April 14, 1942. A. R. VAN C. WARRINGTON 2,279,849

CONTROL OF ELECTROMAGNETIC DEVICES

Filed May 16, 1940

Fig. 1.

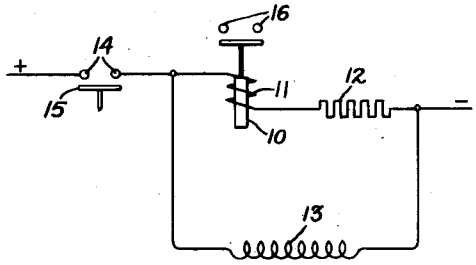


Fig. 4.

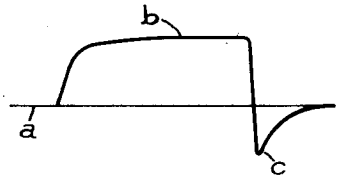


Fig. 2.

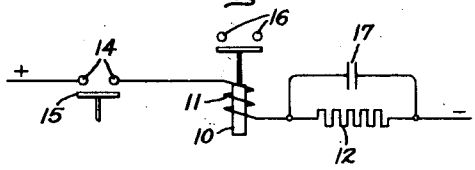


Fig. 5.

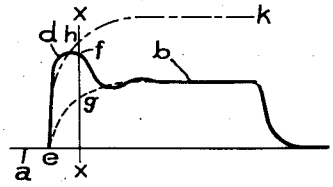


Fig. 3.

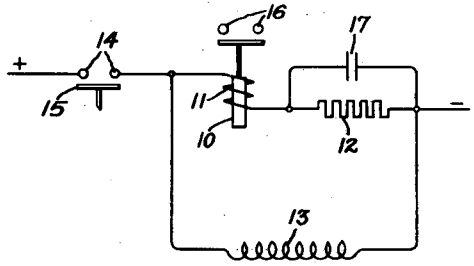
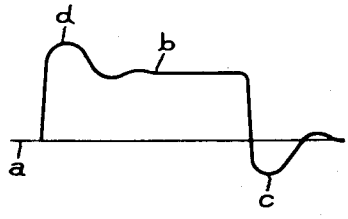


Fig. 6.



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UNITED STATES PATENT OFFICE

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CONTROL OF ELECTROMAGNETIC DEVICES

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Application May 16, 1940, Serial No. 335,518

9 Claims. (Cl. 175—320)

My invention relates to improvements in the control of electromagnetic devices and more particularly relays having movable armatures, and the principal object of my invention is to accelerate the response, such as pickup, drop-out, or both, of such devices.

Refinement of structure, sensitivity of response, and high speed of operation in certain complex relays, such for example as distance relays, frequently limit the number of contacts on the relay to less than may be required in certain more advanced protective systems, such for example as those of the so-called "carrier pilot" type. To circumvent this paucity of contacts, auxiliary devices, such as electromagnetic relays, may be used. However, such added elements necessarily increase the time required for a given cycle of operations. This may add to the delay in opening a circuit breaker or it may retard the operation of other devices and lead to a false operation of the protective relay cycle. In order to minimize this added time delay, the auxiliary relays have been operated at voltages several times the continuous duty voltage for which they are designed. While this may be reasonably satisfactory from the standpoint of accelerating the operation, it is not without serious hazard, especially if the device applying the overvoltage fails to remove such voltage quickly enough. This may readily occur since it is possible for the increased current flow, which results from the use of the overvoltage, to damage the more or less delicate contacts of the sensitive protective relay and even cause them to weld in the closed position. This is, of course, dangerous not only to relay structure but also to the system since the intended cycle of protective operations is disrupted and a system fault may not be cleared in time to avoid damage to the system.

In accordance with my invention, I minimize the time of operation of electromagnetic devices by means embodying the introduction of transient electric current quantities whereby to quicken the response of the devices on pickup, drop-out, or both. Pickup is, of course, understood in the art as that value of the electric quantity which will cause operation of the device, and drop-out is the return or reset of the device to its original position, that is before pickup, when the electric quantity assumes some other value usually less than the pickup value. Since auxiliary relays are generally energized from the station battery, another object of my invention is to provide accelerated pickup and drop-out action for electromagnetic devices which are energized from direct current sources. Other objects of my invention will appear in more detail hereinafter.

