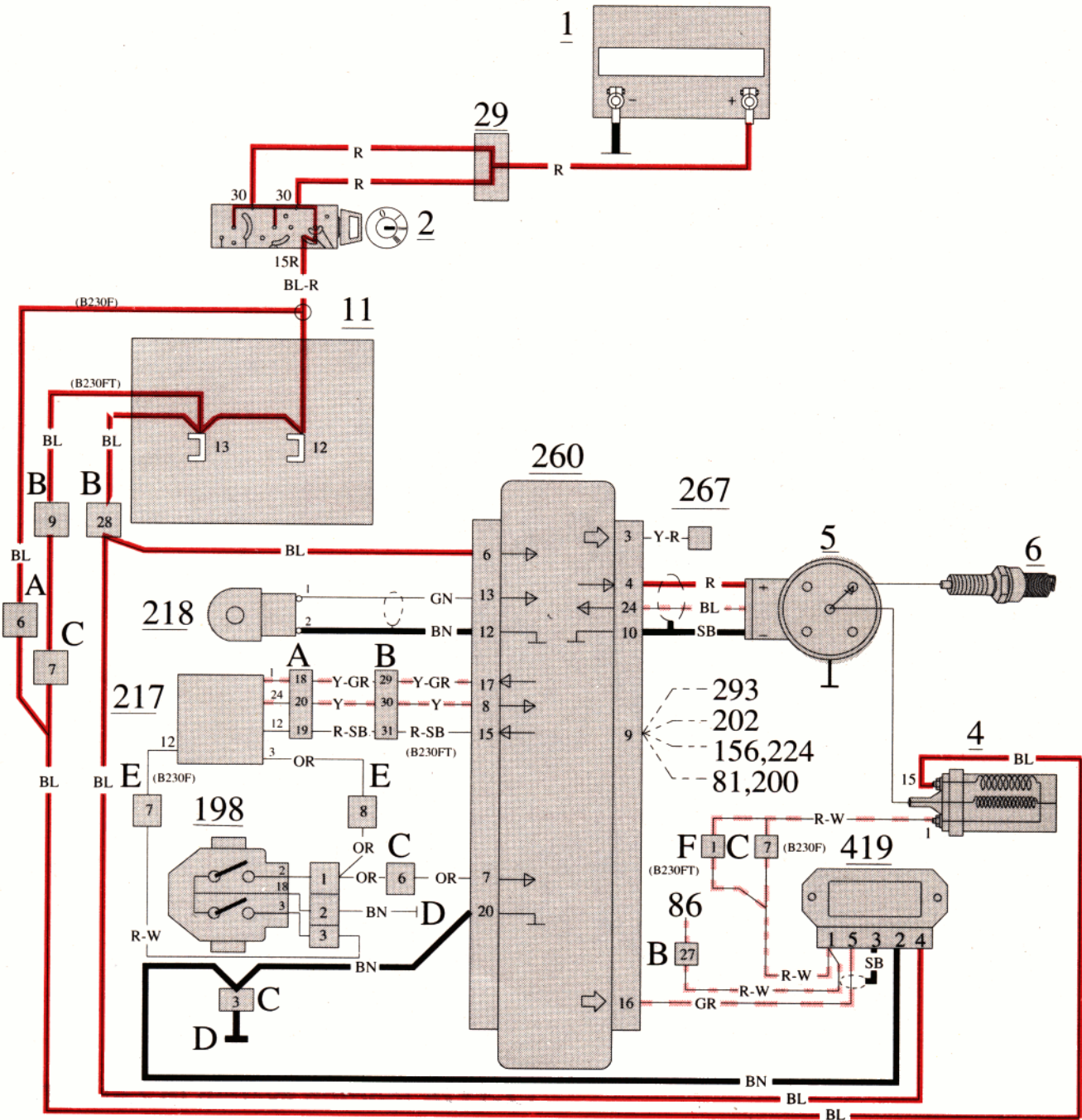


EZ-117K Ignition system (B 230 F/FT)

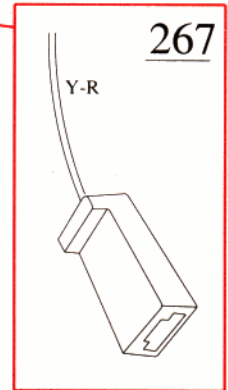
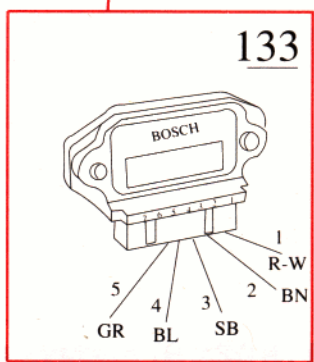
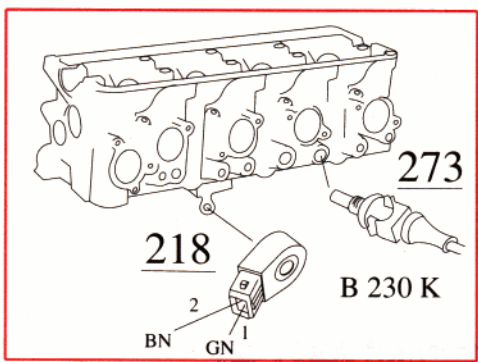
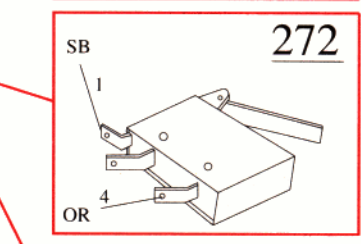
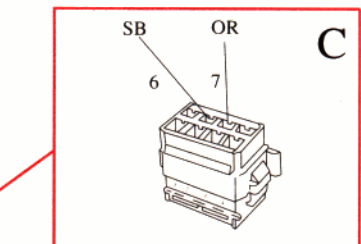
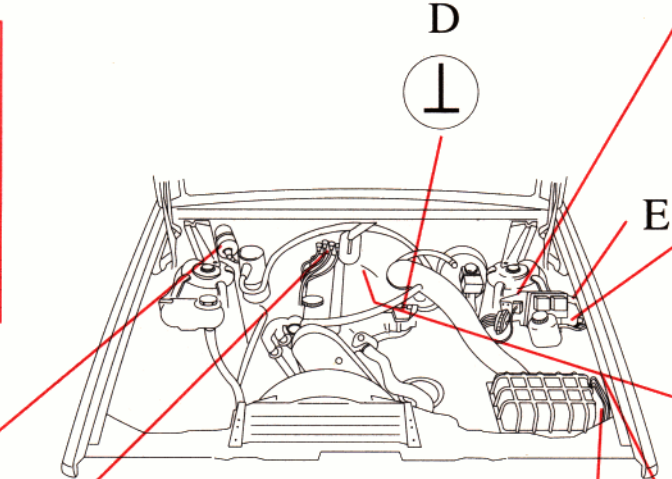
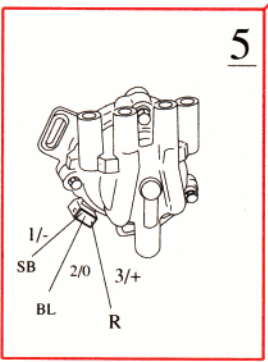
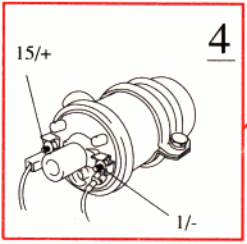
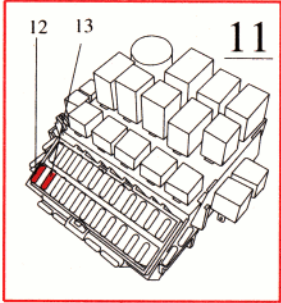
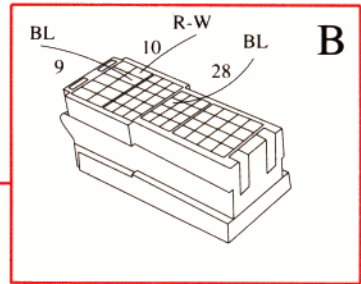
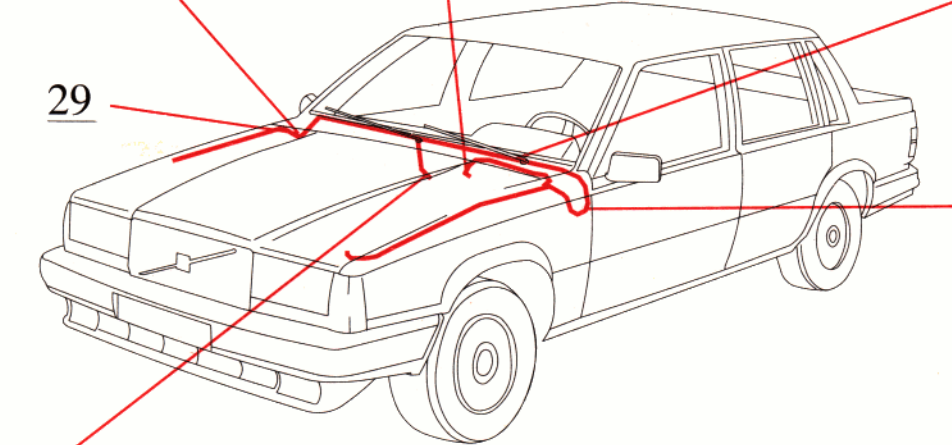
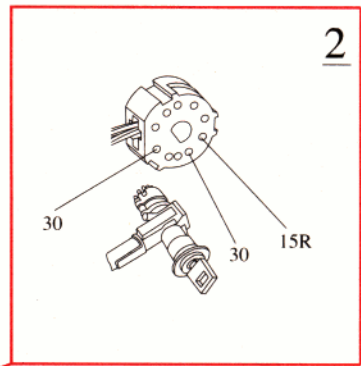
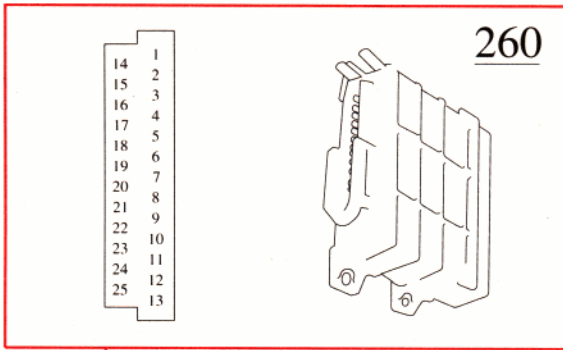
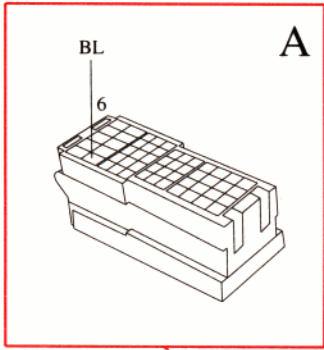
- 1 Battery
- 2 Ignition switch
- 4 Ignition coil
- 5 Distributor
- 6 Spark plugs
- 11 Fusebox
- 29 Positive terminal board
- 81 AC pressure switch
- 86 Rev counter
- 156 Radiator fan motor
- 198 Throttle switch
- 200 AC compressor solenoid

