

Fig. 1

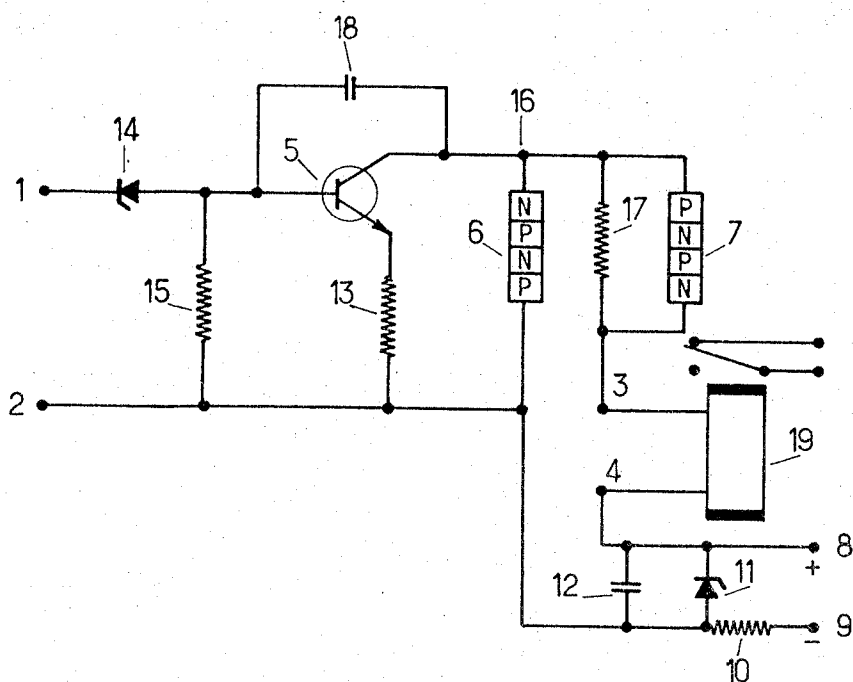
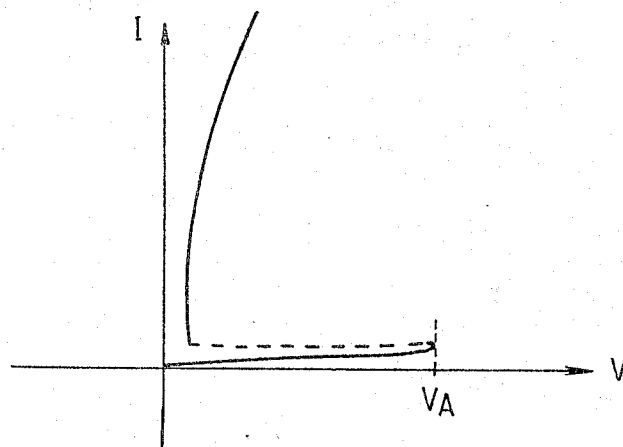


Fig. 2



1

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ELECTRONIC DEVICE FOR THE CONTROL OF RELAYS AND SIMILAR APPARATUS

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6 Claims. (Cl. 317-148.5)

The present invention relates to a device capable of operating, from a direct-current control voltage, an electromechanical apparatus such as an electromagnetic relay which in turn closes (or opens) an electrical contact connected with a working circuit. More precisely, the operation of said apparatus is controlled by the deviation of the value of said control voltage from that of a reference voltage, hereinafter designated as "the normal value." Such operation takes place as soon as said deviation exceeds a predetermined quantity, whatever be the direction, positive or negative, of said deviation. The device of the invention will now be designated, for short, as an "electronic relay control device."

An advantage of the device of the invention is its high sensitivity; i.e., it allows an electromagnetic relay which would normally require a comparatively high control power to be controlled by a very low power.

An electronic relay control device, such as it will be described in the following, may be used in so-called "source permutators," i.e. automatic switching apparatus, the function of which is automatically substituting for a momentarily defective electric power generator another one of similar characteristics but in working condition. The device of the invention can also operate an alarm system or any other electrical equipment capable of being actuated by the closing (or opening) of a contact in a relay. Generally speaking, it plays the part of a very sensitive or galvanometric relay, but its volume is smaller than the latter's and, moreover, it is much sturdier, since it involves no moving parts, pivots or the like.

According to the present invention, there is provided an electronic relay control device comprising a direct-current amplifier including a transistor in common-emitter connection, first and second direct-current supply terminals for biasing said transistor, input circuit means including first and second input terminals for applying a control voltage to the base-emitter circuit of said transistor, an electromagnetic relay having at least one winding and provided with a contact connected with a pair of output terminals for operating an external utilization circuit, connection means between said first input terminals and the base electrode of said transistor, a first resistor connecting said base electrode with a common point itself connected with said second input terminal and with said second direct-current supply terminal, a second resistor connecting the emitter of said transistor with said common point, a series circuit including said winding and a third resistor in series connection and linking said first direct-current supply terminal to the collector of said transistor, and first and second four-layer semiconductor diodes respectively connected across said third resistor and between said collector and common point.

