(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 965 741 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
22.12.1999 Bulletin 1999/51

(51) Int. Cl.^{6}: **F02D 41/16**, F02D 41/08

(21) Application number: 99107971.6

(22) Date of filing: 22.04.1999

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: 19.06.1998 IT MI981409

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(54) Method and device for controlling the idle speed of an engine

(57) A method and an apparatus for controlling the idle operating conditions of an internal-combustion engine of a motor vehicle, upon variation in the power drawn from the voltage generator (W4) by the electric circuit (L-BA). The running speed of the engine is detected by a logic control unit (ME), for example a microcontroller, in relation to the frequency of the generator voltage within a predefined running speed range; by the same logic control unit (ME) the connected or disconnected state of the alternating-current electric load (L) of the vehicle is detected and, depending on the information received regarding the connected or disconnected state of the electric load (L) to the voltage generator (W4) and the running speed of the engine, the logic control unit (ME) causes activation or deactivation of an electronic control switch (SCR3 - figure 4) to connect the voltage generator (W4) to earth.

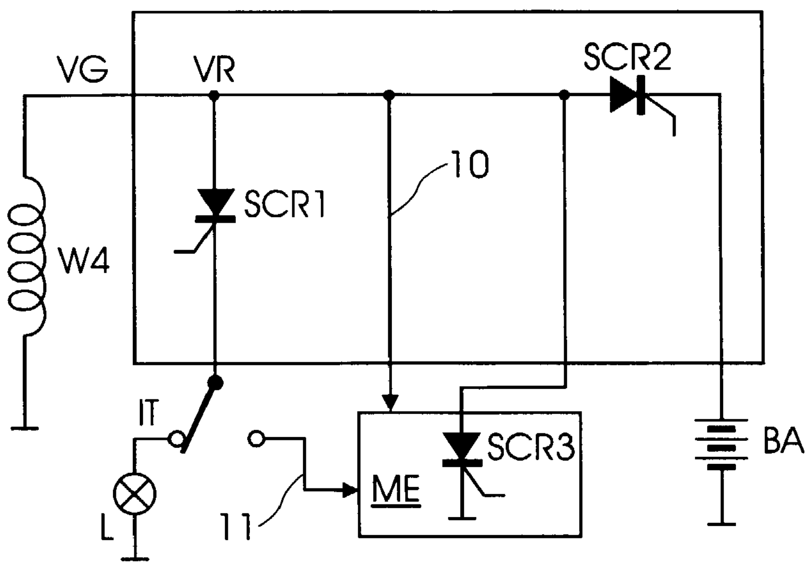


Fig. 1

EP 0 965 741 A2

Description

FIELD OF THE INVENTION

[0001] The present invention relates to a method and an apparatus for controlling the idle operating conditions of an internal-combustion engine of a motor vehicle, upon variation in the power drawn from the voltage generator by the electrical system of the said motor vehicle.

[0002] Although the invention is applicable to the electrical system of any motor vehicle, preferably the invention is applied to an electrical system of a motor vehicle provided with a series voltage regulator of the phase-control type which forms the subject of a co-pending Italian patent application of the same Applicant.

[0003] In mopeds, scooters or low-power motorcycles there exists the problem of correctly maintaining the idle operating conditions of the engine, also called "engine idle speed", when different quantities of power are drawn by the electric loads of the vehicle.

[0004] In the case of motorcycles of the above mentioned kind, these conditions can be basically summarised as being the situation where the vehicle lights are switched on or off, or more generally to the connected or disconnected state of the alternating-current electric loads supplied by the voltage generator which normally provides the necessary power for the ignition circuit.

[0005] Therefore, in motor vehicles of the abovementioned kind, if the engine idle speed is set for example in conditions where the lights are ON, when the lights are switched off, because of the smaller amount of power drawn, the engine tends to increase slightly its speed; on the other hand, if the engine idle speed is set in conditions where the lights are OFF, when the lights are switched on the engine tends to decrease its speed with the risk of stalling.

[0006] At present this problem is solved by ensuring that the alternating-current output from the voltage regulator normally provided in the electrical system of a motor vehicle is always connected to a load with a same value so as to keep substantially unchanged the power which is drawn-off by the engine.

[0007] Basically, this is achieved by switching, by means of a suitable deviator switch, the alternating-current output of the voltage regulator either to the motor vehicle lights or to an electrical resistance of suitable value, which remains constantly connected to the voltage generator during operation of the engine.

[0008] It is therefore obvious that this known system, although solving the problem of the engine idle speed, in practice is wasteful both in terms of assembly, owing to the additional cost of the resistance and the necessary wiring, and in terms of energy consumption since the constant powering of the resistance in order to maintain the idle speed conditions of the engine, in addition to dissipating energy continuously - even when the lights are switched off - also results in more power being drawn by the engine and a consequent greater fuel consumption, thus worsening the environmental pollution.

OBJECTS OF THE INVENTION

[0009] There is therefore the need to find a solution to the problem of the engine idle speed, which allows the above mentioned problems to be overcome.

[0010] Therefore, the object of the present invention is to provide a method and an apparatus for controlling the idle operating conditions of an internal-combustion engine of a motor vehicle, resulting in an economically more advantageous solution which is in any case such that it reduces the dissipation of energy and the fuel consumption, thus helping minimize the factors which are the cause of environmental pollution.

BRIEF DESCRIPTION OF THE INVENTION

[0011] The above may be achieved by means of a method for controlling the engine idle speed in accordance with Claim 1 as well as by means of an apparatus for controlling the engine idle speed according to Claim 6.

[0012] According to a first aspect of the invention a method has been provided for controlling the idle speed of an internal-combustion engine of a motor vehicle, the electrical system of which comprises an electric load which is connectable to a voltage generator winding by means of a manually operable switch device under the control of a voltage regulator, characterized by the steps of:

- detecting the running speed of the engine in relation to the frequency of the voltage provided by the voltage generator winding;
- detecting information relating to the connected or disconnected state of the electric load by a logic control unit; and
- depending on the running speed of the engine and the information regarding the connected and disconnected state of the electric load detected by said logic control unit, selectively causing connection of the voltage generator winding to earth or to the electrical system of the vehicle, to maintain the idle operating conditions of the engine.

[0013] According to a second aspect of the present invention an apparatus has been provided for controlling the idle speed of an internal-combustion engine of a motor vehicle, the electrical circuit of which comprises an alternating-current load which is connectable to a voltage generator by a manually operable switch device and a voltage regulator, characterized by comprising a logic control unit for controlling the engine idle speed which is operationally connected to the voltage regulator and to said switch device, and is preset to detect the running speed of the engine in relation to the frequency of the generator voltage, or to detect the connected and disconnected states of the electric load, said control unit, depending on the running speed of the engine and the connected or disconnected state of the electric load being further preset to actuate an electronic switch for connecting the generator to earth during the disconnected state of the alternating-current electric load of said electric circuit.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The general features and some preferred embodiments of the method and the apparatus for controlling the idle speed of an engine according to the invention, will be described more fully hereinbelow with reference to the accompanying drawings, in which:

- Fig. 1 is a general diagram of an apparatus for controlling the idle speed of an engine according to the invention;
- Fig. 2 shows a first embodiment of a control apparatus which uses a series voltage regulator of the phase-control type for alternating-current and direct-current loads;
- Fig. 3 shows the diagram of a control apparatus which uses a voltage regulator of the phase-control series type for alternating-current loads alone;
- Fig. 4 shows in detailed form the electrical diagram of a logic unit for controlling the engine idle speed, forming part of the apparatuses according to Figs. 2 and 3;
- Fig. 5 shows a third embodiment of the apparatus which again uses a series voltage regulator of the phase-control type for alternating-current and direct-current loads;
- Fig. 6 shows a fourth solution of the apparatus, which again uses a series phase-control type regulator for alternating-current loads alone;
- Fig. 7 shows a detailed electrical diagram of a logic unit for controlling the engine idle speed, forming part of the apparatuses according to Figures 5 and 6;
- Fig. 8 is a graph of the squared output voltage of the generator used to determine the running speed of the engine.