- 202 Climate control
- 217 Fuel system control unit
- 218 Knock sensor
- 224 Radiator fan thermostat
- 260 Control unit
- 267 Test connector
- 293 Idling compensation relay
- 419 Power stage

- A Connector, RH A-post
- B Connector, LH A-post
- C Connector at LH wheel housing
- D Ground terminal on intake manifold
- E Connector at RH wheel housing
- F Connector at LH wheel housing



EZ-118K Ignition system (B 230 K, B 200/230 E)



EZ-118K Ignition system

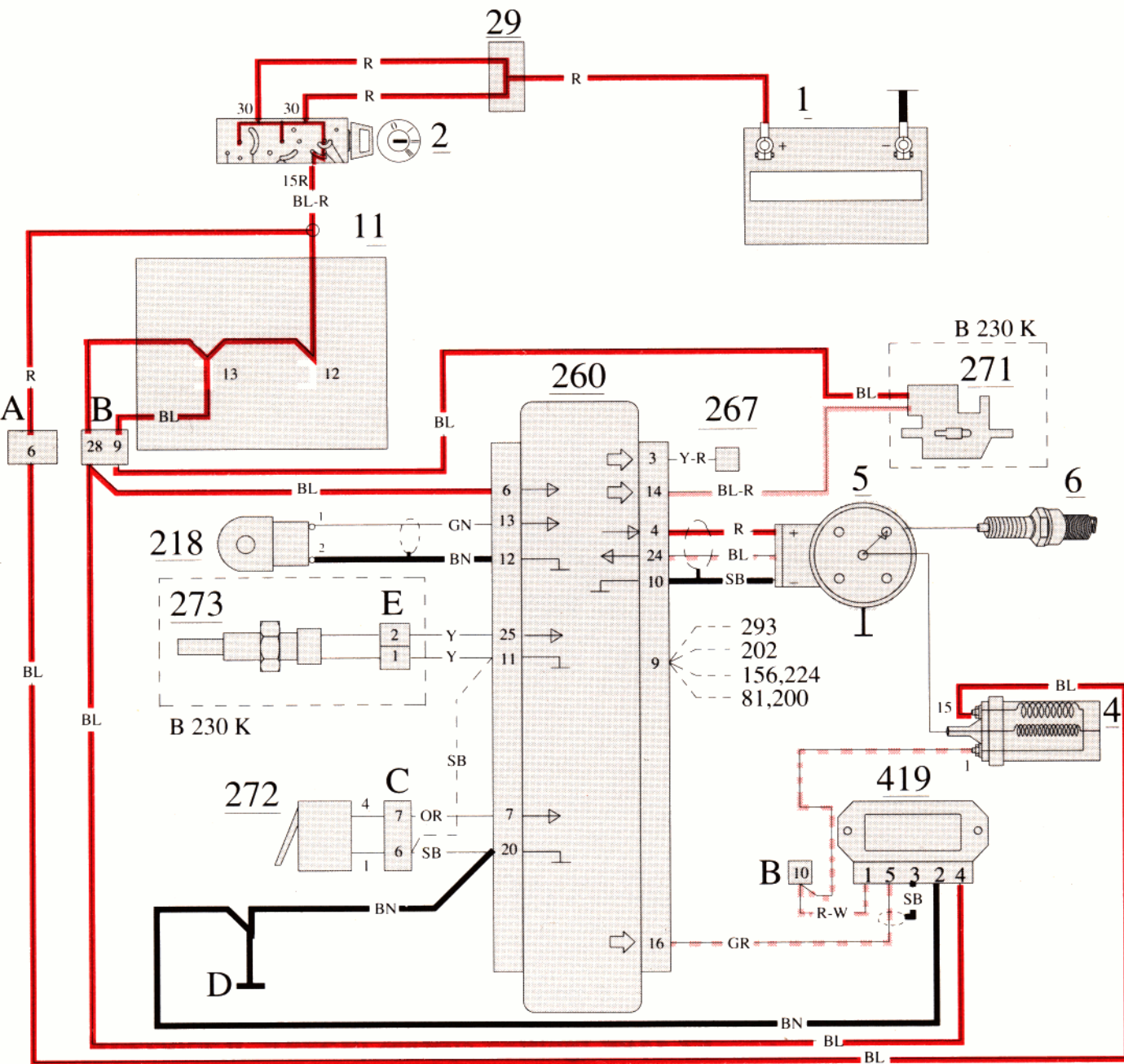
(B 230 K, B 200/230 E)

- 1 Battery
- 2 Ignition switch
- 4 Ignition coil
- 5 Distributor
- 6 Spark plugs
- 11 Fusebox
- 29 Positive terminal board
- 81 AC pressure switch
- 86 Rev counter
- 156 Radiator fan motor
- 200 AC compressor solenoid
- 202 Climate control
- 218 Knock sensor

