Feb. 8, 1944. R. H. WILLIAMS, JR 2,341,349

TIME DELAY RELAY

Filed Aug. 1, 1941

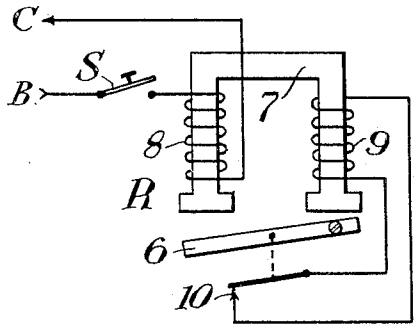


Fig. 1.

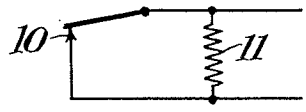


Fig. 2.

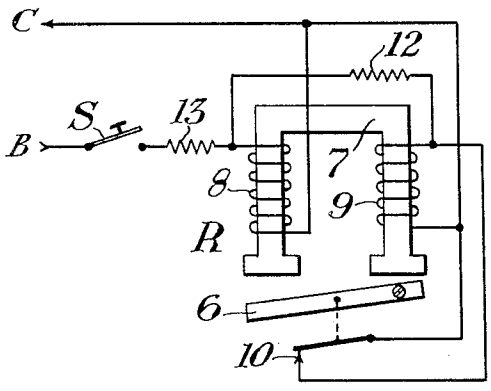


Fig. 3.

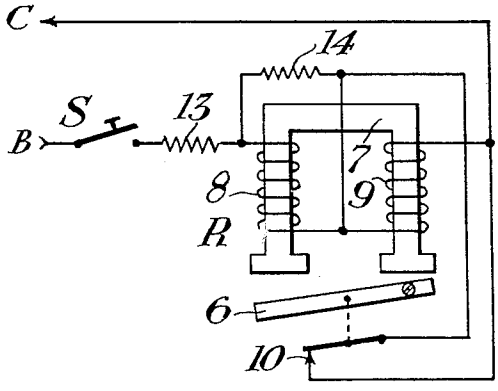


Fig. 4.

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TIME DELAY RELAY

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5 Claims. (Cl. 175—320)

My invention relates to electromagnetic apparatus, and it has particular reference to the provision of electromagnetic apparatus, such as a relay, arranged so as to have a delayed pick-up.

In general, it is proposed in accordance with my invention to provide a relay incorporating novel and improved means for delaying the pick-up but not the release of the relay armature. More specifically, it is an object of my invention to provide a relay incorporating novel and improved means effective initially to delay the pick-up of the armature and effective after the armature starts to pick up, to assist in operating the armature to its full stroke position.

Another object of my invention is to provide novel and improved means effective to limit the initial voltage surge across the relay to a value only slightly greater than the steady state voltage across its windings.

A further object is the provision of novel and improved means for obtaining slow pick-up characteristics in an ordinary acting relay.

The above-mentioned and other important objects and characteristics of my invention, which will become readily apparent from the following description, are attained in accordance with my invention by initially shunting or short-circuiting a portion of the relay winding over a back contact of the relay in such manner that when the back contact opens, the initially shunted portion of the winding is caused to become energized to assist in operating the relay armature to its picked-up position. Additionally, resistors are provided and are arranged in circuit with the relay winding so as to limit the voltage surge across the relay when the voltage is first applied to the circuit.

I shall describe several forms of apparatus embodying my invention, and shall then point out the novel features thereof in claims.

In the accompanying drawing, Fig. 1 is a diagrammatic view illustrating one form of apparatus embodying my invention. Fig. 2 is a diagrammatic view illustrating a modification of a portion of the apparatus represented in Fig. 1. Figs. 3 and 4 are each diagrammatic views illustrating modified forms of the apparatus represented in Fig. 1, and each also embodying my invention. In each of the several views, similar reference characters have been employed to designate corresponding parts.

Referring to Fig. 1, the reference character R designates a relay embodying my invention and comprising a magnetizable armature 6, and a magnetizable core 7 provided with the usual two energizing windings 8 and 9, one winding 9 of which is shunted or short-circuited when back contact 10 of the relay is closed. The other winding 8 is supplied, at such times as switch S is closed, with energy from a suitable source of current, such as a battery not shown but having its opposite terminals designated by the reference characters B and C.

Normally, relay R is deenergized and back contact 10 is closed to complete the shunt path across the terminals of winding 9. When switch S is closed, therefore, the growth of flux in core 7 due to current in winding 8 causes an electromotive force to be induced in winding 9. The flux due to the current produced by this induced electromotive force opposes the flux due to current in winding 8 and delays the growth of the latter flux in the core, thereby causing the relay to have slow pick-up characteristics. After the flux due to current in winding 8 reaches substantially its steady state condition, winding 9 becomes deenergized and armature 6 of relay R is attracted to open back contact 10, thereby placing winding 9 on open circuit. When, therefore, switch S is opened and the flux due to current in winding 8 decays, winding 9 is on open circuit and no current can flow therein to produce a flux effective to delay the decay of the flux in core 7, and hence the release characteristics of the relay are unaffected by winding 9.

Resistor 11, shown in Fig. 2, may if desired be connected as shown across back contact 10 and hence across the terminals of winding 9, in which case the electromotive force induced in winding 9 when switch S is opened, causes a current to flow in this winding. The flux due to this current tends to maintain the net flux in core 7 and hence delays the release of the armature of relay R.

From the foregoing description, it is readily apparent that relay R is made slow to pick up by shunting a portion of the relay winding over a back contact of the relay, and such relay may be made either slow or quick to release according as a resistor 11 is or is not connected across the terminals of the initially shunted portion of the relay winding.