DETAILED DESCRIPTION OF THE INVENTION

[0015] Figure 1 shows the general diagram of an apparatus according to the invention for controlling the idle operating conditions of an internal-combustion engine of a motor vehicle, which is suitable for achieving the objects referred to above.

[0016] The apparatus comprises a voltage regulator VR of any suitable type which is able to control the voltage VG output from a voltage generator which is represented by its winding W4 and which supplies, by means of a first controlled electronic switch SCR1, and a manually operable switch device IT, an alternating-current load L, for example consisting of the headlamps of a motor vehicle to which the apparatus is normally fitted. In the case where the electrical system of the motor vehicle also comprises a power supply battery BA, the latter is supplied by the generator winding W4 in a manner known per se, by means of a second controlled electronic switch SCR2.

[0017] The apparatus according to Figure 1 is completed by a control unit ME for controlling the engine idle speed, which is able to perform the following functions:

- detect, by means of the connection 10, the running speed of the engine in relation to the frequency of the voltage VG generated by the winding W4 of the voltage generator, the rotor of which is operationally connected to the engine shaft;
- detect, by means of the connection 11, whether the alternating-current load L, basically the headlamps of the motor vehicle, is connected or not, i.e. whether the headlamps are switch ON or OFF during the idle operating conditions of the engine;

- trigger an electronic switch SCR3 so as to connect to earth the winding W4 of the generator, when the headlamps are switched off, or the load is disconnected, so as to dissipate electrical energy for braking the internal-combustion engine, thus regulating the idle conditions of the engine.

[0018] With reference to Figure 2, we shall now consider a first method for determining, by the use of a deviator switch IT, whether the lights of the motor vehicle are switch ON or OFF or, more generally, whether the alternating-current load L is in a connected or a disconnected state.

[0019] In the example according to Figure 2 a series voltage regulator of the phase-control type intended both for alternating-current loads (AC) and for direct-current loads (DC) is used, said regulator forming part of a co-pending patent application, as previously mentioned, and the main parts thereof therefore being described hereinbelow.

[0020] As can be seen from this figure, the voltage regulator substantially comprises a number of functional blocks which are indicated by the reference letters A, B, C, D, E, F' H, N and which will be described separately, for controlling the output voltage VG from the winding W4 of a voltage magneto generator supplying an electric circuit with which a motor vehicle is normally equipped.

[0021] In Figure 2, ME denotes again the unit for controlling the engine idle speed, which by means of the connection 10 receives from the output voltage VG of the generator winding W4, a first information relating to the running speed of the engine, while by means of the connection 11 it receives from the deviator switch IT a further information relating to the connected or disconnected state of the load L depending on the position assumed by the switch IT itself.

[0022] In Fig. 2 AL denotes moreover a block for generating a voltage VS supplying the various functional blocks of the voltage regulator; the block AL comprises a diode DS and a resistor RS in series with a capacitor CS, the charging voltage VS of which is stabilised by a Zener diode DZS in parallel with the capacitor CS.

[0023] Passing to the description of the individual functional blocks which make up the voltage regulator according to Figure 2, the block A consists of a controlled electronic switch T1, for example SCR1 shown in Figure 1, which can be connected the AC load L in series to the winding W4 of the generator, through switch IT, so as to supply the AC load L as from a predefined instant during an electrical angle fraction of each positive half-wave of the output voltage VG from the generator winding W4, until the moment when there is no more current flowing through it.

[0024] The characteristic aspect of the series phase-control type voltage regulator shown consists in supplying of the AC electric load L by means of half-waves of a same polarity, and by effecting a control of the conduction phase of the electronic switch T1 for a fraction only of each half-wave, namely for an electrical angle during which the effective value of the generator voltage applied to the AC electric load L corresponds to the effective value of the voltage admissible for the load itself.

[0025] Therefore the voltage VL on the AC electric load, downstream of the electronic control switch T1, is detected by a block B which provides, at its outlet, a voltage V0 proportional to the square of the input voltage VL, i.e. defined by the formula:

$$V0=KVL^2$$

where K is a constant of predefined value such that the voltage V0, subsequently integrated in the block C, is proportional to the "effective value" of the voltage VL on the load L which, according to a well-known formula, consists of the square root of the mean of the squares of the values for the alternate voltage VL considered.

[0026] The output V0 of the block B is supplied to the inlet of an inverting integrator comprising the circuit R1-C1 and an operational amplifier A1, the non-inverting terminal of which is connected to a voltage source VR1 which determines the effective value of the admissible voltage for the load L to be supplied.

[0027] Therefore the output voltage V1 from the inverting integrator block C rises or falls depending on whether the mean of the voltage V0 is less or greater than the reference voltage VR1.

[0028] The output V1 of the block C consisting of an inverting integrator is sent to the inlet of a block D comprising a signal inverting amplifier (A2, R2, R3) which inverts V1 with respect to a second reference voltage source VR2 and the amplification ratio of which is defined by:

$$R3/R2$$

where R2 and R3 are connected to an operational amplifier A2, in the typical configuration of an inverting amplifier.

[0029] At the outlet of A2 there is a second control voltage V2 which, similar to V1, is related to the effective value of the voltage VL existing on the AC load L as defined above. The voltage V2 therefore varies, upon variation of V0 with respect to the reference voltage VR1, depending on whether the voltage generator represented by the winding W4 is operating idle, when T1 is reversely polarised, namely is open or deactivated, or whether current is flowing in the load L, when T1 is closed or in a conductive state.

[0030] The voltage V2 is supplied to the non-inverting inlet of the comparator CP2 of the block F' which has, applied to its inverting inlet, a reference voltage VR3 which provides a threshold voltage suitable for determining the instant in which the battery BA is supplied following triggering of the switch T2.

[0031] The output signal of the comparator CP2, by means of the diode D3, is then sent to the control electrode of the block H comprising of an electronic switch T2, such as SCR2 according to Figure 1, which is arranged in series with the battery BA, between the latter and the winding W4 of the voltage generator.

[0032] The voltage regulator according to Fig. 2 is also provided with a block N comprising a voltage comparator CP1 which compares the voltage ramp VC generated by a block E, with a voltage V3 provided by a block I. The block N is such that, when the voltage VC exceeds the voltage V3 of the output block I, which is directly related to the value of the voltage VB of the battery BA, it actutes the electronic switch T1 of the block A by means of the diode D1, causing it to switch on.

[0033] Since the battery charging voltage is normally fixed at about 14.5 volts for batteries with a nominal voltage of 12 volts, when the electronic switch T2 is closed or in conductive state, the same voltage is also present on the AC load L, although, being limited to the positive half-waves alone, it does not allow the voltage VL of the AC load to exceed a desired value, for example of 13 volts, which is normally less than the charging voltage of the battery BA.

[0034] The block E for generation of the voltage ramp VC for controlling the switching-on phase of T1, consists of an integrator RC-C2 for only the positive half-waves of the voltage VG of the generator, since the negative half-waves, which are intended to supply the electronic ignition circuit of the engine, are blocked by the diode DC.