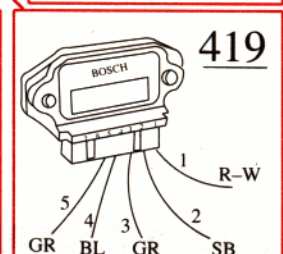
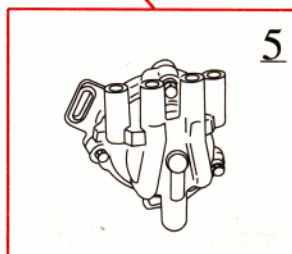
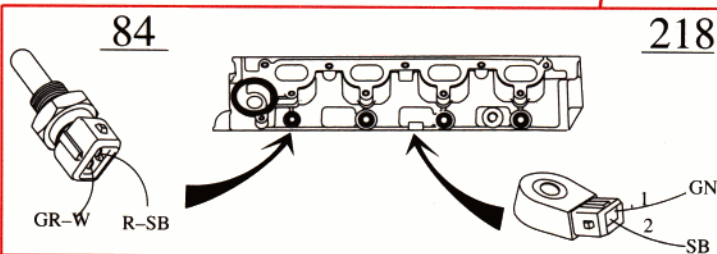
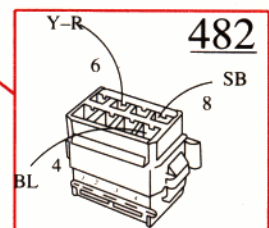
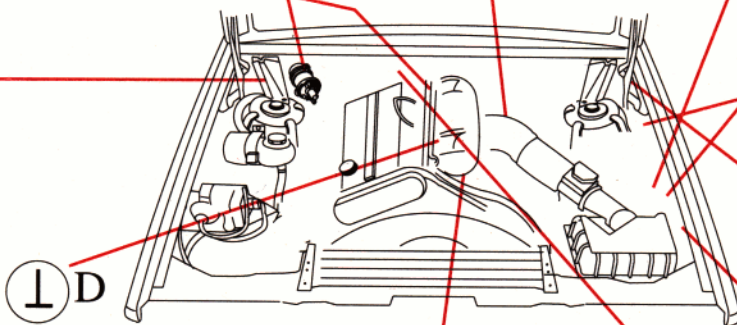
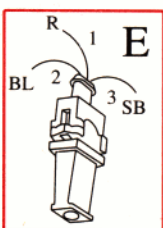
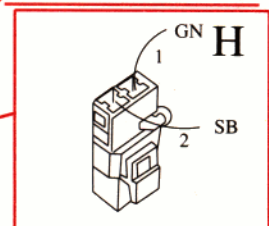
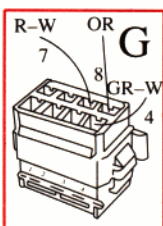
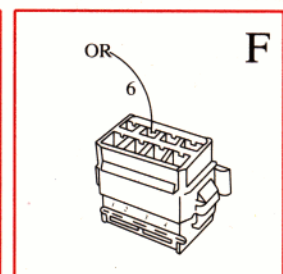
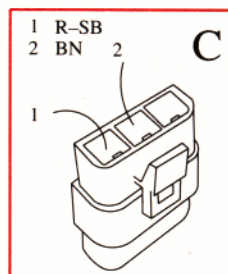
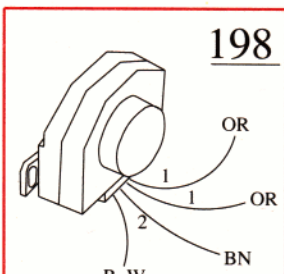
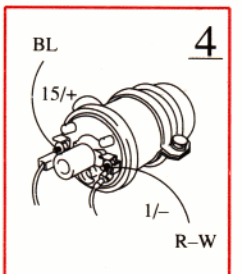
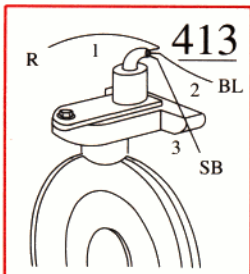
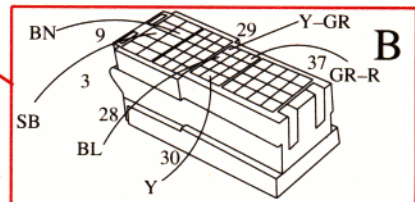
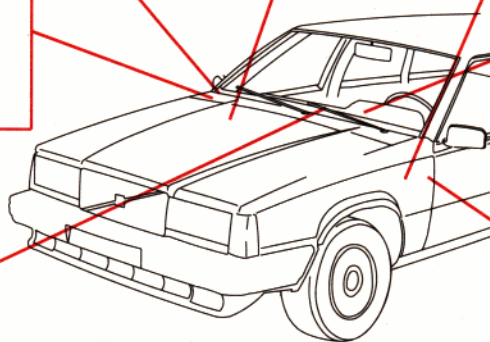
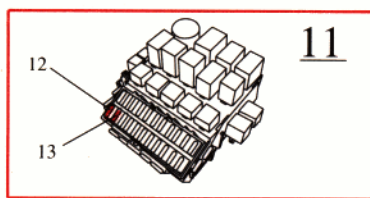
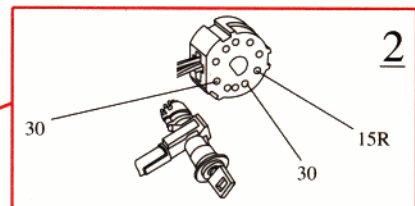
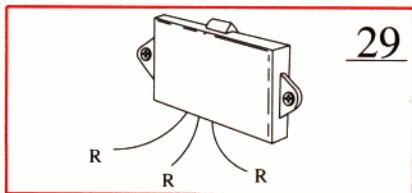
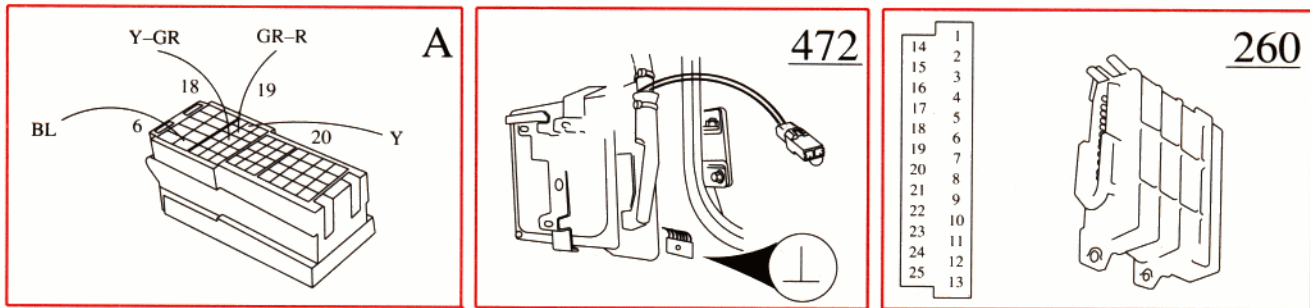
- 224 Radiator fan thermostast
- 260 Control unit
- 267 Test connector
- 271 Fuel cut-off solenoid
- 272 Microswitch
- 273 Temperature sensor
- 293 Idling compensation relay
- 419 Power stage

- A Connector, RH A-post
- B Connector, LH A-post
- C Connector at LH wheel housing
- D Ground terminal on intake manifold
- E Connector at LH wheel housing

Engine running

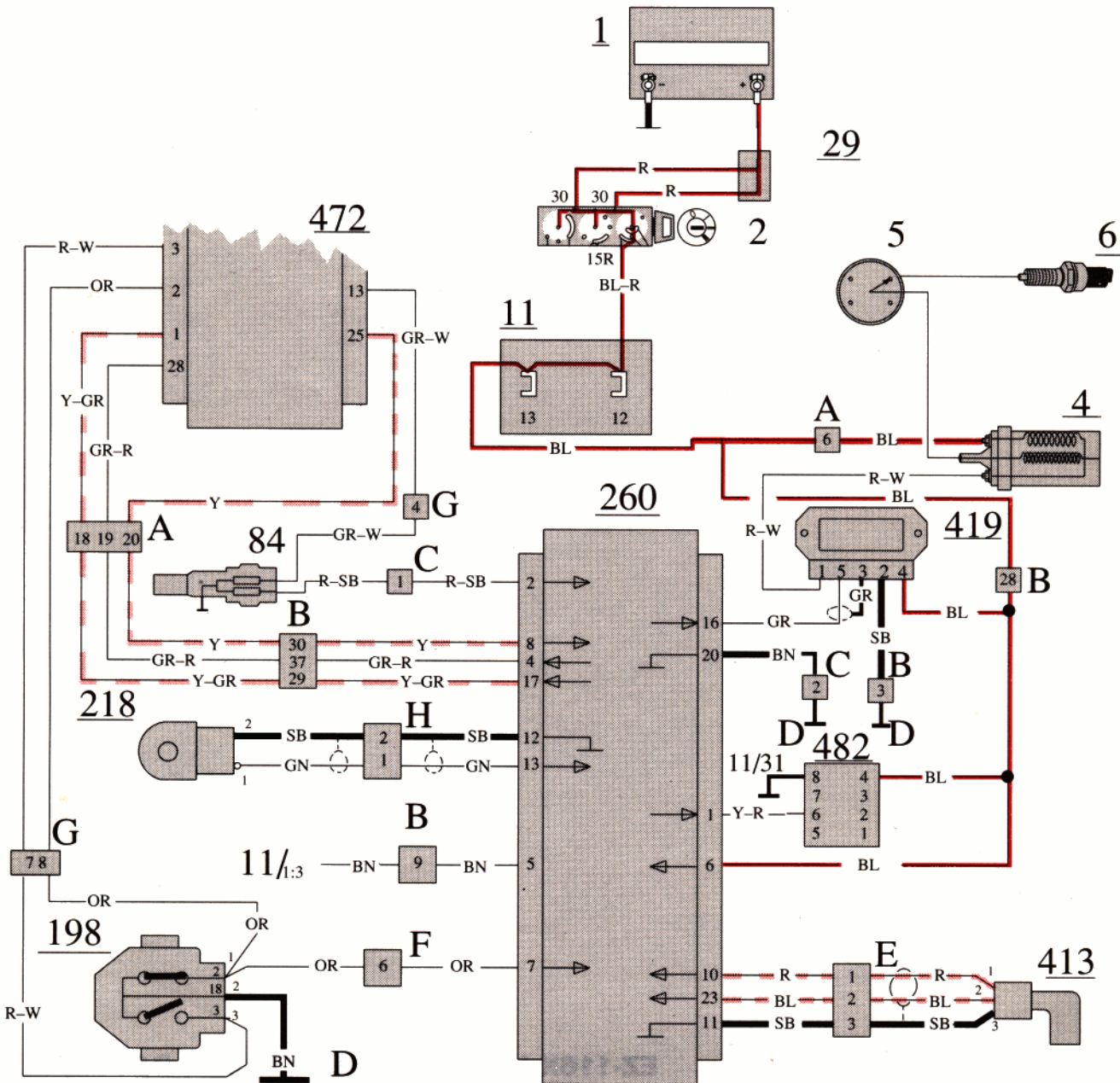


EZ-116K Ignition system (B 234 F, B 204 E)



EZ-116K Ignition system (B 234 F, B 204 E)

