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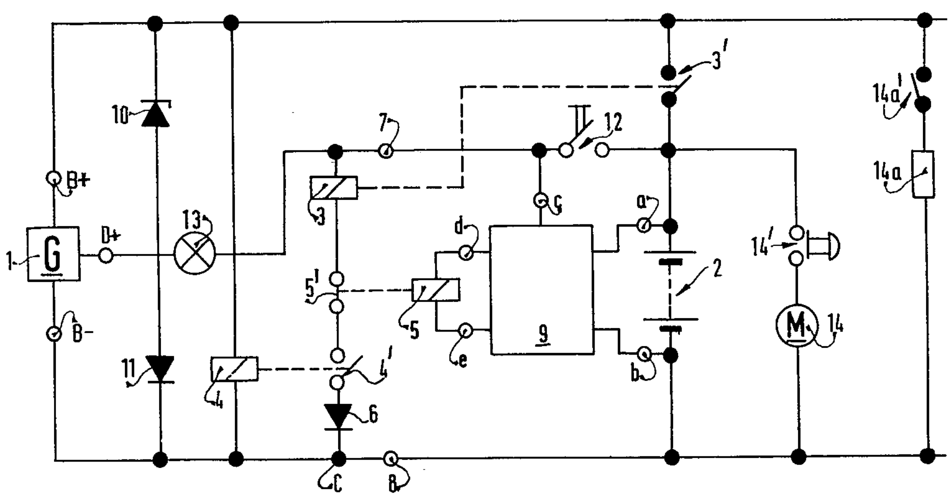
(54) Arrangement for protection against damage due to connection of a battery with incorrect polarity

(57) An arrangement for protecting a generator and/or the load against damage due to incorrect battery polarity includes an electronic sensor *g* whose output controls a switching path 5'. One of the battery connection terminals a is coupled to the generator terminal (B+) by way of a switching path 3' controlled by a further relay 3 in series with the switching path 5' and a further switching path 4' controlled by a solenoid 4 connected across the generator terminals. The switching path 5' is opened when the battery is disconnected or is connected with the incorrect polarity and the switching path 4' is opened when the generator is not operating, whereby the switching path 3' is opened to isolate the battery from the generator and from the load whenever any one or more of the latter three conditions is present. The sensor is described in detail. The invention is applied in a motor vehicle electrical supply system.

FIG 1



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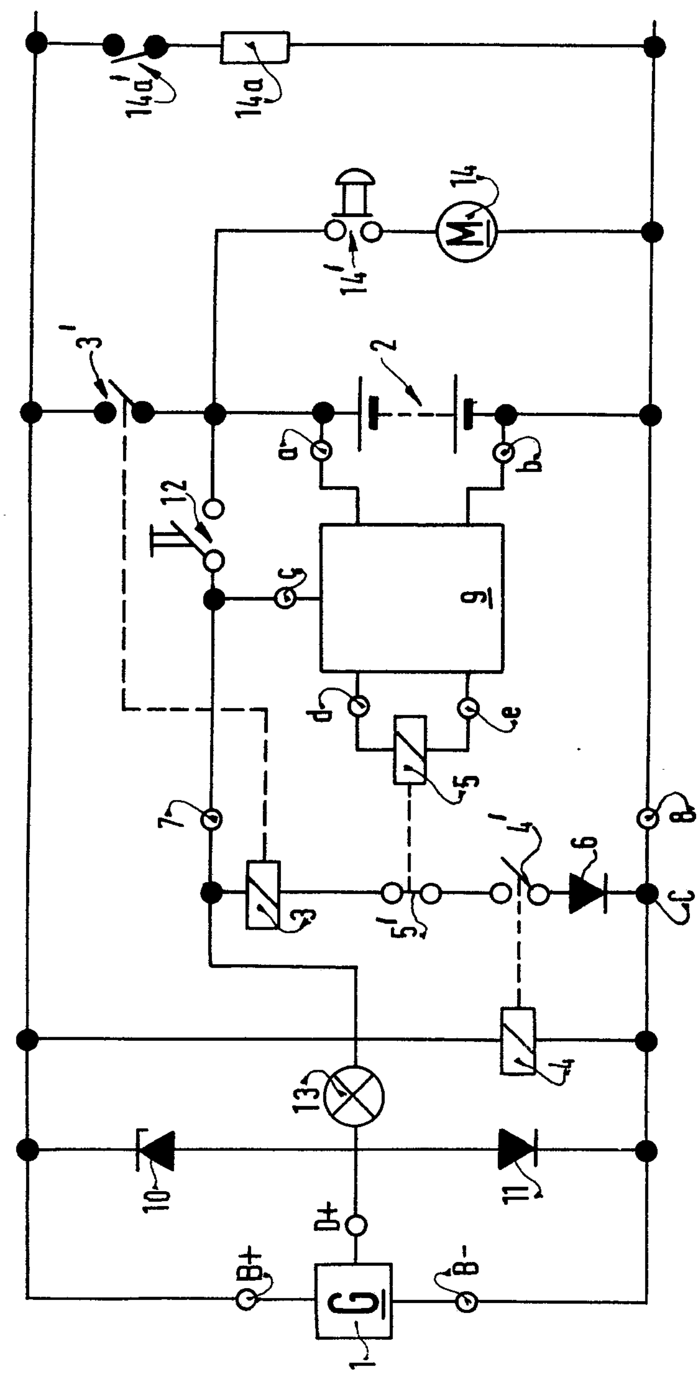


