

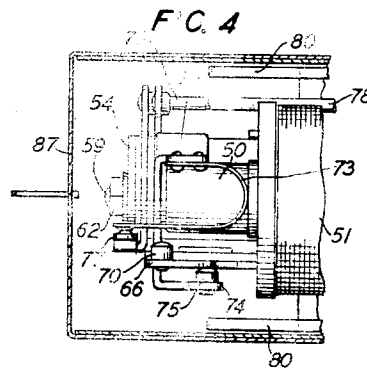
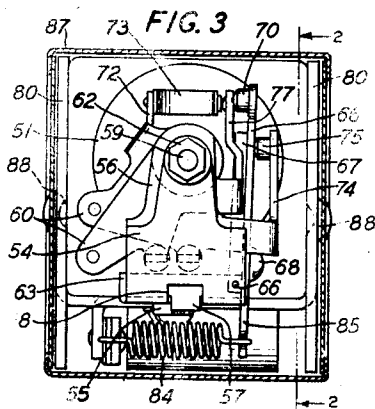
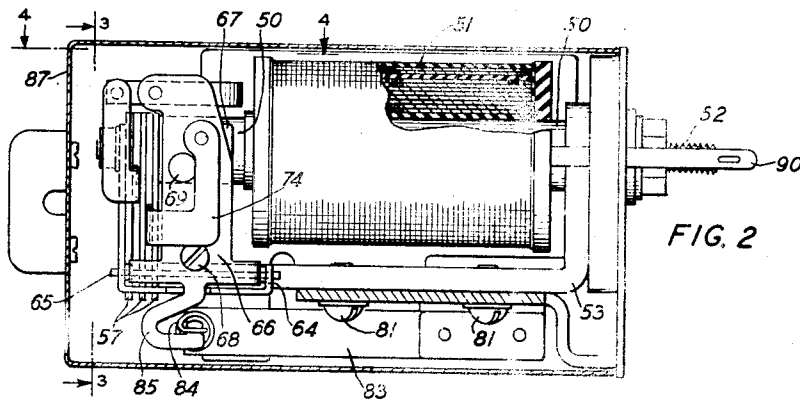
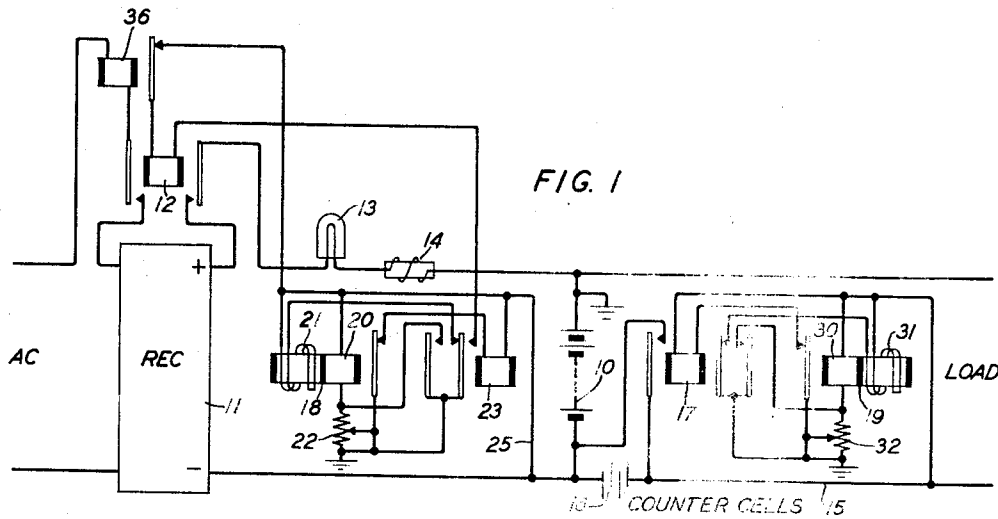
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ELECTROMAGNETIC SWITCHING DEVICE

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INVENTORS: P. E. BUCH  
C. S. KNOWLTON

BY *H. J. Kugler*

ATTORNEY

## UNITED STATES PATENT OFFICE

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## ELECTROMAGNETIC SWITCHING DEVICE

Peter E. Buch, Passaic, and Clarence S. Knowlton, Springfield, N. J., assignors to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

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This invention relates to electromagnetic switching devices and particularly to an electromagnetic relay of the type used for switching or regulating purposes which, when operated, functions to include a resistance in series with its operating winding.