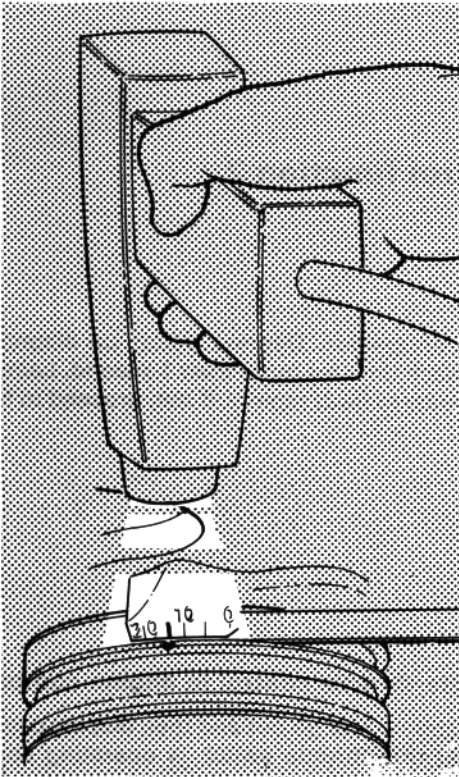
- | | | |
|----------------------------|------------------------------|--------------------------------------|
| 1 Battery | 218 Knock sensor | A Connector, RH A-post |
| 2 Ignition switch | 260 Control unit | B Connector, LH A-post |
| 4 Ignition coil | 413 Pulse generator | C Connector at LH wheel housing |
| 5 Distributor | 419 Power stage | D Ground terminal on intake manifold |
| 6 Spark plugs | 472 Fuel system control unit | E Connector at bulkhead |
| 11 Fusebox | 482 Diagnostic unit | F Connector at LH wheel housing |
| 29 Positive terminal board | | G Connector at RH wheel housing |
| 84 Temperature sensor | | H Connector at LH wheel housing |
| 198 Throttle switch | | |



N. Fault tracing – Rex-I with self-diagnostics

B 230 F engine (Federal USA)

The Rex-I ignition system features self-diagnostics, the functions of which are incorporated in the control unit.
NOTE: All fault codes will be erased if the busbar 30 supply is disconnected. The system features three different control functions.



144 850

Checking

N1

Start and run engine up to working temperature

If engine does not start: Check that fuse No. 1 is intact. If engine still refuses to start, commence fault tracing with operations N5-N6 and proceed to N8-N10.

N2

Check timing

Correct value: $10^{\circ} \pm 2^{\circ}$ before TDC.

NOTE: Timing cannot be adjusted.

N3

If timing is incorrect:

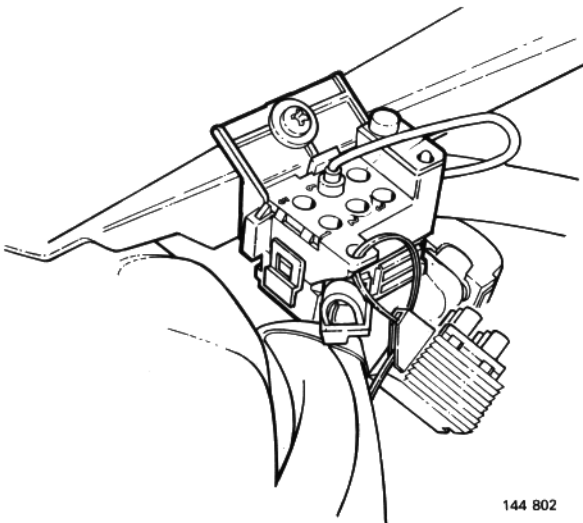
1. Check throttle switch (see N5 and N7).
2. Check that pulse generator leads are wired correctly to connector at bulkhead (see wiring diagram).
3. Open diagnostic unit cover and connect lead to socket 6.

Switch on ignition.

Select **control function 1** and display fault codes (if any). Press pushbutton for more than 1 second and count number of flashes. Record and press again to display next fault code (3 in all). Consult table (N4) for interpretation of fault codes.

Code 111 indicates that no faults are present. Check fuel system.

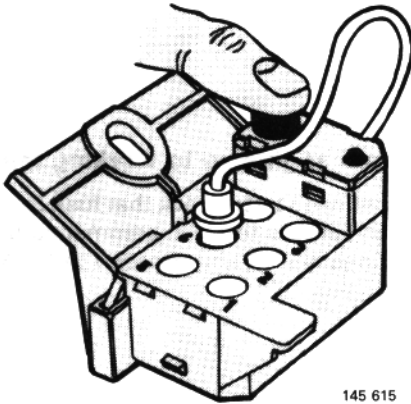
If lamp does not light when button is pressed, or if no fault code is displayed, proceed to N11–N17.



144 802

Control function 1

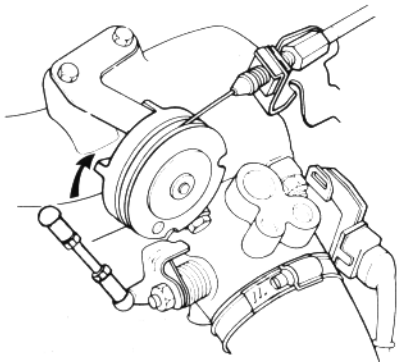
- 111 No fault
- 142 Control unit fault. Replace unit.
- 143 Knock sensor signal absent. See N25.
- 144 Fuel system load signal absent. See N23.
- 214 Pulse generator signal absent intermittently. See N24.
- 224 Engine temperature sensor faulty. See N21.



145 615

Control function 2

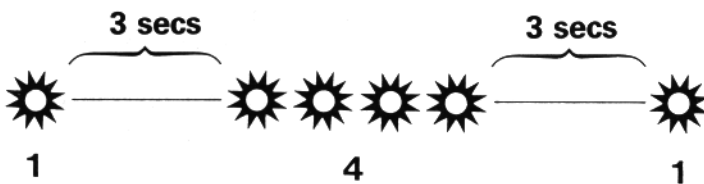
Switch on ignition. Depress button on diagnostic unit twice, each time for more than 1 second. Lamp should commence to flash rapidly. If not, proceed to N11-N18.



146 716

Operate throttle control in engine compartment

Lamp should first go out and then display code 334, indicating that throttle switch is operating correctly in idling position. See N22 if code is not displayed but lamp continues to flash rapidly.

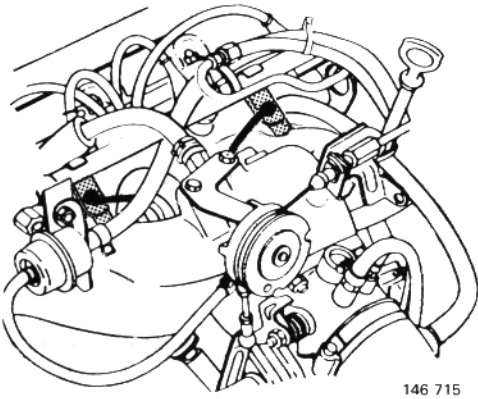


143 804

Operate starter motor

Lamp should first go out and then display code 141, indicating that pulse generator signal is okay. See N24 if code is not displayed but lamp continues to flash rapidly.

Switch off ignition.



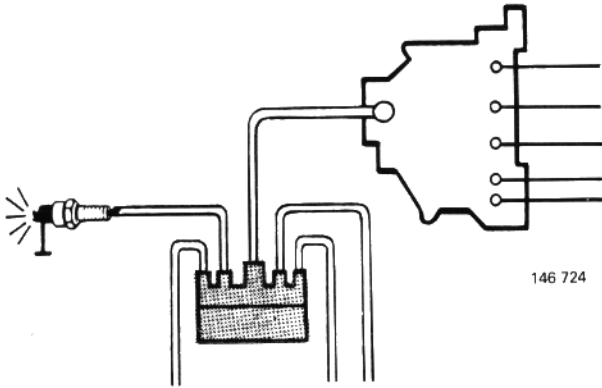
146 715

Engine does not start

N8

Check control unit and power stage ground connections

Ground leads (brown and black) should be tightened securely to terminals on intake manifold.



146 724

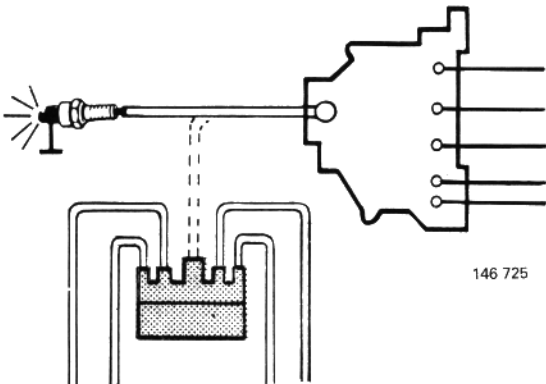
Check for spark at spark plugs

Caution! Fuel system control unit may be destroyed if spark strikes injector or unit wiring.

Disconnect HT lead from one spark plug and connect to spare plug.

Ground plug and operate starter motor.

If powerful blue-white spark is present: Fault is located in engine or fuel system.



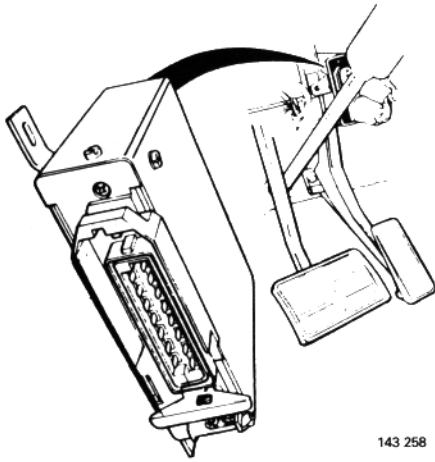
146 725

N10

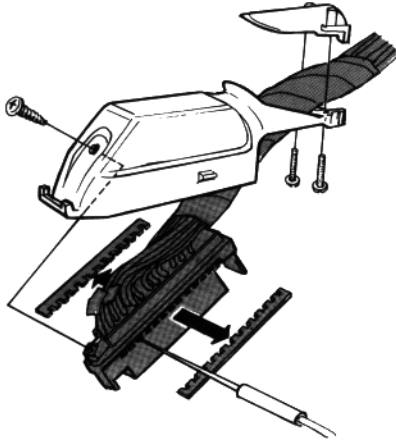
If spark is weak or absent: Connect plug and HT lead directly to ignition coil HT terminal. Ground plug and operate starter motor.

