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IMPULSE ACTUATED ELECTROMAGNETIC RELAY WITH TIME DELAY

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Fig. 1.

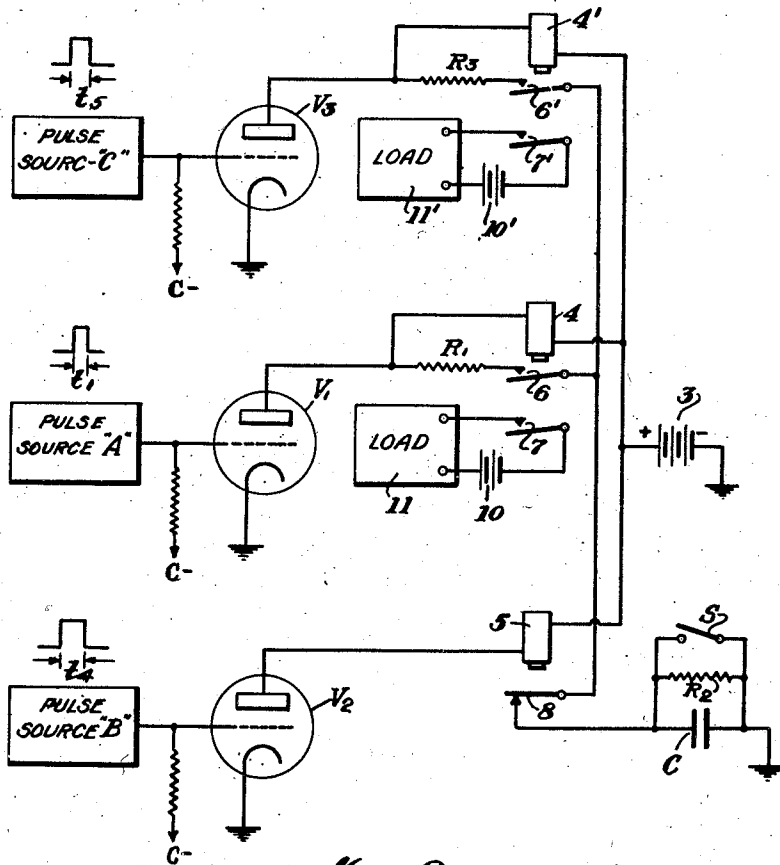
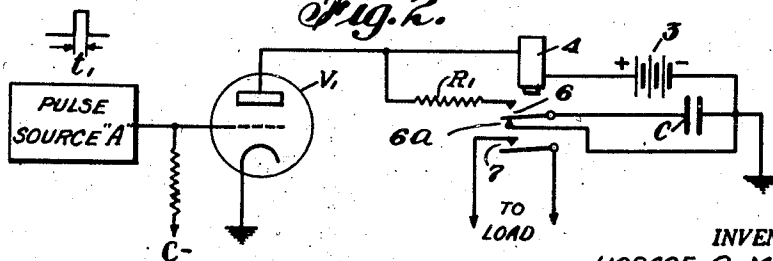


Fig. 2.



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IMPULSE ACTUATED ELECTROMAGNETIC
RELAY WITH TIME DELAY

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The present invention relates to apparatus of the type suitable for regulating the operation of electrically controlled circuit breaking devices.

It is frequently desirable to provide means for automatically maintaining an electrically controlled circuit breaking device such as a relay in one of its control positions after the flow of energy through the device has ceased. It is also desirable to cause the device to remain in this control position for the same predetermined period of time following the initial reception of each of the various intervals of energization, without regard, within certain limits, to the duration of the intervals or the time that elapses between them.

It is accordingly the principal object of the present invention to provide a simple and inexpensive circuit arrangement for carrying out the above aims.

It is a further object of the invention to provide additional means in an arrangement of the above type that will permit the position of the circuit breaking device to be altered before expiration of the said predetermined period of time and without regard to the status of the automatic maintaining means.

It is a still further object of the invention to provide an improved form of time-delay system for a circuit breaking device, the period of delay being determined by the time constant of a resistance-condenser combination.

It is an additional object of the invention to provide a holding circuit for a relay, this circuit being responsive to an initiating input pulse of relatively narrow width, for holding the relay in closed position for an interval of time that is longer in duration than that of the initiating input pulse.

It is a further object of the invention to provide a single time-delay circuit effective to control the operation of a plurality of circuit-breaking devices receptive to pulses generated at separate sources and designed to control separate loads.

It is a still further object of the invention to provide means for deriving pulses of equal width from pulses of unequal width.

Other objects and advantages will be apparent from the following detailed description of preferred forms of the invention and from the drawing, in which:

Fig. 1 is a diagram of a preferred form of circuit incorporating the present invention; and

Fig. 2 is a modification of Fig. 1, showing a different condenser discharging arrangement.

The present invention provides a single time-delay arrangement which is utilized in conjunction with one or more circuit-breaking devices respectively acting to control the operation of one or more circuits, each of these circuit-breaking

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devices being receptive to pulses of energy generated at a different source.