My invention will be better understood from the following description when considered in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

In the accompanying sheet of drawings, Fig. 1 illustrates diagrammatically an embodiment of my invention for accelerating the drop-out of an electromagnetic device; Fig. 2 illustrates diagrammatically an arrangement for accelerating the pickup of an electromagnetic device; Fig. 3 illustrates diagrammatically an embodiment of my invention for accelerating both the pickup and drop-out of an electromagnetic device; and Figs. 4, 5 and 6 are wave diagrams explanatory of the arrangements diagrammatically illustrated in Figs. 1, 2 and 3, respectively.

In the embodiment of my invention shown in Fig. 1 I have illustrated means for accelerating the dfop-out of an electromagnetic device, such as a relay 10, having an energizing winding 11 by means of transient current operation. This is accomplished by connecting in series relation with the relay winding 11 suitable current limiting means, such as a resistance 12, and across the series related relay winding and resistance suitable current limiting means, such as an inductance 13. The two parallel circuit branches thus formed are arranged to be connected to a suitable source of direct current, not shown but indicated by plus and minus signs, through suitable circuit controlling means which may be, for example, the relatively movable contacts 14 and 15 of a protective relay. While the relay 11 is shown as having only one pair of contacts 16, it is well known to the art that such auxiliary relays may be provided with as many sets of contacts as are desirable.

In this embodiment of my invention it will be obvious that, by suitably proportioning the ohmic values of the winding 11, the resistance 12 and the inductance 13, the current in the winding 11 will, when the contacts 14 and 15 are closed, increase exponentially from the zero value at *a* to the constant value *b* when the steady state condition is reached whereupon the relay 11 will be actuated. However, when the contacts 14 and 15 are opened, the current will decrease from the value *b* and overshoot the zero value to some value *c* in consequence of the time constant of the closed circuit comprising the winding 11, the resistance 12 and the inductance

13. Thus the greater the inductance of the inductive means 13 relatively to the inductance of the winding 11, the greater the overshoot c. Subsequently, when conditions have reached a steady state in this circuit, the current will return to the zero value a. It will be obvious that, when the contacts 14 and 15 are open, the current, which was flowing in the winding 11 and its series related resistance 12 and would tend to continue to flow in the closed circuit including the winding 11, resistance 12 and the inductance 13, is opposed by the inductive discharge current of the inductance 13. In consequence of this, the drop-out of the relay 11 is accelerated to produce a quicker action by the transient induced in the closed circuit. In some cases the resistance of the relay winding 11 may be such as to render a separate resistance 12 unnecessary.

In the arrangement shown in Fig. 2, upon closure of the contacts 14 and 15, the resistor 12 is arranged to be momentarily by-passed by suitable means, such as a condenser 17. With this arrangement, it will be apparent that, upon closure of the contacts 14 and 15, the condenser 17, while it is being charged, in effect short-circuits the resistance 12 so that the full voltage of the direct current source is momentarily applied. However, since the by-passing is not done by relay contacts, which may fail, the full voltage is not maintained on the relay beyond its safe time rating.

Fig. 5 shows the current wave form starting at the zero value *a*, when the contacts 14 and 15 are closed, and rising quickly to a value *d* which overshoots or is in excess of the steady current value *b* which is reached by way of a damped oscillation as indicated. When the contacts 14 and 15 are open, the current decreases again to a zero value, as shown. The increased effective effort for pickup of the relay 10 over the arrangement shown in Fig. 1, whereby the action is accelerated, is indicated by the area *edfg* within the full and dotted line curves in Fig. 5 to the left of the line *xx* where the relay operates. To obtain a similar increased effort by operating at above normal voltage rating would require a current flow, such as indicated by the dash and dot line *ehk*. As is obvious, this would require about twice the current flow in the relay winding and would increase the hazard not only to the winding but to the contacts 14 of the protective relay.