If spark is still weak or absent, fault is located in ignition coil or ignition system LT circuit (see N11-N36).

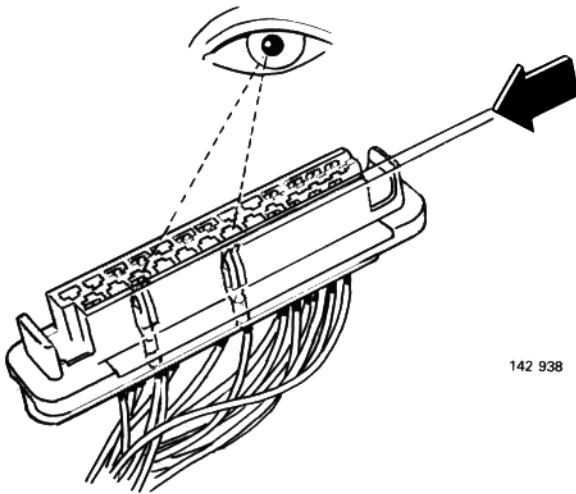
If powerful blue-white spark is now present, check rotor, distributor cap and HT leads. Replace as required.



143 258



138 110



142 938

Inspection and checking

N11

Undo control unit connector

Caution! The ignition must be switched off whenever the connector is disconnected or reconnected.

Remove panel under left-hand side of instrument panel.

Release connector catch and separate connector from control unit.

N12

Remove protective cover from connector

Caution! Never insert instrument probes into front of connector terminals. This may cause damage which will aggravate any faults present.

Always connect probes to terminals through holes in connector side, taking care to avoid **unnecessary** force. Terminal numbers are marked on side of connector.

N13

Check that all terminal sockets are at same height in connector

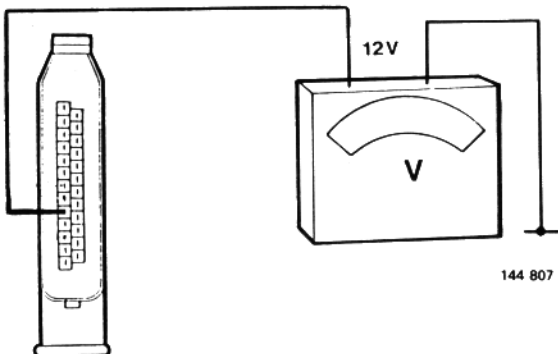
Poor contact may result one terminal socket is lower than the others.

N14

Check busbar 30 supply

Measure voltage between control unit connector terminal 5 (brown) and ground. Reading should be approx. 12 V.

If no reading is indicated, check lead between control unit sleeve and busbar 30 supply at fuseholder.



144 807

N15

Checking diagnostic unit

Switch on ignition

Connect test lead to socket 6.

Measure voltage between control unit connector terminal 1 (yellow/red) and ground. Instrument should read approx. 12 V. Depress pushbutton. Voltmeter should now read 0 V.

N16

Measure voltage at diagnostic unit connector if voltage is not present at control unit or if instrument reads 12 V with pushbutton depressed.

N17

At diagnostic unit

Measure voltage between connector blue lead and ground

Voltmeter should read approx. 12 V.

Measure resistance between connector black lead and ground

Ohmmeter should read 0 ohm.

Switch off ignition

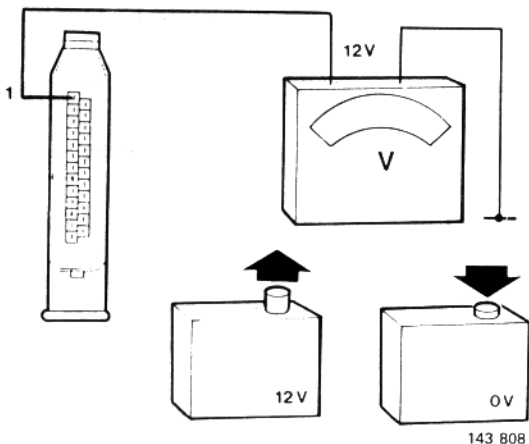
N18

Measure resistance between diagnostic unit test lead and pin (No. 8) under function selector

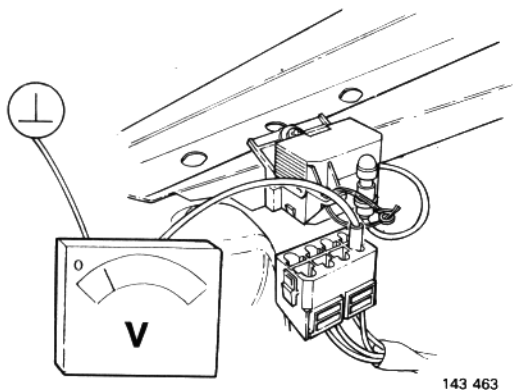
Ohmmeter should read infinity (∞).

Press function selector button.

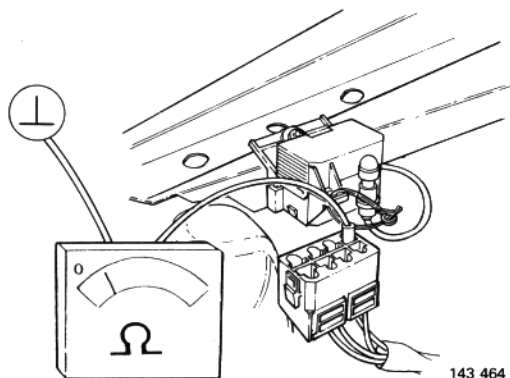
Ohmmeter should now read 0 V.



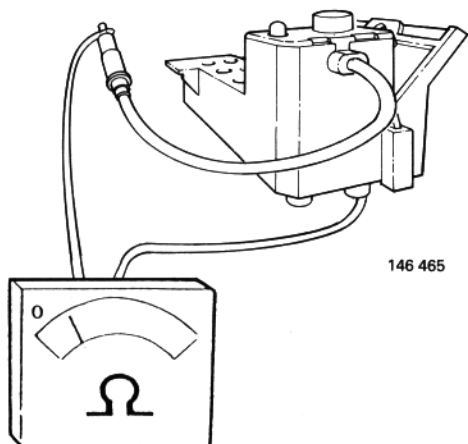
143 808



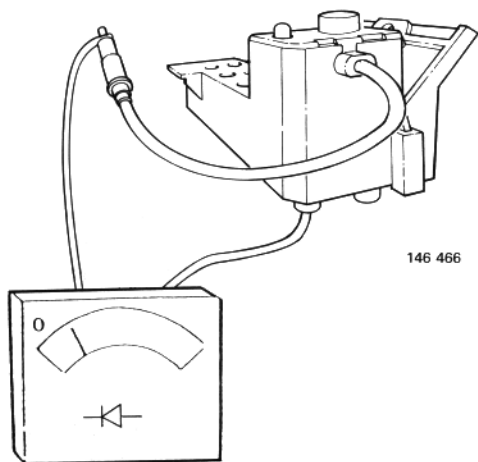
143 463



143 464



146 465



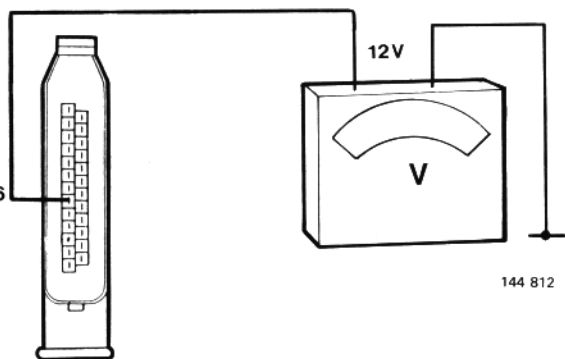
Connect diode tester between diagnostic unit LED and test lead

Connect red probe on diode tester to pin under LED and black probe to test lead.

LED is operating correctly if diode tester gives indication.

Replace diagnostic unit if no indication is observed.

N19



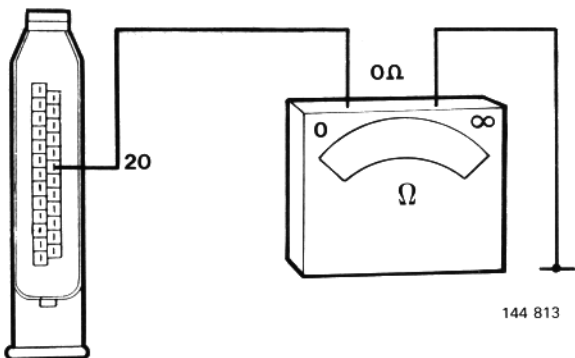
Check for voltage at control unit

Switch on ignition

Measure voltage between control unit connector terminal 6 (blue) and ground. Voltage should be approx. 12 V.

Switch off ignition.

N20



Check control unit ground lead

Measure resistance between connector terminal 20 (brown) and ground.

Resistance should be 0 ohm.