[0035] The block E also comprises a first transistor TR1 for short-circuiting the capacitor C2, the base of which is normally polarised, via the resistor R4, by the voltage VS supplying the various functional blocks of the circuit and in which the base of TR1 in turn is connected to the collector of a second transistor TR2 inhibiting the first transistor TR1, the base of which is polarised by the positive voltage of the generator by means of the resistor RG, while the diode D2 serves to protect TR2 during the negative half-waves.

[0036] The voltage VC from the block E therefore represents the integral value of the voltage VG of the generator, or more generally constitutes a voltage ramp which is related to the voltage VG of the generator and is set to zero every time the voltage VG of the generator becomes negative; in this way the block E is always ready to operate at each positive half-wave or more generally for all the half-waves of the generator voltage which have the same polarity.

[0037] The block I in turn consists of an operational amplifier A3 which is connected to the resistors R5, R6, R7 and R8, as a differential amplifier which amplifies, with a suitable gain, the difference between the voltage VB relating to the charged state of the battery BA and a reference voltage VR4 indicative of the nominal voltage of the battery BA. More precisely it is found that:

$$V3 = \frac{R7 + R8}{R5 + R6} * \frac{R6}{R7} * VB - \frac{R8}{R7} * VR4$$

so that the output voltage V3 from the block I is:

- zero when VB is less than a given value of the battery voltage, for example a value of 14.5 volts which is intermediate of the values typically required for the voltages output by the voltage regulator for the DC loads;
- equal to VC Max for a small increase of VB for example of 0.2 volts in respect to the battery voltage referred to above.

[0038] The diagram according to Figure 2 also comprises a block ME for controlling the engine idle speed, shown in detail in Figure 4.

[0039] As can be seen from this figure, the block ME controlling the engine idle speed comprises two voltage comparators CP3 and CP4 which are connected in an inverting configuration and with a hysteresis determined by the resistors R22, R23 and R24 and R32, R33 and R34, respectively, so that switching is performed without uncertainty.

[0040] The inverting input of the comparator CP3, via the voltage divider R22, R21, receives the voltage VG of the generator winding W4 so that a squared signal VGS, which can be seen in Figure 8, is present for each negative half-wave of the voltage VG at the outlet of the said comparator CP3. The signal VGS is sent to a first inlet I1 of a logic control unit, for example a microcontroller MC which is able to:

a) detect the running speed of the engine by measuring the time period between two positive or negative wavefronts of the voltage VGS;
b) establish whether the voltage VG of the generator winding W2 is positive or negative on the basis of the logic level of VGS; and

c) detect the connected and disconnected state of the AC load L on the basis of the logic level of the voltage VLS output from the comparator CP4; basically if VLS=1 it indicates that current is flowing through the AC load L, namely that the lamps are lit, whereas VLS=0 indicates that the lamps are switched off, namely that no current is flowing in the AC load L.

[0041] Therefore, as again shown in Figure 4, the voltage VL present on the cathode of T1 is sent to the load L when the deviator switch IT is in the position shown, whereas it is sent to the anode of the diode D30 when the movable contact of T1 is switched to the "lamps OFF" position, opposite to the previous one.

[0042] The voltage divider R30, R31, together with the capacitor C30, forms a filter so that a direct voltage will be present at the inverting inlet of the comparator CP4 in the case where no current is flowing in the AC load L - lamps OFF condition - so that the output VLS will be at the low logic level, or zero level, whereas in the case where current is flowing in the AC load L - lamps lit condition - the voltage at the inverting inlet of CP4 will be zero and therefore VLS will assume the high logic level or level 1.

[0043] Figure 3 of the drawings shows a solution substantially similar to that of Figure 2, with the sole difference that in this case a voltage regulator of the series phase-control type for AC loads L alone is used.

[0044] The voltage regulator according to Figure 3 also comprises the blocks A, B, C, D and E according to Figure 2, as well as the power supply block AL, differing in that now the output voltage V2 from the block D is supplied to the inverting terminal of the voltage comparator CP1 which forms part of the block F and the non-inverting terminal of which is in turn supplied with the voltage VC of the ramp generator E. The output voltage VS of the comparator CP1 is in this case directly supplied to the control terminal of the switch T1, again via the diode D1.

[0045] The block ME controlling the engine idle speed, shown in Figure 3, is formed in a manner identical to that of Figure 2, so that reference should be made to that previously stated both as regards the characteristics of this block and as regards its functions and the operating mode of the entire circuit.

[0046] Figures 5, 6 and 7 show a further solution which envisages a different method of detecting the connected and disconnected states of the AC electric load L, in which the deviator switch IT according to the previous example has been replaced by a simple switch. Therefore, in Figures 5 and 6 the same reference numbers have been used to indicate similar or equivalent parts.

[0047] In the block ME for controlling the engine idle speed according to Figure 7, the circuit of the comparator CP3 also remains unchanged with respect to that of the preceding Figure 4, while the logic control unit MC now has a further output 01 able to feed a current of a few milliamperes, for example 5 to 10 milliamperes, through the resistor R25 and the diode D20, the switch IT and the load L, or towards the voltage regulator.

[0048] Since the load in general has a very low resistance, of the order of 5-19 Ohms, when the electronic switch T1 is closed or switched on the load L by the voltage regulator, the logic control unit MC is suitably preset so as to control the signal VGS provided on the inlet I1 by the comparator CP3, measure the running speed of the engine and check again whether the half-wave of the voltage VG of the generator is positive or negative. In this case, if the voltage VG is negative, there will certainly be no voltage on the AC load L since the electronic switch T1, being inhibited, is certainly not connected. Hence the logic control unit MC during this phase may activate to the high logic level the outlet 01 so as to allow the flow of a current limited by the resistor R25, through D20 and the switch IT, towards the load L if said switch IT is closed so as to be connected to the load itself.

[0049] In this situation, owing to the resistance values of the load L and the current values at the outlet 01, the inlet I2 of the logic control unit will certainly recognise as low the logic level of the voltage present on the anode of the diode D20 and, by means of suitably programming of the said logic control unit MC, this level will be assimilated to the condition of electric load L connected, i.e. lamps lit.

[0050] Otherwise, if the switch IT is open, then only the impedance of the blocks B and C of the voltage regulator is present on the cathode of D20 and, since it is very high, i.e. about 100 KOhm, it will enable the microprocessor to recognise as high the logic level of the voltage which is present at the anode of D20 and which will therefore be assimilated to the disconnected condition of the load L or to the lamps being switched off.

[0051] The diode 20 also has the function of protecting the logic control unit, for example the microcontroller MC, from the high peaks which are present on the load L, since said diode D2 is polarised in a reverse manner when the voltage on the load L exceeds that present on the anode of the diode itself.

[0052] By way of example, let us assume that the supply voltage of the circuit is VS = 5 with R25 = 500 Ohm, L = 5 Ohm, that the direct voltage drop onto the diode D20 is 0.7 volts and that the equivalent resistance, present on the cathode of P1, with P open, is 100 KOhm.

[0053] In these conditions, if the switch IT is switched on the load L, when the outlet 01 of the logic control unit is activated, then 5 volts will be present on this output, while 0.74 volts will be present at the inlet I2 and will be recognised by the microprocessor as being a low logic level; if, on the other hand, the switch IT is open, then a voltage of 4.98 volts will be present on the anode of D20 and will be recognised by the logic control unit MC as being a high logic level.