In battery charging and voltage control systems as employed in power plants today it is common practice to provide a relay which functions at a particular voltage to effect the discontinuance of a charging current to a power supplying battery or to cut in counter cells in the battery discharge circuit. Such relays are called upon not only to operate at a particular value of voltage but also to release when the voltage reaches a predetermined lower value. To accurately regulate the voltage at which such a relay will release, an adjustable resistance is provided and is connected in series with the operating winding of the relay when the relay operates. Such relays are also compensated for temperature variations. Such compensation may be effected by means of a bimetal strip which responds to temperature variations to regulate the armature tension or to adjust the armature air-gap, thereby necessitating a greater or lesser voltage to operate the relay depending upon whether the armature tension or the air-gap has been increased or decreased.

Relays of this type are constantly connected across a battery or similar circuit, the voltage of which determines the operation or release of the relay. Prior to its operation, the operating winding of the relay is connected across the battery terminals and a certain amount of power is dissipated in the relay and manifests itself as heat. When the relay operates, the resistance is connected in series with the operating winding so that the power dissipated as heat in the relay is considerably reduced under this condition. This difference in dissipated power causes a corresponding change in the resistance of the operating winding as well as a differential between the temperature of the air inside the relay structure and the ambient temperature and, therefore, produces a shifting of the operate and release voltages at which the relay functions.

It is the object of this invention to compensate for any decrease in power dissipated in a regulating relay when energized by way of its operating winding only and subsequently by way of its operating winding and a series resistance.

This object is attained in accordance with a feature of the invention by providing means which functions to dissipate additional power

in the relay when it operates to connect a resistance in series with its operating winding. More specifically, this object is attained by including in the relay structure a non-inductive winding and connecting it to the same source of power to which the relay is connected when the latter operates to include a resistance in its circuit.

A further feature of the invention resides in embodying such a compensating winding in a relay whose armature tension or air-gap varies with variations in ambient temperature.

The invention will be readily understood from the following detailed description made with reference to the accompanying drawing in which:

Fig. 1 is a schematic circuit diagram of a battery charging system to which the relay of the present invention is particularly adaptable;

Fig. 2 is a side view of the relay embodying the features of the invention, with the relay winding structure partially exposed;

Fig. 3 is a front view of the relay shown in Fig. 2 taken along the line 3—3 of Fig. 2 and looking in the direction of the arrows; and

Fig. 4 is a fragmentary view of the front end of the relay taken along the line 4—4 of Fig. 2 and looking in the direction of the arrows.

It is believed that the invention will be best comprehended by resorting first to a description of the circuit shown in Fig. 1. In this figure a storage battery 10 is employed to supply a load indicated at the right of the figure and is adapted to be charged from an alternating current source through the medium of a rectifier 11. The rectifier may be of any well-known type.

The input and output leads of rectifier 11 are shown open at the left and right armatures respectively of relay 12. The charging lead to the battery 10 includes a ballast resistance lamp 13 and usual impedance coil 14. In the ungrounded discharge lead 15 a plurality of counter-electromotive force cells 16 are included which function in a well-known manner to reduce the voltage across the load and may be excluded from the discharge lead 15 by the operation of relay 17, as will appear more fully later.

The relay of the present invention is schematically represented at 18 on the charge side of the battery 10 and at 19 on the load side of the battery. The relay 18 as illustrated, is provided with an operating winding 20 and a non-inductive winding 21, each of which is shown connected across the battery 10, the former or operating winding 20 by way of an adjustable resistance 22, and the latter or winding 21 by

way of the back contact and inner armature of relay 23.