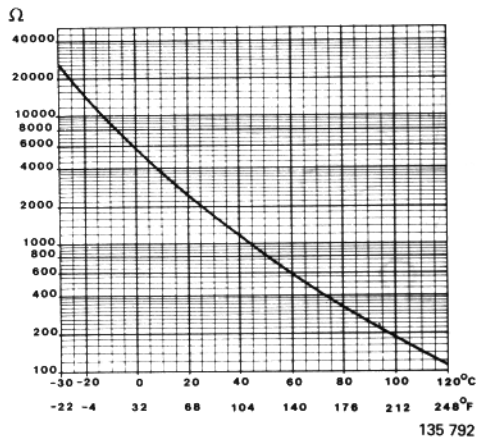
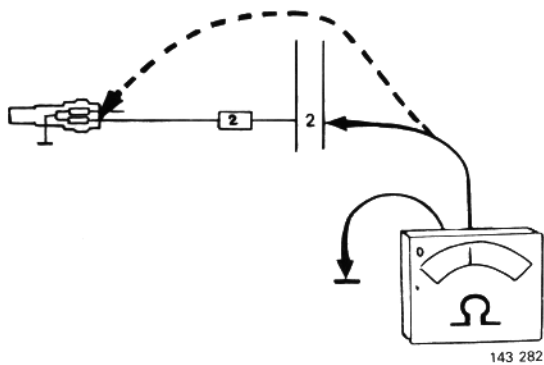
N21

Check temperature sensor

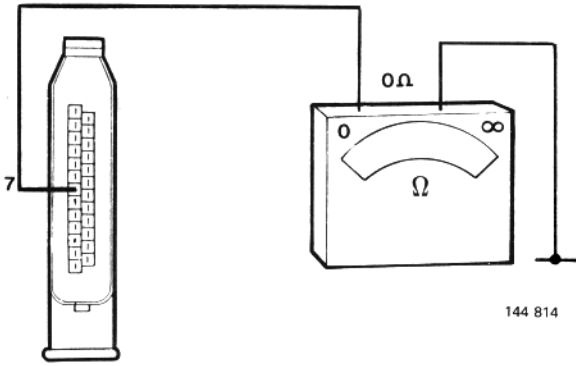
Measure resistance between connector terminal 2 (red/black) and ground.

Ohmmeter reading should agree with adjoining chart.

If value is incorrect: Measure sensor resistance directly to determine whether sensor or lead is faulty. Replace sensor or lead as appropriate.



N22

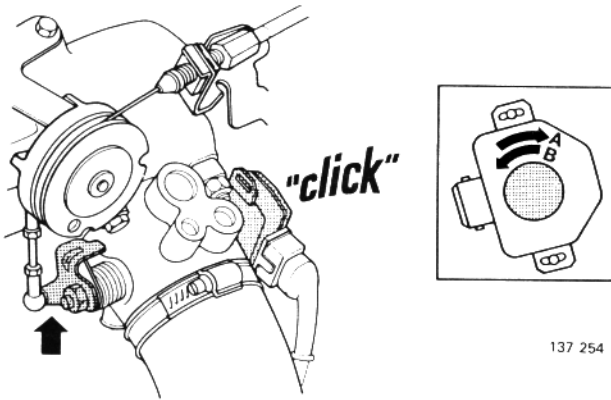
**Check throttle switch**

Measure resistance between control unit connector terminal 7 (orange) and ground.

Resistance should be 0 ohm.

Depress accelerator until throttle switch opens slightly. Resistance should increase to infinity.

In case of fault: Measure throttle switch resistance directly to establish whether fault is in wiring or switch itself.

**If necessary:****Check throttle switch setting**

Open throttle slightly and listen to switch. Click should be heard (as idling contacts open) immediately throttle opens.

Adjustment

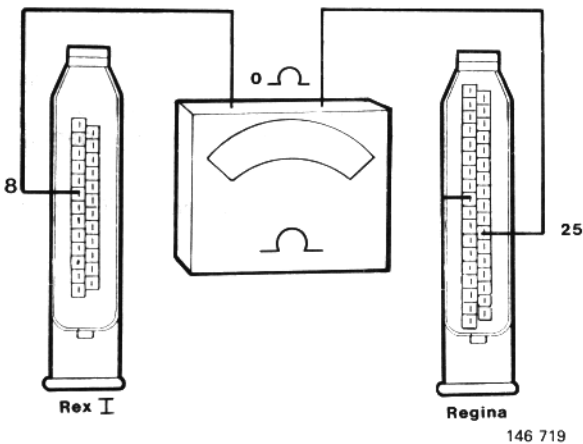
Loosen mounting screws (3 mm Allen screws).

Turn switch slightly clockwise.

Turn switch back counterclockwise until click is heard from contacts. Tighten screws.

Check adjustment.

N23

**Check load signal from fuel system control unit**

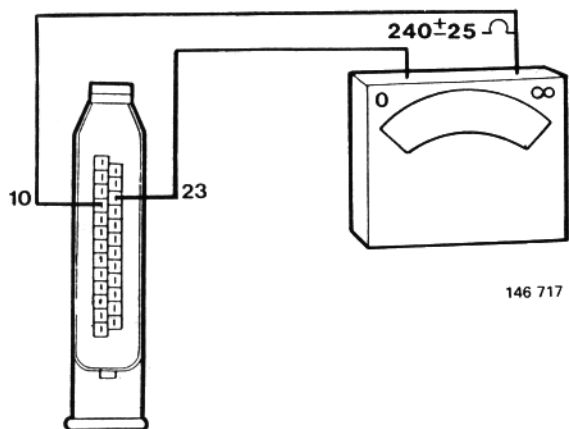
Remove panel under right-hand side of instrument panel and panel at right-hand side of bulkhead. Remove glove compartment. Undo fuel system control unit connector.

Measure resistance between ignition system connector terminal 8 (yellow) and fuel system connector terminal 25 (yellow). Instrument should read 0 ohm, otherwise lead is open-circuited. Check connectors as per wiring diagram.

If fault persists although lead is intact, internal fault is present in one of control units.

Replace panels and glove compartment.

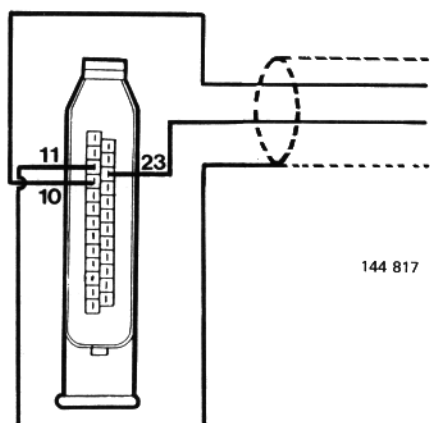
N24



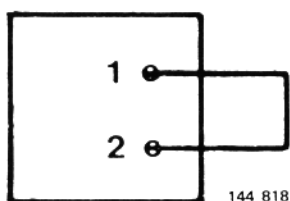
Check pulse generator

Measure resistance between connector terminals 10 (red) and 23 (blue).

Resistance should be approx. 240 ± 25 ohm.



Check that screen is connected to terminal 11.



N25

Check knock sensor leads

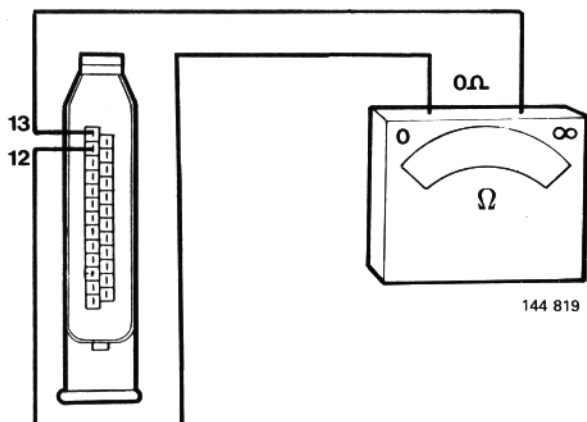
Undo knock sensor connector and bridge terminals 1 and 2.

Measure resistance between terminal 12 (black) and 13 (green) in control unit connector. Resistance should be 0 ohm.

If resistance is too high (∞), one or both leads is faulty (open-circuited). Remove jumper and measure each lead separately with ohmmeter. Replace damaged lead(s).

If leads are intact, replace knock sensor. Tightening torque 20 ± 5 Nm (15 ± 3.5 ft lb).

Reconnect knock sensor connector.



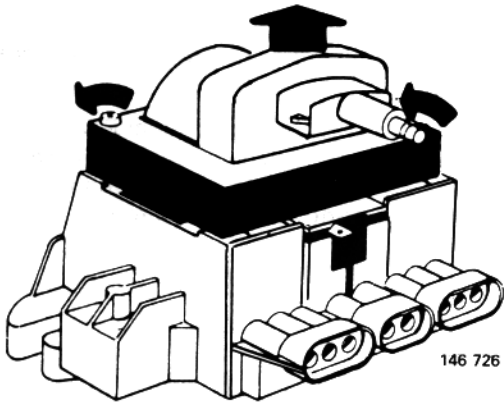
N26

Check ignition coil and power stage (420)

Undo connectors.

Separate ignition coil from power stage

Remove both mounting screws with a Torx TX 215 screwdriver and lift off ignition coil.