[0054] At this point, the apparatus is able to establish, using one of the two methods described above, whether the

AC load L is connected or disconnected, namely whether the lamps are ON or OFF and determine the running speed of the engine.

[0055] Let us assume that the internal-combustion engine is running at the idle speed. In these conditions, its running speed must be kept within well-defined limits which, for small engines with a capacity of 50 cc, typically lies between 1700 and 1900 revolutions per minute.

[0056] It is therefore obvious that the electric load L consisting of the lamps of the motor vehicle affects these idle speed values; therefore, when the load is not connected, it is necessary to ensure that the engine keeps its minimum speed within the predetermined limits, by connecting up to the generator winding W4 another load only in a well-defined speed range, so as to prevent power dissipation also when it is not required.

[0057] Let us assume that in the preceding example the idle speed of the engine is fixed at 1800 rpm, with the lamps lit, i.e. with the AC load connected, and that in this situation the block ME detects this condition, remaining inactive.

[0058] The said speed of 1800 rpm must be maintained also when the lamps are switched off, i.e. with the AC load L disconnected; in this condition the block ME controlling the engine idle speed detects using one of the two methods described above, the condition where the load is disconnected or the lamps switched off, measures the running speed of the engine and, if said speed exceeds the minimum value of 1800 rpm mentioned above, namely exceeds the speed limits envisaged for that engine, then the electronic switch SCR3 is triggered so as to switch on. In this way the winding W4 of the generator is short-circuited to earth with a consequent high current flow in the generator itself which will dissipate a much greater amount of power, to brake the internal-combustion engine at least by the same amount as the electric load L which normally consists of about 50-60 watts.

[0059] Following triggering of SCR3, the engine speed falls below the minimum speed, within the permitted range, and then the logic control unit with its outlet 02, which is connected to the control electrode of SCR3, will inhibit the latter, diconnecting the generator short-circuit so as to allow the internal-combustion engine to gain speed again.

[0060] In this way control of the engine idle speed is performed.

[0061] If more fuel is now supplied to the internal-combustion engine, its running speed will increase even if SCR3 remains connected, since the power of the internal-combustion engine is certainly much greater than the power dissipated by the generator W4 with a voltage half-wave short-circuited.

[0062] Following this event, if the running speed of the internal-combustion engine exceeds the minimum speed by a certain programmed range, for example 400 rpm in the case previously mentioned, then it will be evident to the logic control unit MC that the driver of the vehicle intends to increase the speed so that, above this speed, it will cause SCR3 to be inhibited, thus avoiding the needless dissipation of energy.

[0063] To summarise, from what has been said and shown in the accompanying drawings, it will therefore be understood that a method and an apparatus have been provided for controlling the idle speed of an internal-combustion engine, capable of detecting the running speed of the internal-combustion engine, whether the alternating-current electric load is connected or disconnected and, on the basis of these two sources of information may trigger an electric switch which connects the generator to earth.

[0064] In particular the apparatus thus conceived is able to perform braking of the internal-combustion engine without the use of additional electric loads, but only by short-circuiting to earth the voltage generator by means of a unidirectional electronic switch.

[0065] Activation of the unidirectional electronic switch for braking of the internal-combustion engine moreover takes place only in the condition where the load is disconnected and with the minimum running speed of the engine lying within a predefined range of values.

[0066] Finally, according to the invention, detection of the condition where the load is connected or disconnected may be performed by means of a deviator switch which connects the electric load to the input of a functional block controlling the idle speed of the engine, so as to provide said information to a logic control unit which is suitably programmed to manage operation of the entire apparatus controlling the engine idle speed. Alternatively, detection of the condition where the load L is connected or disconnected, or the lamps are switched on or off, may be performed by reading the voltage drop upstream of the switch IT and the protection diode D20 of the logic control unit, which voltage drop is generated by a current with an extremely low value, which is provided by the said block ME controlling the engine idle speed when the electronic switch T1 of the voltage regulator is in turn inhibited, i.e. during the negative half-waves of the voltage output from the generator.

[0067] It is obvious, however, that what has been said and shown in the accompanying drawings has been provided purely by way of example of certain preferred embodiments of the apparatus and the method according to the invention, it remaining understood that other modifications or variations are possible both as regards the type of voltage regulator used and as regards the said circuit for detecting the speed of the engine and the condition status of the alternating-current load for controlling the engine idle speed, without thereby departing from that which is claimed.

Claims

1. Method for controlling the idle speed of an internal-combustion engine of a motor vehicle, the electrical system of which comprises an electric load (L-BA) which is connectable to a voltage generator winding (W4) by means of a manually operable switch device (IT) under the control of a voltage regulator (A-N), characterized by the steps of:

   - detecting the running speed of the engine in relation to the frequency of the voltage (VG) provided by the voltage generator winding (W4);
   - detecting information relating to the connected or disconnected state of the electric load (L) by a logic control unit (ME); and
   - depending on the running speed of the engine and the information regarding the connected and disconnected state of the electric load (L-BA) detected by said logic control unit (ME), selectively causing connection of the voltage generator winding (W4) to earth or to the electrical system of the vehicle, to maintain the idle operating conditions of the engine.

2. Method according to Claim 1, characterized by the step of maintaining the connection to earth of the voltage generator winding (W4), in the disconnected state of the electric load (L), so as to cause braking of the engine, while maintaining idle speed conditions within a predefined range of the engine running speed.

3. Method according to Claim 1, characterized by the step of detecting the connected and disconnected state of the electric load (L) by detecting the open or closed condition of the switch device (IT) connecting the electric load (L) to the voltage generator winding (W4).

4. Method according to Claims 1 and 3, characterized by the step of detecting the connected or disconnected state of the electric load (L) by detecting the working condition of a manually operable deviator switch (IT) connecting the voltage generator winding (W4) to the said electric load (L) or to said logic control unit (ME).

5. Method according to Claims 1 and 3, in which the voltage generator is connectable to the electric load (L) by means of an electronic switch (T1) controlled by the voltage regulator (A-N), characterized by the step of detecting the connected and disconnected state of the electric load (L), by detecting the voltage drop generated by a current flowing from said logic unit (ME) towards said switch device (IT), and an alternating-current load (L) when said electronic control switch (T1) is inhibited.

6. Apparatus for controlling the idle speed of an internal-combustion engine of a motor vehicle, the electrical circuit of which comprises an alternating-current load (L) which is connectable to a voltage generator (W4) by a manually operable switch device (IT) and a voltage regulator (A-N), characterized by comprising a logic control unit (ME) for controlling the engine idle speed which is operationally connected to the voltage regulator and to said switch device (IT), and is preset to detect the running speed of the engine in relation to the frequency of the generator voltage, or to detect the connected and disconnected states of the electric load (L), said control unit (ME), depending on the running speed of the engine and the connected or disconnected state of the electric load, being further preset to actuate an electronic switch (SCR3) for connecting the generator (W4) to earth during the disconnected state of the alternating-current electric load (L) of said electric circuit.

7. Apparatus according to Claim 6, characterized in that the voltage generator (W4) is connectable to earth by a unidirectional electronic switch (SCR3).

8. Apparatus according to Claim 6, in which the voltage generator (W4) is connected to the electric load (L) by an electronic switch (T1) controlled by a voltage regulator (A-N), characterized in that said manually operable switch device comprises a deviator switch (IT) selectively connectable and disconnectable between said electronic switch (T1) and the electric load (L) respectively the logic control unit (ME) for controlling the engine idle speed, and in that said logic control unit (ME) is preset to detect the connected and disconnected state of the electric load (L) to the electronic switch (T1) depending on the condition assumed by said deviator switch (IT).