FIG 1

2/3.

FIG 2

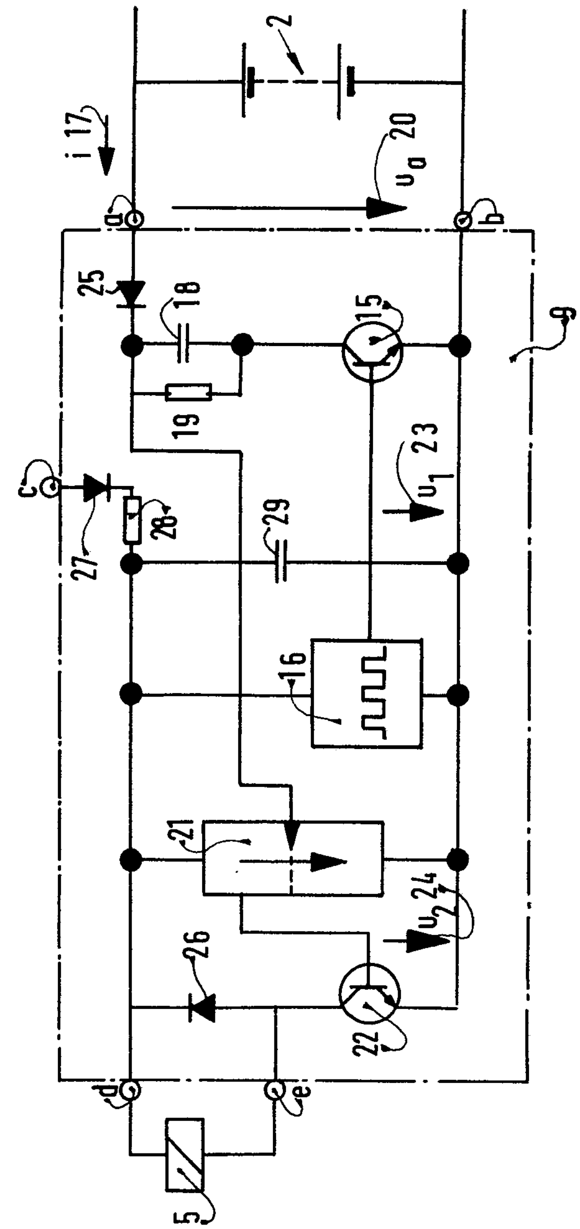
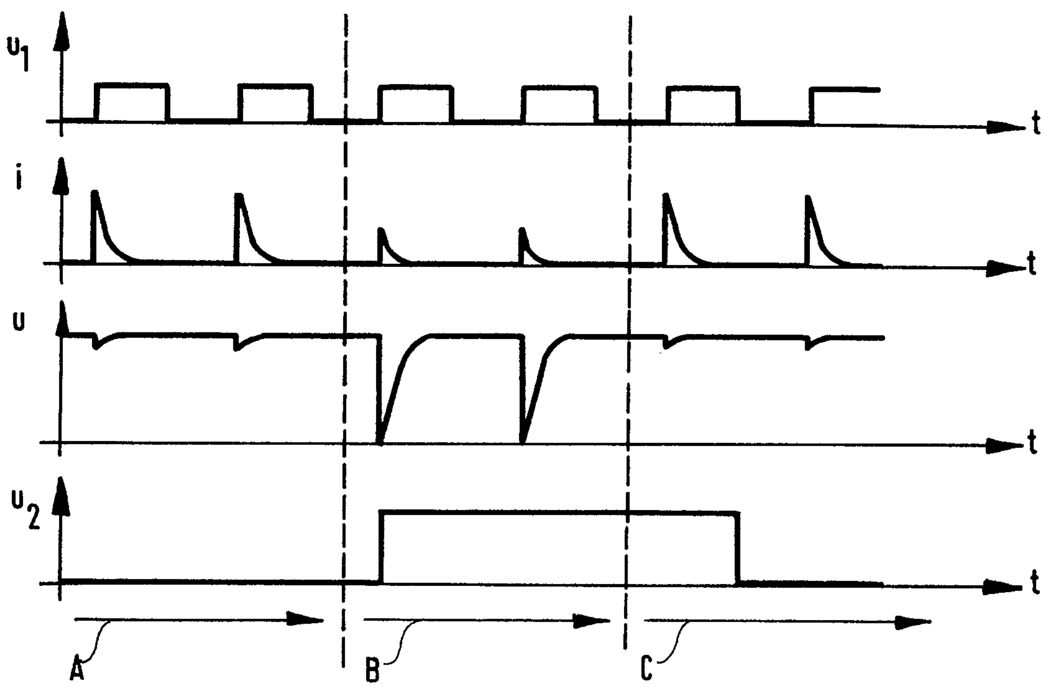