On the load side of the battery 10, relay 17 corresponds to relay 23 and relay 19 to relay 18, and their connections across the battery terminals are the same as just described in connection with relays 23 and 18. Relay 17 at its left armature functions, as hereinbefore mentioned, to control the connection of the counter cells 16 in the discharge lead 15.

In the following description of the operation of the circuit shown in Fig. 1 it will be assumed that the battery 10 is fully charged. Under this condition relay 18 will operate in a circuit extending from grounded battery 10, conductor 25, operating winding 20 of relay 18, adjustable resistance 22 to ground. Relay 18, operated, attracts its armature, thereby opening the operating circuit for relay 23, which relay, if operated, would release its armatures. At its inner armature relay 23 opens the circuit to relay 12, which relay restores its armatures, thereby opening the charging circuit to the battery 10 and also the alternating current lead to the rectifier 11. Charging of the battery would therefore cease when the battery 10 reaches a fully charged condition, at which time relay 18 operates, as just mentioned. Instead of completely interrupting the charging of the battery when relay 18 operates, the circuit may be designed to merely reduce the charging rate in accordance with the well-known two-rate charging method.

The circuit conditions which now prevail with relay 20 operated are the following: The operating winding 20 and resistance 22 are connected in series across the battery 10 and the non-inductive winding 21 of relay 18 is also connected across the battery by way of the back contact and inner armature of relay 23. The purpose of resistance 22, as hereinbefore stated in a general way, is to insure the release of relay 18 at some predetermined value of battery voltage lower than the value of voltage at which relay 18 operates. With the resistance 22 in series with the operating winding 20 of relay 18, the heat dissipated in the relay is only a fraction of that dissipated in the relay when the operating winding alone is connected across the battery as will be the case when relay 23 is operated, as will appear presently. Obviously, therefore, this drop in power dissipated in the relay affects the resistance of the relay winding to such an extent as to cause a shifting of the operate and release values of voltage from their original values depending on the length of time that the relay has been in either the operate or release condition. The relay 18 would not, therefore, function at the required or same voltage levels at all times.

To compensate for this drop in wattage dissipated in the relay, the winding 21 is, as already described, connected across the battery 10 in parallel with the operating winding 20 and resistance 22. This winding dissipates enough additional power in the relay to compensate for that lost when the resistance 22 is connected in series with the operating winding 20 so that the total power dissipated as heat in the relay will be substantially the same regardless of whether the relay operating winding 20 is connected across the battery by itself or in series with resistance 22.

It will now be assumed that the battery voltage falls to that value at which the resistance 22 is set to permit the release of relay 18. Relay 18 would thereupon release its armature, thus connecting the winding of relay 23 across battery 10.

Relay 23 in attracting its inner armature opens the circuit to the non-inductive winding 21 of relay 18 and closes the circuit to the winding of relay 12, which relay operates to close the alternating current and direct current leads of rectifier 11 so that the battery 10 will start to charge. At its outer armature relay 23 short-circuits resistance 22 so that the operating winding only of relay 18 is connected across the battery prepared to cause the operation of relay 18 when the battery voltage again reaches full charge.

It will be observed that when relay 18 is released its operating winding 20 only is connected across battery 10, the non-inductive winding 21 is open and resistance 22 is short-circuited, whereas when relay 18 is operated its operating winding 20 is connected in series with resistance 22 across the battery 10 and the non-inductive winding 21 is connected directly across the battery.