9. Apparatus according to Claim 8, characterized in that said logic control unit (ME) comprises a microcontroller (MC) having a first inlet (I1) connected, via a first voltage comparator (CP3), to the winding (W4) of the voltage generator to receive information regarding the running speed of the engine, as well as a second inlet (I3) connected to said electronic switch (T1), via an RC filter and a second voltage comparator (CP4), to receive information regarding the connected and disconnected state of the electric load (L) via the abovementioned deviator switch (IT), and in that

a third outlet (O2) of the microcontroller (M2) is connected to the control electrode of said electronic switch (SCR3) connecting the generator (W4) to earth.

10. Apparatus according to Claim 6, in which the voltage generator (W4) is connected to the electric load (L) by an electronic switch (T1) controlled by the voltage regulator (A-N), characterized in that said manually operable switch device (IT) is preset for connection and disconnection of the electric load (L) only with respect to the voltage generator (A-N) and in that the logic control unit (ME) for controlling the engine idle speed is preset for detecting the connected or disconnected state of the electric load (L) in relation to a voltage drop generated by an electric current flowing towards the manually operable switch device (IT) and an alternating-current electric load (L) under the control of said logic control unit (ME).

11. Apparatus according to Claim 10, characterized in that said logic control unit (ME) comprises a microcontroller (MC) having a first inlet (I1) connected, via a voltage comparator (CP3), to the generator (W4) to receive information regarding the engine running speed; a second inlet (I2) to receive information regarding the connected and disconnected state of the electric load (L) provided by a voltage drop resistor (R25) connected to the anode of a protection diode (D20) between said second outlet (I2) of the microcontroller (MC) and the manually operable switch device (IT) and to the electric load, in an inhibited state of the electronic switch (T1) controlled by the voltage regulator (A-N).

12. Apparatus according to any one of Claims 8 to 11, characterized in that said voltage regulator is a series voltage regulator of the phase-control type.

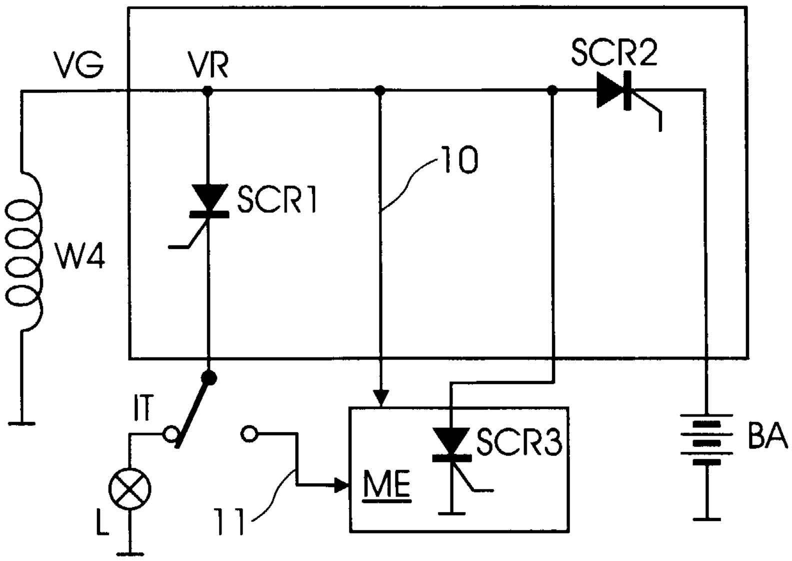


Fig. 1

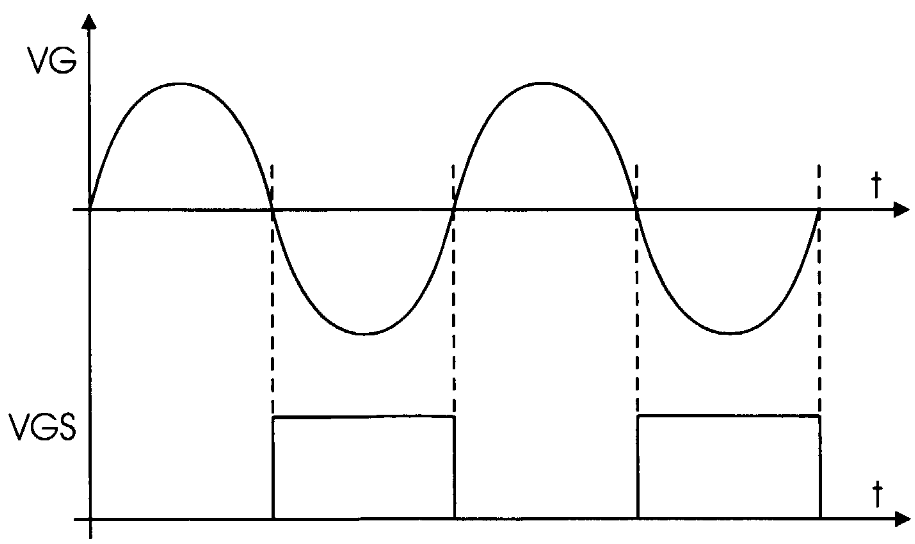
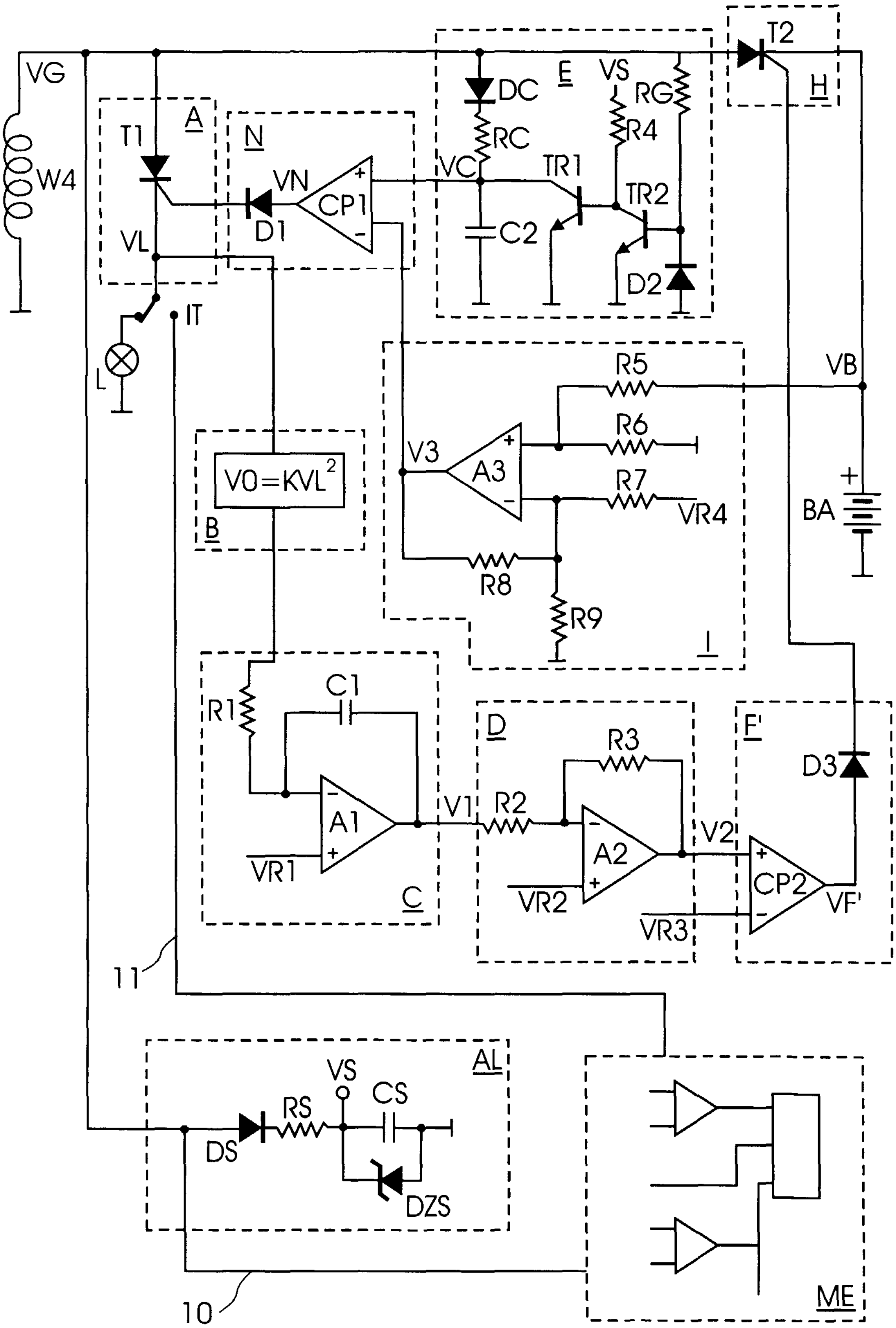