146 726

N27

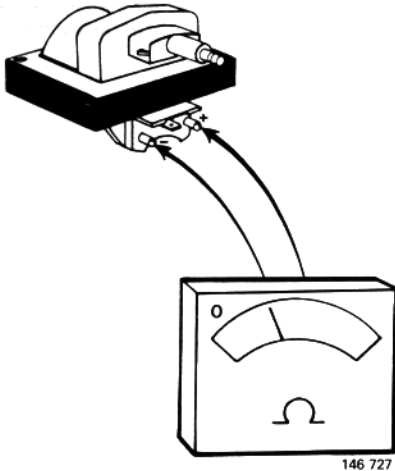
Measure resistance across ignition coil terminals

Measure resistance across LT terminals (+ and -) as illustrated.

Resistance should be approx. 0.5 ohm.

Measure resistance between HT terminal and each LT terminal.

Resistance should be approx. 5 kohm.



146 727

N28

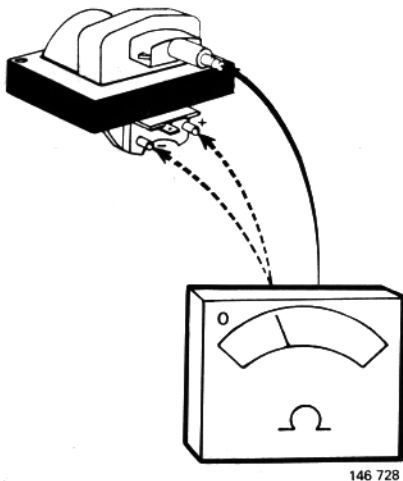
Check for voltage at ignition coil/power stage terminals

Switch on ignition.

Measure voltage between terminal A in 3-pole connector and ground. Instrument should indicate system voltage (12 V). **If voltage is absent or is too low:** Check supply lead connections at control unit and ignition coil/power stage.

Check that voltage does not fall below 10.5 V when starter motor is operated.

Switch off ignition.



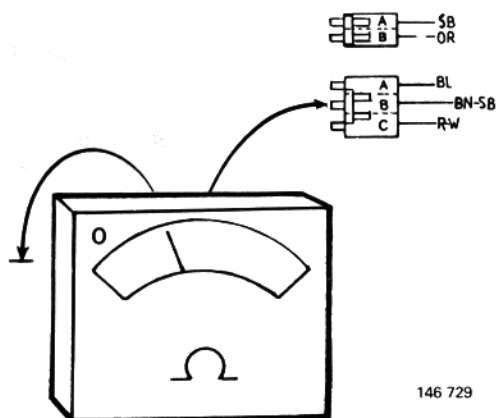
146 728

N29

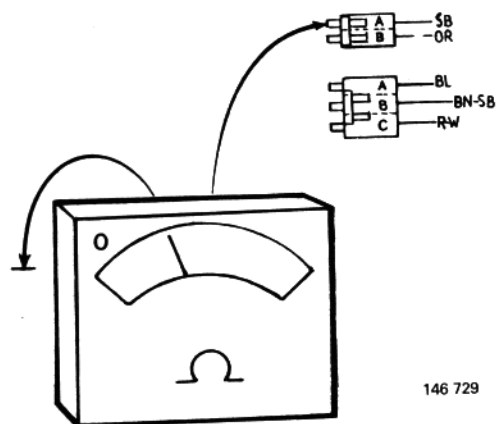
Check ignition coil/power stage ground connections

Measure resistance between terminal B in 3-pole connector and ground. Resistance must not exceed 0.1 ohm. If resistance is too high, clean ground connection and/or replace ground lead as required.

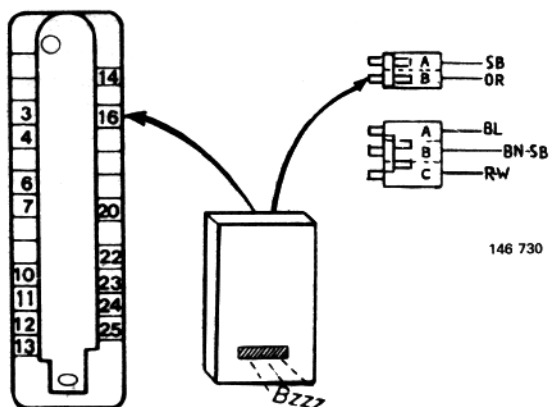
Measure resistance between terminal A in 2-pole connector and ground. Clean ground connection and/or replace ground lead as required if resistance exceeds 0.1 ohm.



146 729



146 729



146 730

N30

Check signal lead between ignition coil/power stage and control unit

Connect buzzer between terminal B in 2-pole connector and terminal 16 in control unit connector. Buzzer should sound if lead is intact.

N31

Persistent failure of engine to start despite absence of faults or correction of fault(s) which have been located indicates internal fault in control unit or power stage.

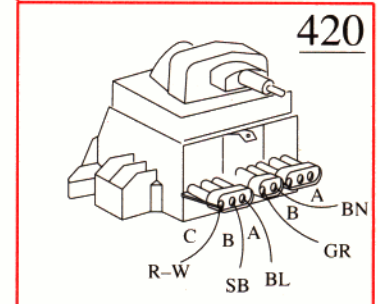
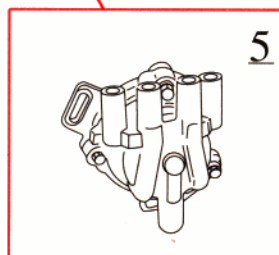
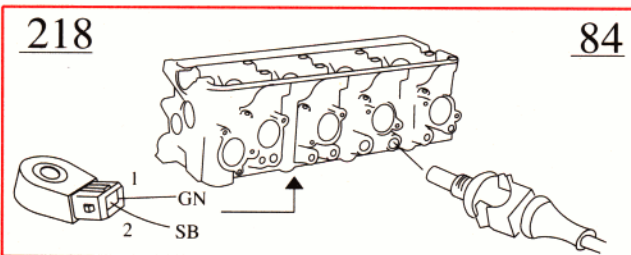
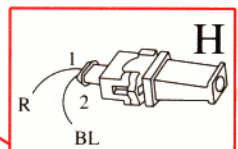
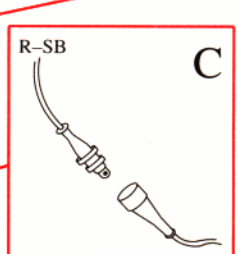
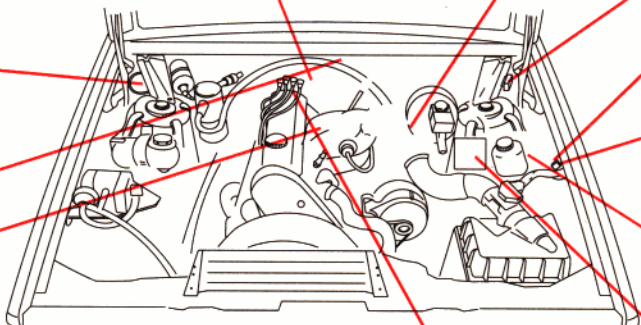
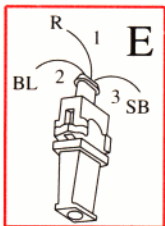
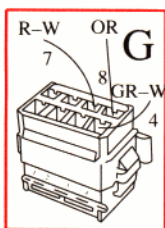
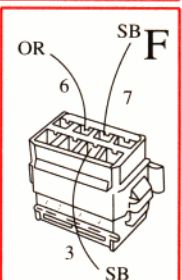
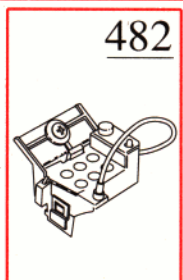
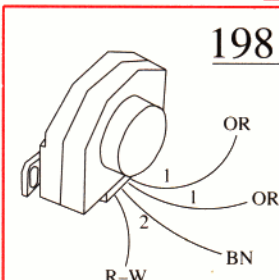
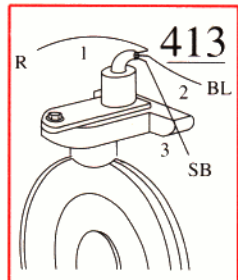
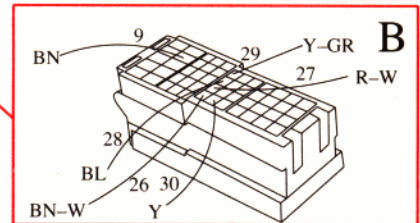
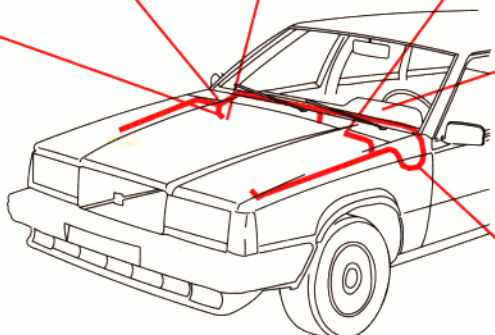
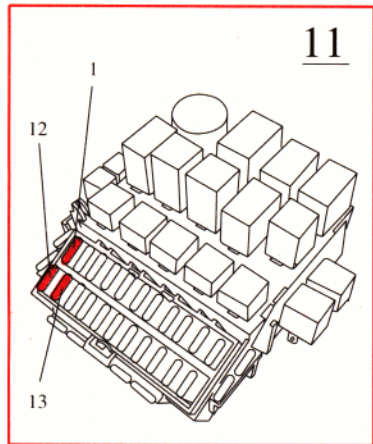
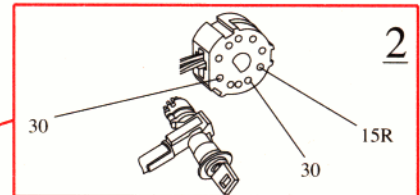
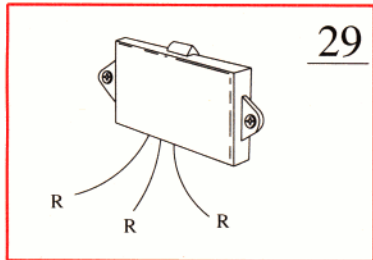
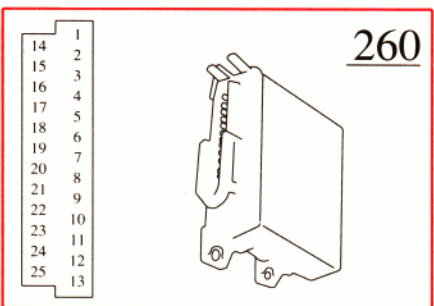
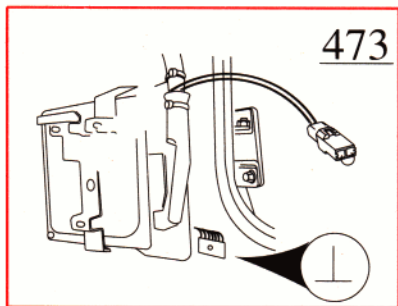
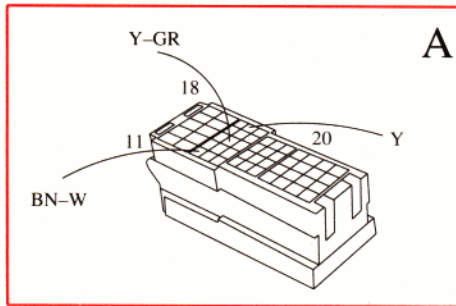
Verify by installing new control unit or new power stage.