Relays 17 and 19 on the load side of the battery function in a manner similar to relays 18 and 23 on the rectifier side of the battery and serve to connect or disconnect the counter cells 16 in the discharge lead 15 as the load voltage increases or decreases. As illustrated in the drawing the non-inductive winding 31 is shown connected directly across the load by way of the inner right armature and back contact of relay 17; the operating winding 30 is shown connected across the load in series with adjustable resistance 32 whereas the winding of relay 17 is connected across the load by way of the back contact and armature of relay 19. Assuming the load voltage to be such as to hold relay 30 operated, the relay 17 would be unoperated owing to the fact that its circuit is open at the back contact and armature of relay 19, the non-inductive winding 31 would be connected across the battery and the resistance 32 would be effectively connected in series with the operating winding 30 of relay 19. Under this condition the countercells 16 are effectively included in the discharge lead 15. Now, should the load voltage fall below that value at which relay 19 is held operated, relay 19 would restore its armature to connect the winding of relay 17 across the load. Relay 17 thereupon operates and at its inner and outer right armatures, respectively, opens the non-inductive winding 31 and short-circuits the resistance 32. At its left armature relay 17 short-circuits the countercells 16 thereby effectively removing them from the discharge lead 15. The load voltage would accordingly be raised by the amount previously applied across the countercells and due to load or battery voltage changes would again reach a value which would cause relay 19 to operate by way of its operating winding 30, and in so doing would cause relay 17 to release and restore its armatures. The resistance 32 is therefore reconnected effectively in series with the operating winding 30 of relay 19, the non-inductive winding 31 is connected across the load and the short circuit is removed from the countercells 16.

The function of the winding 31 is identical to that of winding 21 of relay 18 and need not be repeated.

Relay 36 which is shown connected in the alternating current supply lead to rectifier 11 serves to protect the rectifier from flashover. When the rectifier is operating normally, the relay 36, though connected in the alternating current supply lead, does not operate. However, in the event of a flashover in the rectifier an abnormal current is drawn from the alternating current supply with

the result that relay 36 operates to open the circuit to relay 12, which functions to open the alternating current supply lead to the rectifier as well as the direct current lead from the rectifier to the battery. The rectifier is accordingly protected against damage. When the condition subsides or is corrected relay 36 restores its armature to reestablish normal circuit conditions.

Relays 18 and 19, one form of which is disclosed in detail in Figs. 2, 3 and 4, are equipped with a bimetal strip which functions to vary the armature tension in accordance with variations in ambient temperature. This detail has been omitted from Fig. 1 in order not to complicate the showing but is clearly illustrated in Figs. 2, 3 and 4, which will now be referred to in the following description of the relay structure.

The relay consists essentially of a core 50 upon which is fitted a spool 51 comprising the windings 20 and 21 of relay 18 or windings 30 and 31 of relay 19 (Fig. 1). At its front end the core 50 is slightly smaller in diameter than the main body portion thereof and projects from the front end of the spool by an appreciable amount. Extending from the rear end of the core 50 is a screw bolt 52 over which the shorter portion of an L-shaped yoke 53 is slipped and forced up tightly against the rear end of the core 50 by means of a nut (not seen) which is made up on the screw bolt 52. The longer portion of yoke 53 extends towards the front of the structure parallel to the core 50 below the spool 51 (Fig. 2) and is substantially of the same length as the core.

Mounted on the front end of the core 50 is an L-shaped bracket 54, having one end thereof secured to the underside of the core by means of a screw 55. This bracket extends forwardly from the core end a sufficient distance to accommodate three insulators 56, each of which is provided with a projection 57 which protrude through an aperture or slot 58 in the bracket 54. The front end of the core 50 is provided with a projecting screw bolt 59 which serves to mount and secure the three insulators 56 and their interposed contact elements 60. The contact elements 60 and their associated insulators 56 are provided with apertures by virtue of which they are slipped onto the screw bolt 59. When these contact elements and insulators are fed onto the screw bolt 59 the L-shaped bracket 54 is likewise slipped over the bolt 59 with the insulator projections 57 confined within the slot 58 and a nut 62 is then screwed up on the bolt 59 to rigidly fix the spring pile-up, consisting of insulators 56 and contact elements 60, and the bracket 54 in position. The bracket 54 is provided with an upturned ear-like projection 63 which embraces one side of the yoke 53 and cooperates with a similar projection 64 on its other side in holding the bracket against rotation.