Thus with the arrangement shown in Fig. 1 a normal pickup and accelerated drop-out is effected, whereas with the arrangement shown in Fig. 2 an accelerated pickup with a normal drop-out is obtained. In accordance with my invention, I combine the arrangements shown in Figs. 1 and 2 in order to insure both an accelerated pickup and an accelerated drop-out. In the arrangement shown in Fig. 3 the inductance 13 is connected across the relay winding 11 and the series related parallel connected condenser 17 and resistance 12. This arrangement provides three parallel branches in the direct current circuit with the ohmic values of the winding 11, resistance 12, inductance 13 and condenser 17 so proportioned as to provide the desired initial and final transient effects in order to obtain the accelerated pickup and drop-out.

While I have shown and described my invention in considerable detail, I do not desire to be limited to the exact arrangements shown, but seek to cover in the appended claims all those modifications that fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In combination, an electromagnetic device having an energizing winding, a direct current circuit comprising two parallel branches including in one branch said winding and in another branch an inductance, the ohmic values of said winding, and inductance being such that when said circuit is interrupted the flow of current in said winding is quickly suppressed.

2. In combination, an electromagnetic device having an energizing winding, a resistance connected in series relation with said winding, a source of direct current, a switch for connecting said source across said series related winding and resistance, means for accelerating the pick-up of said electromagnetic device when said switch is closed comprising a condenser connected across said resistance, and means for accelerating the drop-out of said electromagnetic device when said switch is opened comprising an inductance connected directly across said winding and said resistance.

3. In combination, an electromagnetic device having an energizing winding, means for limiting the flow of current in said winding, a source of direct current, circuit controlling means for connecting said source across said winding and current limiting means, and means for quickly retarding the flow of current in said winding when said circuit controlling means is operated to disconnect said source.

4. In combination, an electromagnetic device having an energizing winding and a circuit comprising three parallel branches including in one branch said winding and a condenser, in a second branch said winding and a resistance and in a third branch an inductance, the ohmic values of said winding, condenser, resistance and inductance being such that when a source of direct current is connected to said circuit a predetermined momentarily increased flow of current appears in said winding and when said source is disconnected the flow of current in said winding is quickly suppressed.

5. In combination, an electromagnet comprising an armature and an energizing winding, current limiting means connected in series relation with said winding, a source of direct current, circuit controlling means for connecting said source across said series related winding and current limiting means to cause the pickup of said armature, and means for accelerating the drop-out of said armature when said circuit controlling means is operated to disconnect said series related winding and current limiting means from said source.

6. In combination, an electromagnet comprising an armature and an energizing winding, current limiting means connected in series relation with said winding, a source of direct current, circuit controlling means for connecting said source across said series related winding and current limiting means, means for momentarily by-passing said current limiting means when said circuit controlling means is operated to connect said source of direct current across the series related winding and current limiting means whereby to accelerate the pickup of said armature, and inductive current limiting means for accelerating the drop-out of said armature when said circuit controlling means is operated to disconnect said source of direct current from said series related winding and current limiting means.

7. In combination, an electromagnetic device

having an energizing winding, a resistance connected in series relation with said winding, a source of direct current, a switch for connecting said source across said series related winding and resistance to cause the pickup of said electromagnetic device, and means for accelerating the drop-out of said device when said switch is opened comprising an inductance connected directly across said series related winding and resistance.

8. In combination, an electromagnetic device having an energizing winding, a source of direct current, circuit controlling means for connecting said source across said winding, and means for quickly retarding the flow of current in said winding when said circuit controlling means is operated to disconnect said source.

9. In combination, an electromagnetic device having an energizing winding, a resistance connected in series relation with said winding, a source of direct current, a switch for connecting said source across said series related winding and resistance, means for accelerating the pick-up of said electromagnetic device when said switch is closed comprising a condenser connected across said resistance, and means for accelerating the drop-out of said electromagnetic device when said switch is open comprising an inductance connected in parallel relation with said winding.

ALBERT R. VAN C. WARRINGTON.