Reinstall ignition coil. Reassemble control unit connector and reconnect to unit.

Reconnect ignition coil/power stage connectors.

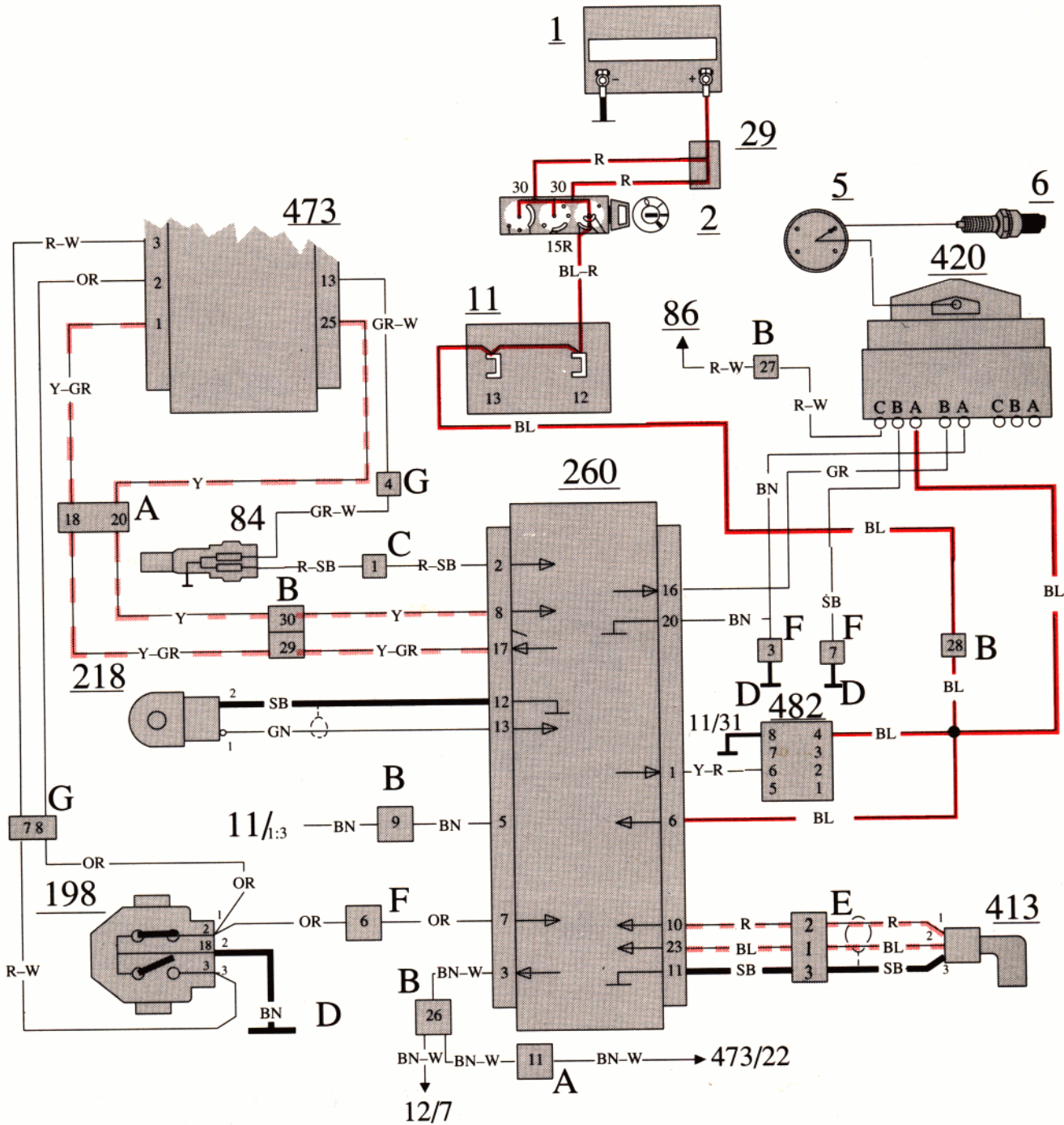
Check that no new fault codes are displayed.

Rex-I Ignition system (B 230 F)



Rex-I Ignition system (B 230 F)

- | | | |
|------------------------------|-------------------------------|--|
| 1 Battery | 198 Throttle switch | A Connector, RH A-post |
| 2 Ignition switch | 218 Knock sensor | B Connector, LH A-post |
| 5 Distributor | 260 Control unit | C Connector at LH wheel housing, single-pole |
| 6 Spark plugs | 413 Pulse generator | D Ground terminal on intake manifold |
| 11 Fusebox | 420 Power stage/ignition coil | E Connector at bulkhead |
| 12 Combined instrument (CEL) | 473 Fuel system control unit | F Connector at LH wheel housing |
| 29 Positive terminal board | 482 Diagnostic unit | G Connector at RH wheel housing |
| 84 Temperature sensor | | |
| 86 Rev counter | | |



Index

	Page
Adaptive timing retardation	37
Ballast resistor:	
A/E/F 6-cylinder engines	81, 107
Basic parameters	11-13
Centrifugal advance	74-75, 97, 109
Control unit	14-16, 77-78
Diagnostic system	63-67
Distributor	19, 73, 82-83, 87-102
Distributor tester	96, 111
Fault tracing:	
General procedures	79-104
Fault-tracing chart	104
Fault-tracing procedures:	
System	Procedure
TSZ-4	E1-E23
Renix-F	F1-F26
TZ-28H	G1-G7
EZ-102K	H1-H21
EZ-115K	J1-J45
EZ-117/118K	K1-K26
EZ-116K (B 234 F, B204 E)	L1-L36
EZ-116K (B 230 F)	M1-M38
Rex-I	N1-N31
	Page
TSZ-4	106-114
Renix-F	115-124
TZ-28H	125-134
EZ-102K	135-150
EZ-115K	151-168
EZ-117/118K	169-186
EZ-116K (B 234 F, B204 E)	187-200
EZ-116K (B 230 F)	201-214
Rex-I	215-226
Firing order	71
General instructions	69
Ground terminals:	
TZ-28H	103
TSZ	113
Renix-F	115
EZ-102K	137
EZ-115K	161
EZ-117K/118K	171
EZ-116K	189, 203
Rex-I	217

Hall generator	20-21, 98-102, 128-130, 141-144
Ignition coil	69, 72, 77-78, 81
Ignition coil/power stage	17-18
Ignition timing table	71, 84
Knock control	28-38
Knock-controlled fuel enrichment	39
Knock sensor	30-31
Lubrication:	
B 19 E - B 23 E, B 28 A - B 28 F	95
Spark plugs	11-12, 72
Speed/position pick-up	22-24, 78, 157, 194, 208, 222
System descriptions:	
TSZ	43
TZ-28H	44
Renix-F	45
EZ-102K	47
EZ-117K	49
EZ-118K	51
EZ-115K	55
EZ-116K	58
Rex-I	60
Temperature sensor ..	41-42, 155, 178, 192, 206, 220
Test equipment	68
Throttle switch/idling switch	40, 146, 156, 177, 193, 207, 221
Timing retardation:	
B 19 E	86
Vacuum advance	75-76, 85
Wiring diagrams:	
TSZ	113-114
Renix-F	123-124
TZ-28H	133-134
EZ-102K	148-150
EZ-115K	167-168
EZ-117K/118K	182-186
EZ-116K	198-200, 213-214
Rex-I	225-226