FIG 3



SPECIFICATION

Arrangement for protection against damage due to connection of a battery with incorrect polarity

The present invention relates to generator systems of the type which employ an electrical generator and a chargeable battery and is particularly concerned with arrangements for protecting such systems against connection of the battery with incorrect polarity.

Known arrangements for protecting generator systems against incorrect connection of the battery use a quick-break switch which reacts to the short-circuit current and isolates the battery when the battery is connected with incorrect polarity. The battery must be isolated very rapidly in order to keep within admissible limits the product of the short-circuit current and the time during which this current flows. At least the rectifier of the generator would otherwise be destroyed. The requirement of rapidity is difficult to fulfil with the bimetal switches which are generally used to isolate the battery. Furthermore, with the known switches, there is the risk that the contacts of the switch might become welded together if the incorrect connection of the battery is repeated, so that thereafter there is no longer any protective action.

In accordance with the present invention, there is provided an arrangement for protecting an electrical current generating system and/or loads against damage as a result of connecting a battery with incorrect polarity, which arrangement has a sensor for detecting such incorrect polarity connection which includes semiconductor elements and whose input terminals are connected to connection terminals for the battery, the sensor being operatively coupled to a switching means which enables one of the battery connection terminals to be selectably connected to an associated terminal of the generator system.

The aforegoing arrangement has the advantage that the sensor for detecting incorrect polarity detects electronically, and not thermally, whether a battery is correctly connected to the generator system or whether a battery is or is not connected thereto. Thus, this arrangement provides a protection against connection with incorrect polarity in which no battery short-circuit currents have to be switched. The maximum current to be switched off by this arrangement is only equal to the maximum output current of the generator.

The invention is described further hereinafter, by way of example, with reference to the accompanying drawings, in which:—

Figure 1 shows, diagrammatically, a motor vehicle power supply having a device, in accordance with the invention, for protection against connection with incorrect polarity;

Figure 2 is a block circuit diagram of the battery sensor; and

Figure 3 is a graph showing the voltage and current characteristics in the battery sensor.

The invention will be described in conjunction with the power supply of a motor vehicle. It will be appreciated that the invention can be used for other applications which include a generator system, electrical loads and a battery. The following cases of error are typical in battery-charging systems in motor vehicles;

(a) The vehicle engine is not running, and a battery is not installed. An external battery is then connected with incorrect polarity.

(b) The vehicle engine is not running, and a sulfated battery or a discharged battery is in the vehicle. An external battery is then connected with incorrect polarity.

(c) A vehicle is stationary with the engine running, but without the battery. The vehicle battery is then connected with incorrect polarity.