Fig. 8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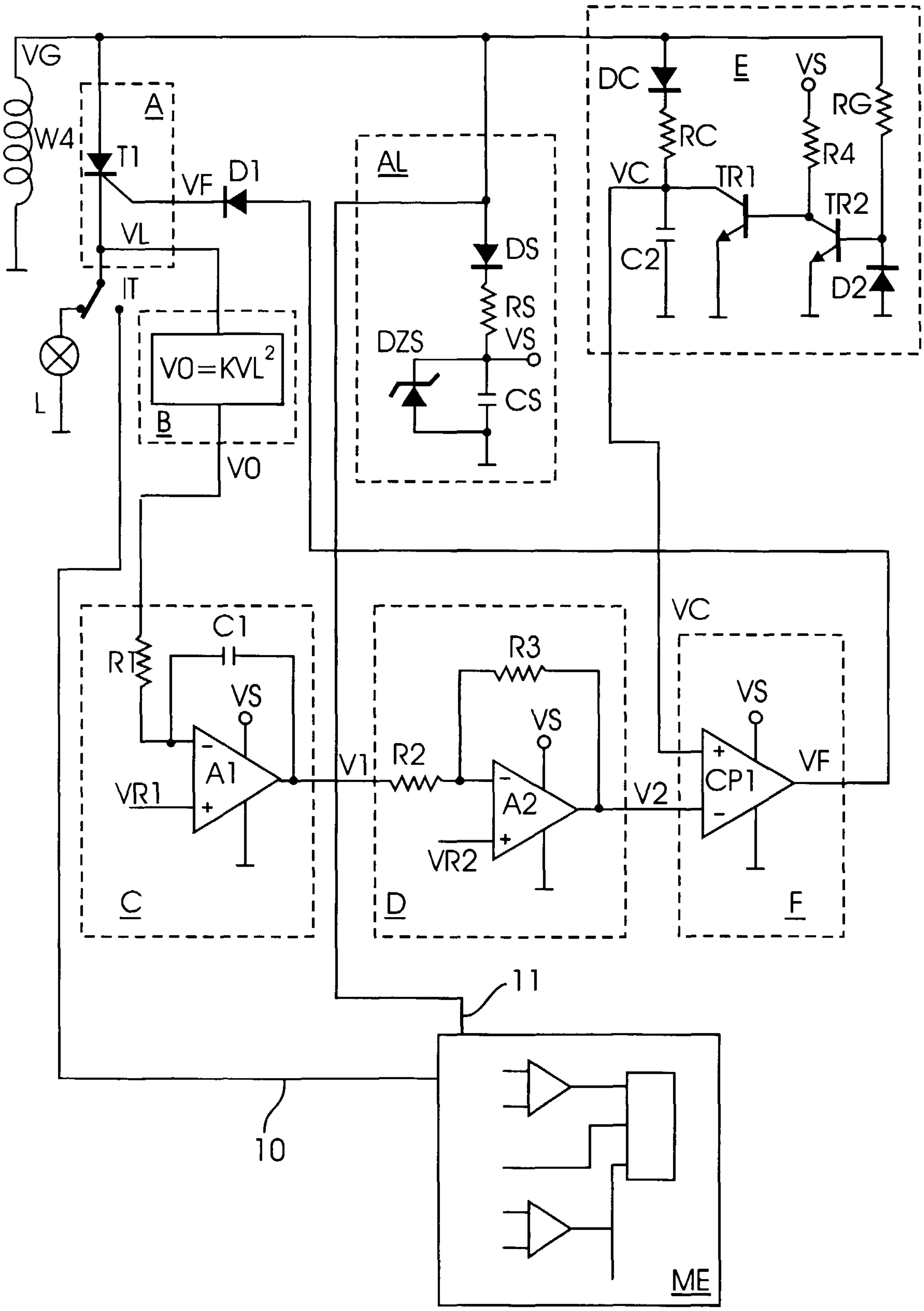
W4
T1
A
N
VN
CP1
D1
VL
IT
L
DC
E
VS
RG
R4
RC
VC
TR1
TR2
C2
D2
T2
H
R5
VB
R6
V3
A3
R7
VR4
BA
VO=KVL²
B
R8
R9
I
R1
C1
A1
VR1
C
V1
R2
D
R3
A2
VR2
V2
F'
D3
CP2
VF'
VR3
11
AL
VS
CS
RS
DS
DZS
ME
10