In a variant of embodiment of the invention, a feedback capacitor is connected between the emitter and base electrodes of said transistor.

2

In another variant of embodiment of the invention, said connection means between said first input terminal and said base electrode include a series-connected Zener diode.

In any one of the said variants of embodiment of the invention, said direct-current supply terminals may advantageously be fed from a direct-current source through a further resistor; a further Zener diode is then connected across said direct-current supply terminals, in order to stabilize the voltage developed between the latter terminals.

Other particulars and advantages of the invention will be better understood from the hereinbelow given detailed description of an example of embodiment of the invention, made in connection with the appended drawings, in which:

FIG. 1 shows an example of embodiment of an electronic relay control circuit according to the invention; and

FIG. 2 shows a characteristic current-voltage curve of a four-layer diode (also known as avalanche diode) used in the circuit of the invention.

Referring now to FIG. 1, the electronic relay control circuit of the invention comprises a pair of input terminals 1 and 2, which are the terminals to which a control voltage from an external apparatus to be monitored is applied. This control voltage is supposed to be a direct-current voltage of such a polarity that terminal 1 be positive with respect to terminal 2. Transistor 5 is of the NPN type. Its collector is connected at point 16 and through resistor 17 and the winding of relay 19 (provided with terminals 3, 4) with the positive direct-current supply terminal 8 of a direct-current source connected between terminals 8 and 9, the latter being the negative terminal of said source. Terminal 8 thus constitutes the first direct-current supply terminal hereinabove referred to, while the common point 2, i.e. the second input terminal, is at the same time the above-mentioned common point and coincides with the second direct-current supply terminal. A resistor 10 connected between 2 and 9, together with a Zener diode 11 and a high capacity capacitor 12 connected across the direct-current supply terminals of the device, ensures voltage stabilization and filtering of the current from (8, 9), this within a 10 to 20 percent margin of variation of the voltage effectively applied between 8 and 9. Capacitor 12 filters out parasitic voltages, noise impulses, etc., originating in the direct-current supply source.

To ensure proper biasing of transistor 5, its emitter is connected through resistor 13 with the common point 2; the choice of the resistance value of 13 allows adjustment of the transistor gain and of the general sensitivity of the device. The base electrode of 5 is connected through resistor 15 with the common point 2. The input voltage (control voltage) received between 1 and 2 may be directly applied across 15, or else, as shown in FIG. 1, applied to 15 through a Zener diode 14, the usefulness of which will be explained later on. Relay 19 closes or opens a contact connected with two output terminals for an external utilization circuit, according to the intensity of the current flowing through its winding.

Relay 19 is assumed to have only a comparatively low resistance between terminals 3, 4 of its winding, this resistance being much lower than that of resistor 17.

3

Facultatively, a capacitor 18 may be inserted between the collector and base electrodes of 5, to minimize the effects of transient voltages applied between 1 and 2, thanks to the degenerative feedback it introduces for said transient voltages.

The originality of the device of the invention resides in the provision and method of connection of two four-layer semiconductor diodes 6 and 7, respectively connected across resistor 17 and between the collector of 5 and the common point 2.

The mode of operation of the device of FIG. 1 will now be explained in greater detail.

It will first be assumed that the control voltage applied between 1 and 2 has a "normal" value comprised between two prescribed limit values, a lower and an upper one. The corresponding control current into the base electrode of 5 causes the collector current to assume a normal intensity, for which the gain of the transistor is fairly high. The collector current develops a proportional voltage drop V across resistor 17. No current then flows through diodes 6 or 7, and relay 19 is in its rest position.

If the input voltage is increased, said voltage drop also increases, so long as it does not reach the value V_A corresponding to the initiation of the avalanche process in diode 7. When V reaches the value V_A , the voltage across 7 suddenly changes in the known manner illustrated by the curve of FIG. 2 (which shows the relationship between the current I in an avalanche diode and the voltage V across this diode) and suddenly drops to a new value much lower than V_A . The voltage across diode 6, which is equal to the supply voltage between terminals 4 and 2 less the voltage V across 7 (neglecting the voltage drop between 3 and 4 in the winding of relay 19), suddenly increases and reaches the avalanche value for said diode 6. This causes in turn the voltage across 6 to decrease and the voltage between 3 and 4 to increase. The energization current of relay 19 is suddenly increased and the relay passes to its work position and changes the condition of the contact associated therewith.