It is particularly in these cases that an arrangement in accordance with the invention is intended to protect the generator system and the electrical loads within the vehicle against damage caused by connecting the battery with incorrect polarity.

In the diagrammatic illustration of a power supply shown in Figure 1, having an arrangement in accordance with the invention for protection against connection with incorrect polarity, a generator is designated by the reference numeral 1 and may be, for example, a three-phase generator having a rectifier connected to the output thereof, and having a voltage regulator. The generator 1 is connected to the vehicle battery 2 by way of a positive lead B+ and a negative lead B−. The battery 2 can be isolated from the positive lead B+ by means of a switch 3′ which is controllable by a relay 3. The solenoid of a first auxiliary relay 4 is connected across the leads B+ and B− in parallel with the generator 1. A lead incorporating a control switch 12 and a pilot lamp 13 is connected in a conventional manner between the positive pole of the battery 2 and a terminal D+ which is connected to the excitation system of the generator 1. A junction 7 is provided between the control switch 12 and the charging pilot lamp 13. A series combination comprising the solenoid 3 associated with the switch 3′, a switching path 5′ controllable by a second auxiliary relay 5, a switching path 45′ controllable by the first auxiliary relay 4, and a diode 6 whose cathode is connected to B−, is connected between the junction 7 and a junction 8 in the negative lead B−. The input terminal *a* of a battery sensor 9 is connected to the positive pole, and the input terminal *b* of the battery sensor is connected to the negative pole of the battery 2. The solenoid of the second auxiliary relay 5 is connected to the output terminals *d* and *e* of the sensor 9. A power supply terminal *c* of the sensor 9 is connected to the junction 7. For protection against the occurrence of an over-voltage when the battery 2 is absent, a series combination comprising a reverse biassed Zener diode 10 and a forward biassed diode 11 is connected between the positive lead B+ and the negative lead B− in parallel with the output of the generator 1. Finally, a starter 14 having an associated push button 14′, and a load 14a having an associated switch 14a′, are shown in Figure 1. Due to the necessarily large cross-section of the lead, the starter 14 is connected directly to the battery 2, and the load 14a is connected to the positive lead B+ and the negative leans B−.

The first auxiliary relay 4 is pulled up when the generator 1 has been energized. The diode 6 can only carry current when the junction 7 carries a voltage which is more positive than that carried by the junction 8, and when the switching paths 4′ and 5′ are conductive. The solenoid 3 of the switch 3′ is energized when the first auxiliary relay 4 has been pulled up and the second auxiliary relay 5 has been released, that is to say, the switching path 5′ is conductive and the diode 6 is conductive. Furthermore, it will be appreciated that the control switch 12 has to be closed. In order that the switching path 3′ can be closed, and thus the voltage of the battery 2 can be applied to the power supply, the generator must be energized, the second auxiliary relay 5 must have been released, and the junction 7 must have a more positive voltage than that of the junction 8. The auxiliary relay 5 is pulled up when the battery 2 is incorrectly connected to the power supply or is not connected thereto. This will be explained with reference to Figure 2.

In the block circuit diagram of the battery sensor of Figure 2, the input of a switching transistor 15 is controlled by the output of a square-wave generator 16. A capacitor 18 is connected in parallel with a collector resistor 19 in the collector circuit of the switching transistor 15. A diode 25 is connected between the input terminal *a* and the parallel combination comprising the resistor 19 and the capacitor 18, the anode of the diode 25 being connected to the terminal *a*. The cathode of the diode 25 is connected by way of a lead to the input of a monostable trigger stage 21. Advantageously, the output of the monostable trigger stage 21 is connected to the output terminal *e* of the sensor 9 by way of an output transistor 22. Power supply leads are connected between the power supply terminal *c* and the square wave generator 16, the monostable trigger stage 21, and the output terminal *d* of the sensor 9 by way of a decoupling diode 27 and a filter circuit comprising a resistor 28 and the capacitor 29. A free-running diode 26 is connected in parallel with the output terminals *e* and *d*.