A modification of the relay shown in Fig. 1 is represented in Fig. 3, wherein the apparatus is arranged so as to energize the initially shunted portion of the relay winding after back contact 10 opens. Referring now to Fig. 3, winding 9 is initially shunted by back contact 10, hence when switch S is closed and winding 8 becomes

energized, the growth of flux due to current in this winding is opposed by the electromotive force caused to be induced in winding 9, and relay R accordingly is caused to be slow to pick up. After the flux due to current in winding 8 reaches substantially its steady state condition, which substantially corresponds to the pick-up value of the relay, armature 6 is attracted and back contact 10 opens. Winding 9 now becomes energized, in multiple with winding 8, over a circuit extending from one terminal of winding 8 through resistor 12 and winding 9 to the other terminal of winding 8. The energization of winding 9 creates a flux which assists the flux due to current in winding 8 and functions to cause armature 6 to go to its full stroke position with a snap action.

Resistor 11, shown in Fig. 2 connected across the terminals of winding 9, may if desired be incorporated into the relay shown in Fig. 3 to alter the release period of the relay.

It is contemplated that relay R shown in Fig. 3 may be connected with a source of current having a voltage fixed at a value such that limiting resistors must be employed to reduce the voltage across the relay to its pick-up value. For this purpose, a resistor 13 has been incorporated into the circuit of the relay. The other resistor 12, connected across winding 8 through back contact 10 of the relay, cooperates with resistor 13 to provide a potentiometer arrangement which functions to permit adjustment of the voltage across the relay and hence provides an adjustment of the pick-up time of the relay. This arrangement of the resistors 12 and 13 and winding 8 is further effective to limit, when switch S is first closed, the initial surge voltage across winding 8 to substantially its steady state value, hence there is little tendency for the relay armature to pick up immediately when switch S is closed, due to a transitory high energy level in the relay.

In Fig. 4, the apparatus is arranged so that the portion of the relay winding initially shunted is placed in series with winding 8 when back contact 10 opens. In this arrangement, winding 9 is initially shunted over back contact 10 of the relay, hence when switch S is closed, the other winding 8 becomes energized and creates a flux which produces a counter-electromotive force in winding 9. After the flux due to current in winding 8 reaches substantially its steady state position, armature 6 is attracted and back contact 10 opens to open the shunt path connected across the terminals of winding 9. Winding 9 now becomes energized in series with winding 8, and as a result of the increased resistance introduced into the circuit by winding 9, the current in the circuit drops, but armature 6 is retained in its picked-up position due to the additive action of the fluxes due to current in the two windings 8 and 9. During the growth of flux due to current in winding 9, resistor 14 connected across the terminals of winding 8 acts as a snub to delay the decay of the flux due to the decrease of current in that winding to the new value of the current in the circuit, thereby preventing release of the relay armature during this interval.

The combination of the resistors 13 and 14 with winding 8 of Fig. 4 functions, in a manner similar to the resistor combination of Fig. 3, to limit, when switch S is closed, the initial surge voltage across winding 8 to substantially its steady state value, thereby avoiding any tendency for the relay armature to pick up immediately due to a momentary high energization of winding 8. In addition, the insertion of winding 9 in series with winding 8 after back contact 10 opens, causes the current in the circuit to be decreased, thus limiting the current consumption of the relay for a given voltage.

Although I have herein shown and described only a few forms of electromagnetic apparatus embodying my invention, it is to be understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. In combination with a magnetizable core provided with a winding and an armature operable from a released to a closed position upon energization of said winding, a source of current connected across a portion of said winding, a resistor for connecting another portion of said winding to said source in multiple with said first portion of said winding, and a short-circuit path connected across said other winding portion and completed only when said armature is in its released position.

2. In combination with a source of current having a predetermined voltage and a relay designed for operation at a voltage substantially less than the voltage of said source, a first resistor, a circuit including said first resistor for connecting said source to the winding of said relay, a second resistor, a circuit path including a back contact of said relay for connecting said second resistor to said source in multiple with a portion of said relay winding, and connections from a selected portion of said relay winding to said circuit path, whereby when said back contact is closed said relay winding portion is shunted to delay the pick-up of the armature due to the reduced number of coil turns available and the snubbing action of the short-circuited relay winding portion on the growth of flux in the relay but when said back contact opens, said relay winding portion becomes energized to create flux that assists in operating the relay armature to its closed position.

3. In combination with a source of current having a predetermined voltage and a relay designed for operation at a voltage substantially less than that of said source, a first resistor, a circuit including said resistor for connecting said source to a portion of the winding of said relay, another resistor, a circuit including said other resistor for connecting the remainder of said relay winding to said source in multiple with said portion of said relay winding, and a circuit path connected in shunt with said remainder of said relay winding through a back contact of said relay.

4. In combination with a source of current having a predetermined voltage and a relay designed for operation at a voltage substantially less than that of said source, a first resistor, a circuit including said resistor for connecting said source to the winding of said relay, another resistor, a circuit path including a back contact of said relay for connecting said other resistor to said source in multiple with said relay winding, and connections from a portion of said relay winding to said circuit path, whereby to short-circuit said relay winding portion when said back contact is closed and to energize said

relay winding portion when said back contact is open.

5. In combination, a relay having a winding acting on a single armature through a single magnetic circuit, a source of current, an electrical circuit for connecting said source to said winding for effectively energizing the entire winding when said relay is picked up, and means effective to shunt a portion of said winding only when said relay is released, said means comprising an alternate circuit path including said portion of said winding and a back contact of said relay operated by said armature.

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