Fig. 2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VL
IT
L
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B
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AL
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RS
VS
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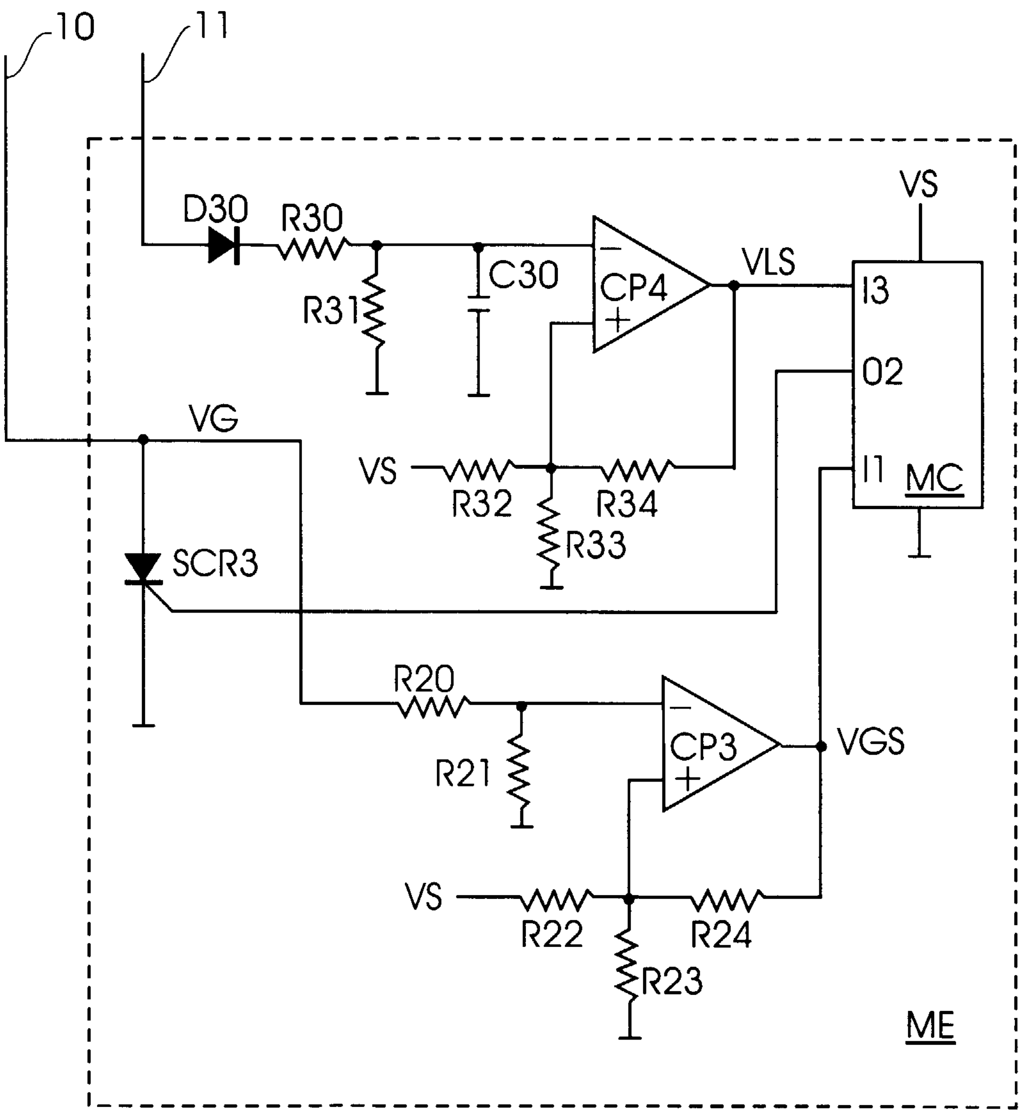
CS
DC
E
VS
RG
RC
R4
VC
TR1
TR2
C2
D2
VC
C1
R1
VS
A1
VR1
C
V1
R2
R3
VS
A2
VR2
D
V2
VS
CP1
VF
F
11
10
ME

Fig. 3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R30
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C30
CP4
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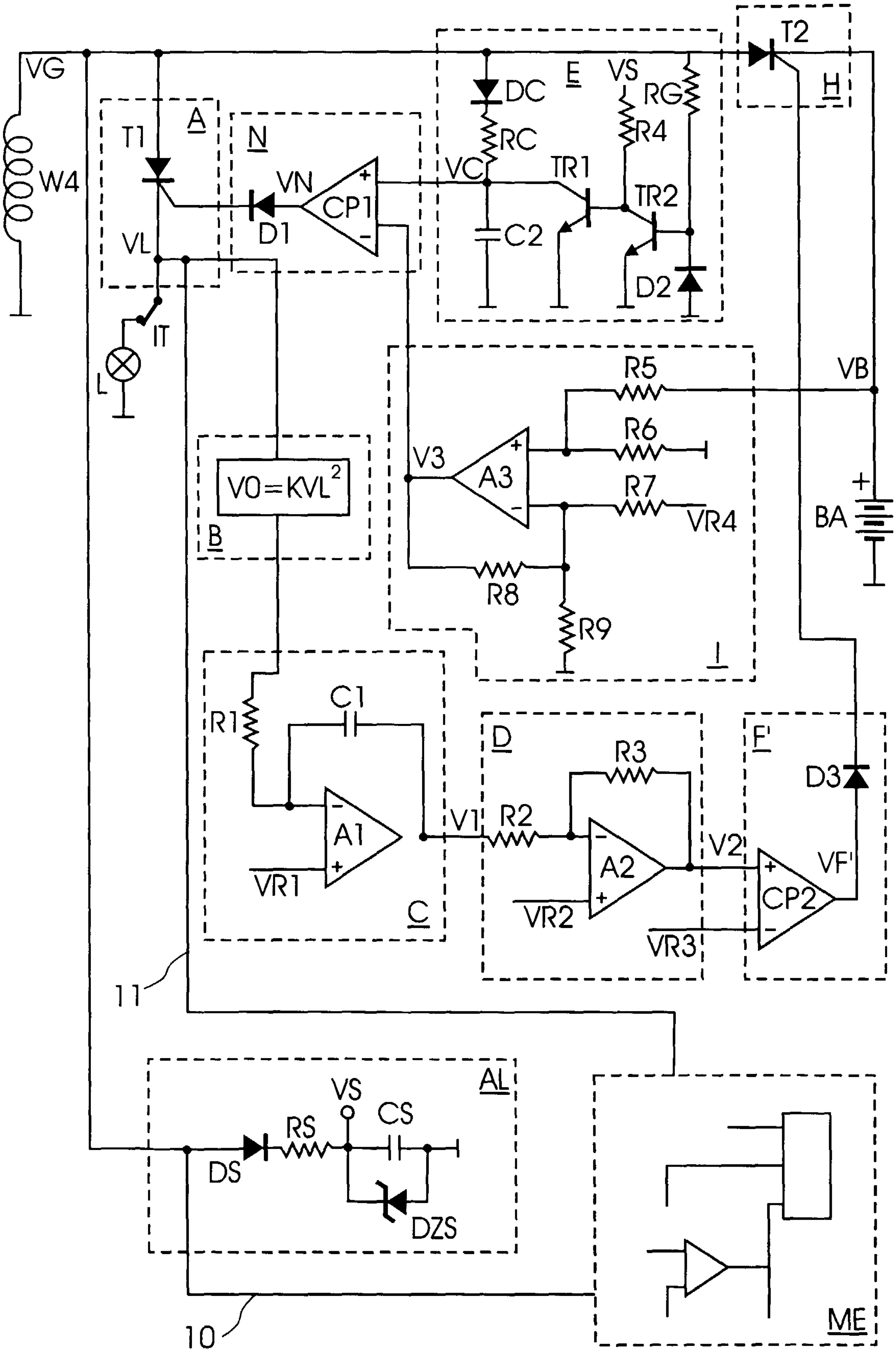
VS
I3
02
I1
MC
VG
VS
R32
R34
R33
SCR3
R20
CP3
VGS
R21
VS
R22
R24
R23
ME