When a battery 2 is connected to the terminals *a* and *b* of the sensor 9 with correct polarity, the square-wave generator 16 provides an oscillating output and thus switches the switching transistor 15 on and off periodically. Consequently, a pulse-like current 17 flows from the power supply and the terminal *a* by way of the capacitor 18. The resistor 19 ensures that the capacitor is completely discharged during the non-conductive phase of the switching transistor 15. When the battery 2 is isolated from the power supply, the voltage u_a (20) between the terminals *a* and *b* breaks down for a short period of time at the commencement of the conductive phase of the transistor 15 to the value of the saturation voltage of the transistor 15. When the battery 2 is connected, the voltage u_a (20) remains largely constant during the conductive phase of the transistor 15. The voltage surges which appear at the terminal *a* when there is no battery 2 in the power supply, control the triggerable monostable trigger stage 21. The duration of the unstable switching phase is set so as to be approximately 50% longer than the period of the square-wave generator 16. If the voltage surges are produced at the terminal *a* due to the fact that there is no battery, the monostable trigger stage 21 is thus permanently in its unstable state. If the monostable trigger stage remains in its unstable state, the output transistor 22 becomes conductive and the coil of the second auxiliary relay 5 is energized. The switching path 5′ thus becomes non-conductive and thus the coil is de-energized, and the switching path 3′ becomes non-conductive.

Figure 3 shows the time characteristics of the output voltage u_1 (23) of the square-wave generator 16, the current *i* (17), the voltage u_a (20) and the output voltage u_2 (24) of the monostable trigger stage 21, with and without a battery 2 in the power supply. A battery 2 is connected during the period A, disconnected during the period B, and connected again during the period C.

Thus, the mode of operation of the aforegoing arrangement in accordance with the invention in the event of the three faults described above can be summarised as follows:

The diode 6 becomes non-conductive and the switch 3′ remains non-conductive when an external battery is connected with incorrect polarity.

The engine fails to start with its own battery 2. The first auxiliary relay 4 is not pulled up, and thus the switch 3′ also remains non-conductive.

If the battery 2 is disconnected whilst the engine is running, the second relay 5 is pulled up by way of the sensor 9. The coil 3 is de-energized and the switching path 3′ becomes non-conductive. In the event of a battery 2 being then connected with incorrect polarity, the diode 6 becomes non-conductive, and the switching path 3′ remains non-conductive.

Auxiliary relays 3, 3′, 4, 4′, 5, 5′ are used in the embodiment. It will be appreciated that each of these relays can be replaced by controllable semiconductor elements.

CLAIMS

1. An arrangement for protecting an electrical current generating system and/or loads against damage as a result of connecting a battery with incorrect polarity, which arrangement has a sensor for detecting such incorrect polarity connection which includes semiconductor elements and whose input terminals are connected to connection terminals for the battery the sensor being operatively coupled to a switching means which enables one of the battery connection terminals to be selectably connected to an associated terminal of the generator system.

2. An arrangement as claimed in claim 1, for a vehicle having a control switch, in which the solenoid of a first auxiliary relay having a first switching path is connected in parallel with the output terminals of the generator system and in which there are connected in parallel with the connection terminals for the battery a series combination comprising said control switch, a solenoid controlling said switching means, a second switching path controllable by the solenoid of a second auxiliary relay which is connected to the output of the sensor, said first switching path of the first auxiliary relay and a diode which

is forward biassed when the battery is connected with correct polarity.

3. An arrangement as claimed in claim 1 or 2, in which one power supply terminal of the sensor is connected to the junction between the control switch and the solenoid of said switching means.

4. An arrangement as claimed in any of the preceding claims, in which the sensor includes a switching transistor, a square-wave generator and a monostable trigger stage, and in which power supply terminals of the monostable trigger stage and of the square-wave generator are coupled to that power supply terminal of the sensor which is not connected to earth, the input of the switching transistor being connected to the output of the square-wave generator, the output of the switching transistor and that input terminal of the sensor which is not connected to earth being coupled to the input of the monostable trigger stage, and the output of the monostable trigger stage being coupled to output terminals of the sensor.

5. An arrangement as claimed in claim 4, in which the duration of the unstable switching phase of the monostable trigger stage is set so as to be approximately 50% longer then the period of the square-wave generator.

6. An arrangement as claimed in any of the preceding claims, in which at least one of the switching paths is controlled by a respective controllable semiconductor element.

7. An arrangement for protecting an electrical current generating system and/or loads against damage, substantially as hereinbefore described with reference to the accompanying drawings.

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