A small pin 65 has one end housed in an aperture 66 in the bracket 64 and its other end protruding through a similar aperture in the bracket extension 64. The two apertures mentioned above serve as bearings for the pin. The major portion of the pin 65 is sandwiched between a non-magnetic element 66 and a magnetizable armature 67, said non-magnetic element 66 and armature 67 being made substantially integral by means of a screw 68 and a rivet 69. The armature 67 extends upwardly to a position opposite the front end of core 50 while the non-magnetic element 66 extends further and at its upper end accommodates an insulating stud 70.

The magnetic circuit of the relay thus far described may be traced from the rear end of the core 50, through the L-shaped yoke 53, across to the hinged or pivoted end of armature 67, the armature air-gap to the front end of the core 50 and thence through the core to the rear end.

The innermost contact element 60 is spider-like in construction, being provided near its point of attachment to the core with projection 72 (Fig. 4) to which is secured by means of rivets 10 one end of a J-shaped sheet spring 73. Diagonally opposite to the projection 72, the innermost contact element 60 is provided with a substantially L-shaped projection 74 which at its upper end supports an insulating stud 75 which 15 serves as an armature back-stop. The outer contact element 60 is also provided with a projection 77 which extends upwardly and at its upper end carries a contact which cooperates with a corresponding or complementary contact secured to the free end of the J-shaped spring 73. Wire springs 78 and 19 are made fast to the contact elements 60 and extend rearwardly to the back of the structure and are provided with tab-ends to which conductors may be secured. 25

A cover supporting bracket 80, substantially U-shaped in cross-section, is secured to the yoke 53 by means of screws 81 and extends substantially the whole length of the core 50. A depending portion or projection 82 of the cover support has riveted thereto a bimetal strip 83 which extends towards the front end of the structure. The non-magnetic element 66 is provided at its lower end with a hook-like projection 85 to which one end of a coil spring 84 is hooked, 35 the other end being hooked through an aperture in the free end of the bimetal strip 83. As the ambient temperature varies, the bimetal spring 83 flexes to correspondingly vary the tension on the spring 84, thereby varying the tension on the armature 67 which is rigidly secured to the non-magnetic element 66. 40

A cover 87 is adapted to be slid over the cover supporting bracket and is held securely in position by means of bosses 88 in the bracket which 45 recess in corresponding depressions on the inside of the cover. The cover supporting bracket 80 also serves to shield the relay from neighboring equipment.

The spool structure, as understood from the 50 description of Fig. 1, comprises two windings 20 and 21. In assembling or constructing the spool first a relatively heavy layer of insulation is wrapped upon the core 50; over this insulation is wound the inductive winding 20 over which is 55 wrapped a thin layer of insulation; over the second layer of insulation is wound the non-inductive winding 21 over which a layer of insulation is placed to keep the heat in; and finally, the spool covering of insulation is applied. This 60 construction is clearly shown in Fig. 2. Extending from the rear of the relay structure are four wire terminals, two furnishing means whereby connections are made to the inductive winding and two providing means whereby connections are made to the inductive winding. But one of these terminals 90 is shown in the drawing.

What is claimed is:

1. In combination, a relay having an energizing circuit comprising a magnetizing coil, a second energizing circuit for said relay comprising said magnetizing coil and a series connected resistance, means compensating for the difference in power dissipated in said magnetizing coil 75

when energized alone and in series with said resistance, said means comprising a power dissipating device associated with said relay and electromagnetic means effective upon the operation of said relay for completing said second energizing circuit and connecting said heat dissipating device in parallel therewith.

2. In combination, a relay having an energizing circuit comprising a magnetizing coil, a second energizing circuit for said relay comprising said magnetizing coil and a series connected resistance, means compensating for the difference in power dissipated in said magnetizing coil when energized alone and in series with said resistance, said means comprising a non-inductive winding on said relay and electromagnetic means effective upon the operation of said relay for connecting said non-inductive winding across said magnetizing coil and the series connected resistance.