Fig. 4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VN
CP1
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VL
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L
DC
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VS
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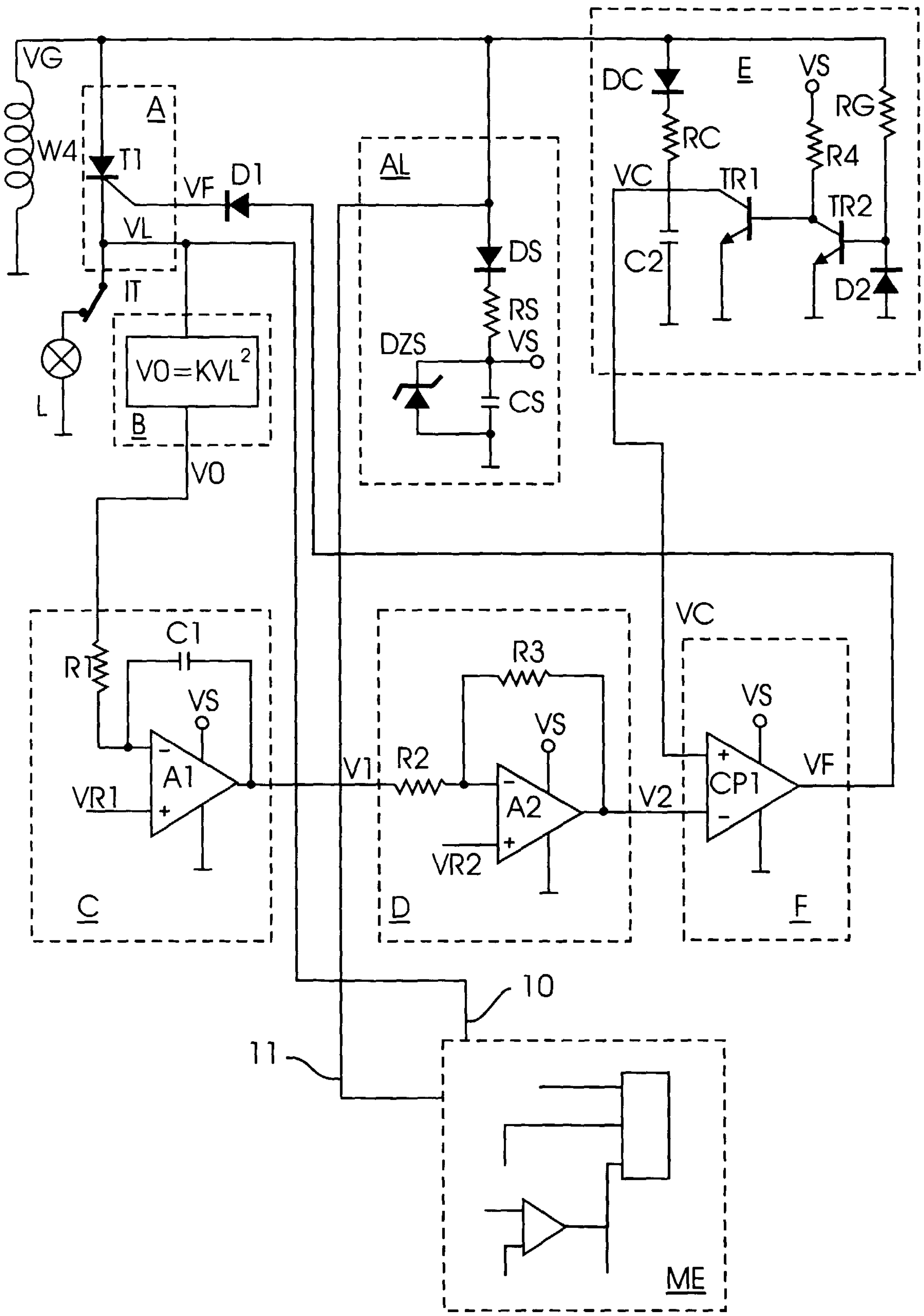
RC
R4
VC
TR1
TR2
C2
D2
T2
H
VB
R5
R6
R7
VR4
V3
A3
R8
R9
I
BA
VO=KVL²
B
R1
C1
A1
VR1
C
D
R3
R2
V1
A2
VR2
V2
VR3
F'
D3
VF'
CP2
11
AL
VS
CS
RS
DS
DZS
ME
10

Fig. 5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T1
VF
D1
VL
IT
L
VO=KVL²
B
VO
AL
DS
RS
VS
DZS
CS
DC
E
VS
RG
RC
R4
VC
TR1
TR2
C2
D2
VC
C1
R1
VS
A1
VR1
C
V1
R2
R3
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A2
VR2
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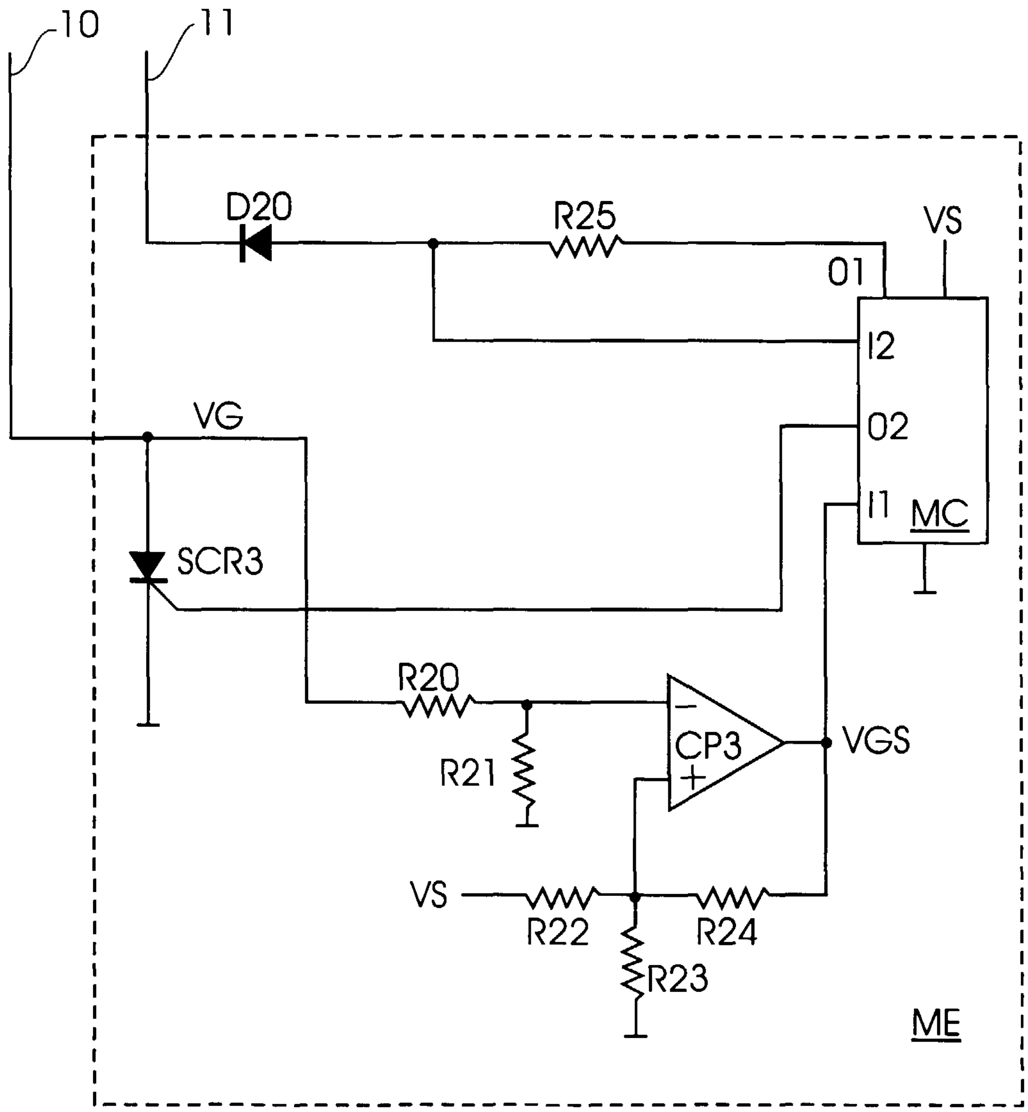
V2
VS
CP1
VF
F
10
11
ME

Fig. 6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D20
R25
VS
01
I2
VG
02
I1
MC
SCR3
R20
CP3
VGS
R21
VS
R22
R24
R23
ME

Fig. 7