If, on the contrary, the input control voltage decreases, the collector current of 5 also decreases, and the collector potential with respect to the common point 2 increases. When this potential reaches the avalanche value for diode 6, the current in the latter is initiated, the voltage across diode 6 suddenly decreases and, consequently, the voltage between 16 and 4 increases, causing a corresponding increase in the voltage across diode 7. When the latter voltage reaches the avalanche value, the voltage across 7 suddenly decreases, causing a corresponding increase in the voltage across the relay winding, between terminals 3 and 4. Relay 19 thus operates in the same manner as in the former case.

In practice, to obtain the best performance of the device, the voltage across 17 is so adjusted that, in the normal condition of the input control voltage, its value be approximately half that of the supply voltage between 2 and 4. The resistance value of resistor 17 is so chosen that the normal "rest" current in the collector circuit of 5 be substantially equal to twice the current variation which is required for altering the voltage across 17, and consequently between points 2 and 16, to a sufficient extent to cause diodes 6 and 7 to pass to the avalanche condition. The avalanche voltage of the diodes should preferably be comprised between two-thirds and three-fourths of the supply voltage available between 2 and 4, to ensure that the voltage between the collector and emitter of transistor 5 remains high enough for giving the collector current (in the "rest" condition) a suitable intensity for the normal value of the control voltage. The just-mentioned dimensioning always allows the transistor to be operated in a condition remote enough from both cut-off and saturation of its collector current.

Capacitor 18 which in FIG. 1 is shown connected between the base and collector electrodes of the transistor, has for its purpose that of producing degenerative feed-

4

back for alternating and transient currents, to avoid untimely operation of the relay under the action of pulses or other disturbances of short duration appearing in the control circuit connected between terminals 1 and 2.

The usefulness of the Zener diode 14 shown in FIG. 1 in the input circuit of the device will now be explained. It may happen that the control voltage available at terminals 1, 2 be too high for operation of the transistor at a suitable working point. In this case, however, it is desirable to retain the full variation of the control voltage for the operation of the system without applying across 15 too high a permanent voltage. This is what is done by inserting the Zener diode 14 in the input circuit of transistor 5. The insertion of 14 reduces the permanent voltage developed across resistor 15 by a constant quantity equal to the Zener voltage (breakdown voltage) of said diode 14, without reducing in any manner the amplitude of the variations in the control voltage transmitted to 15. Thus, a suitable working point is obtained without reducing the sensitivity of the device, provided, of course, that the normal value of the control voltage exceeds that of the Zener voltage of diode 14.

It must be pointed out that, by selecting Zener diodes having the best possible performance from the viewpoints of Zener voltage constancy and minimum width of the transition region between the non-conducting and Zener discharge conditions, it has been found of practical interest to use diodes with Zener voltages in the vicinity of 7 volts. This value being not always compatible with the above-mentioned conditions, for instance if the available control voltage is too low, it is sometimes convenient to add to said control voltage a fixed direct-current voltage, which may be derived in any known manner from the supply voltage available between terminals 2 and 4, for instance by means of a voltage divider including resistors, Zener diodes or any combination of such elements.

Finally, it must also be remarked that the described system is a "self-monitoring" one, as it can easily be seen that a short-circuit in either of the four-layer diodes, in the transistor or in the input Zener diode, or a cut-off in anyone of the two latter, all result into the passing of the relay to its work condition and the operation of any warning device associated therewith.

We claim:

1. An electronic relay control device comprising a direct-current amplifier including a transistor in common-emitter connection, first and second direct-current supply terminals for biasing said transistor, input circuit means including first and second input terminals for applying a control voltage to the base-emitter circuit of said transistor, an electromagnetic relay having at least one winding and provided with a contact connected with a pair of output terminals for operating an external utilization circuit, connection means between said first input terminal and the base electrode of said transistor, a first resistor connecting said base electrode with a common point itself connected with said second input terminal and with said second direct-current supply terminal, a second resistor connecting the emitter of said transistor with said common point, a series circuit including said winding and a third resistor in series connection and linking said first direct-current supply terminal to the collector of said transistor, and first and second four-layer semiconductor diodes respectively connected across said third resistor and between said collector and common point.

2. An electronic relay control device as claimed in claim 1, in which said input circuit means include a Zener diode in series connection in the emitter-base circuit of said transistor.

3. An electronic relay control device as claimed in claim 2, in which said Zener diode is connected between one of said input terminals and the base electrode of said transistor.

4. An electronic relay control device as claimed in claim

5

1, in which a feedback capacitor is connected between the base and collector electrodes of said transistor.

5. An electronic relay control device as claimed in claim 1, in which said direct-current supply terminals are supplied from a direct-current source through a further resistor, and in which a further Zener diode is connected across said supply terminals. 5

6. An electronic relay control device as claimed in claim 5, in which a high-capacity capacitor is connected across said supply terminals.

6

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