3. In combination, a relay having a core, an energizing circuit for said relay comprising a magnetizing coil carried by said core, a second energizing circuit for said relay comprising said magnetizing coil and a series connected resistance, means compensating for the difference in power dissipated in said magnetizing coil when energized alone and in series with said resistance, said means comprising a non-inductive winding superimposed on said magnetizing coil, and electromagnetic means controlled by said relay for connecting said compensating means in parallel with said series connected resistance and magnetizing coil.

4. In combination, a relay having an operating winding and a non-inductive winding wound upon the core thereof, a resistance element, a source of power, and means comprising an electromagnet controlled by said relay when operated for connecting said resistance element in series with the operating winding of said relay and for connecting said non-inductive winding across said source of power.

5. In combination, a relay comprising an electromagnet having a magnetizing coil and an armature, a resistance adapted to be included in the circuit of the magnetizing coil when the armature is in its attracted position and to be excluded from the circuit of the magnetizing coil when the armature is in its released position, thereby causing a difference in power dissipation in said relay when operated and when released, means for maintaining the power dissipated in said relay substantially constant whether operated or released, said means comprising a power dissipating device associated with said magnetizing coil and electromagnetic means responsive to the operation of said relay for connecting said power dissipating device across said serially connected magnetizing coil and said resistance.

6. In combination, a source of power, a relay having an operating winding adapted to dissipate a certain amount of power when said winding is energized from said source of power, means responsive to the operation of said relay for causing a decrease in the power dissipated in said relay, means for compensating for the decreased power dissipation in said relay, said means comprising a non-inductive winding associated with said operating winding and means effective upon

the operation of said relay for connecting said non-inductive winding across said source of power.

7. In combination, a relay having an operating winding and a non-inductive winding wound in relatively intimate association on the core of said relay, an armature, means for variably tensioning said armature in accordance with variations in ambient temperature, a resistance element, a source of power, and means comprising an electromagnet controlled by the armature of said relay when operated for connecting said resistance element in series with the operating winding of said relay and for connecting said non-inductive winding across said source of power.

8. In combination in an electric circuit, a source of power, a relay having an operating winding connected across said source of power, a resistance element, a non-inductive winding for said relay, and means comprising an electromagnet, controlled by said relay when operated for connecting said resistance element in series with said operating winding across said source of power and for connecting said non-inductive winding in parallel with said operating winding and its series connected resistance.

9. In combination in an electric circuit, a source of power, a relay having an armature, means comprising a bimetal spring for variably tensioning said armature in accordance with variations in ambient temperature, an operating winding for said relay connected across said source of power, a resistance element, a non-inductive winding for said relay, and means including an electromagnet controlled by the armature of said relay for connecting said resistance element in series with said operating winding across said source of power and for connecting said non-inductive winding across said source of power.

10. In combination, a source of current, a relay having an operating winding connected across said source when said relay is in its unoperated condition and an energizing circuit including said operating winding and a serially connected resistance when said relay is in its operated condition whereby the power dissipated in said relay when operated is less than when unoperated, means for compensating for the decrease in dissipated power, said means comprising a non-inductive winding wound upon said operating winding and means comprising an electromagnet responsive to the operation of said relay for connecting said non-inductive winding across said source of current and in parallel with said relay energizing circuit.

11. In combination, a relay having an operating winding and a non-inductive winding wound in relatively intimate association on the core of said relay, an armature, means for rendering said armature operable on different voltages applied to said operating winding for different conditions of ambient temperature, a resistance element, a source of power, and means comprising an electromagnet controlled by the armature of said relay when operated for connecting said resistance element in series with the operating winding of said relay and for connecting said non-inductive winding across said source of power.

PETER E. BUCH.

CLARENCE S. KNOWLTON.