Fig. 1 of the drawing accordingly shows two separate control circuits each including a separate circuit-breaking device, these circuits being energized by pulses generated at different sources. A single time-delay circuit is so incorporated with these control circuits as to provide a delay interval for each, this interval being of equal duration to thereby cause all of the control circuits to remain energized for substantially identical periods of time.

Although any number of control circuits may be incorporated with the single time-delay circuit as will later become apparent, only two have been illustrated, and the operation of the invention will be described in connection with but one.

In Fig. 1 is shown three triodes V_1 , V_2 and V_3 , the grids of which are respectively connected to three pulse sources "A", "B" and "C." These sources produce pulses of widths t_1 , t_2 and t_3 , as indicated, which may be equal or unequal. The anodes of triodes V_1 , V_2 and V_3 are connected to a source of power 3 through the coils of three relays 4, 5 and 4' respectively. Relays 4 and 4' are each provided with two pairs of normally open contacts 6, 7 and 6', 7' respectively. Relay 5 is provided with a pair of normally closed contacts 8. In a conventional manner each of these pairs includes a stationary contact and a movable contact as illustrated.

A resistor R_1 is connected between the anode terminal of the coil of relay 4 and normally open contacts 6. Another resistor R_2 is connected in a similar manner between the anode terminal of the coil of relay 4' and normally open contacts 6'. Contacts 6 and 6' are joined as shown to normally closed contacts 8. Contacts 8 are in turn connected to one plate of a condenser C, the other plate of the condenser being grounded.

Shunted across condenser C is a further resistor R_2 . In parallel with C and R_2 is a manually operable switch S. Normally open contacts 7 and 7' respectively control the flow of power from sources 10 and 10' to loads 11 and 11'.

The invention will now be described in connection with one of the control circuits shown in Fig. 1. Since the principle of operation of each of these circuits is the same, the one including triode V_1 has been selected. Obviously, however, the one including triode V_3 might as readily have been chosen. In the following description, switch S is assumed to be open.

When a pulse from source "A" of duration t_1 is applied to the grid of triode V_1 (both V_1 and V_2 being biased to or beyond cut-off) the tube becomes conductive and current will flow through the coil of relay 4. Contacts 6 and 7 will now close.

As soon as contacts 6 close, a circuit will be

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established through source of power 3, coil 4, resistor R_1 , normally closed contacts 8 and to ground through condenser C. This will charge condenser C for a period which will be designated as t_2 . During this period t_2 that C is charging through R_1 , current flowing through the coil of relay 4 maintains contacts 6 and 7 closed.

When C becomes fully charged (the time constant t_2 required for such charging being dependent on the values of R_1 and C in a manner known in the art), the current flow through the coil of relay 4 will cease, and contacts 6 and 7 will open. It will be noted that the energy represented by the pulse from source "A" may or may not be applied to the grid of triode V_1 during the entire period t_2 that C is charging, it being immaterial whether the initiating energy continues or not after such time as the relay 4 is "locked-in" by establishment of a circuit through R_1 as above described. However, the interval t_1 preferably should not exceed the time constant t_2 of R_1C , the values of R_1 and C being selected with this condition in mind.

Resistor R_2 is chosen to be of a considerably higher value than R_1 so as not to affect to any appreciable degree the charging of C through R_1 as previously described. The purpose of R_2 is to discharge condenser C upon breaking of the circuit through resistor R_1 , and to thereby restore the system in preparation for another cycle of operation. If the time required for C to completely discharge through R_2 after contacts 6 open be designated as t_3 , then it will be seen that the sum of t_2 and t_3 can equal but not exceed the time between successive pulses from source "A."

The loads 11 and 11' respectively controlled by contacts 7 and 7' may be of any standard type, such as for example stepping relays. Also the contacts 7 and 7' may, if desired, control the operation of pulse generating devices for producing pulses having a width corresponding to the intervals during which contacts 7 and 7' are closed. Many other control applications will also be readily apparent to those skilled in the art.

The above cycle of operation has assumed that switch S is open (or that the system is "self-clearing"), and that triode V_2 is non-conductive. If, however, switch S be closed (making the system "remote-clearing"), elements C and R_2 will be short-circuited, and a closing of contacts 6 and 7 as above described would normally result in the contacts remaining in such position indefinitely.

However, if a pulse from source "B" of some duration such as t_4 is now applied to the grid of triode V_2 , the latter becomes conductive to energize the coil of relay 5. Contacts 8 now open, breaking the circuit from the coil of relay 4 through R_1 to ground by way of switch S. Contacts 6 and 7 now open due to the deenergization of the coil. It will be seen that a pulse from source "B" may be received by triode V_2 at any time subsequent to the arrival of a pulse from source "A" on the grid of triode V_1 . It will also be seen that the "remote-clearing" action of the system dominates the "self-clearing" or automatic action. This is true because opening of contacts 8 as a result of the energization of relay 5 by the pulse from source "B" clears the holding circuit and opens contacts 6 and 7 regardless of whether switch S is open or closed. Also the duration t_4 of the pulse from source "B" may be immaterial, if the only requirement is that the triode V_2 be conductive for a sufficient time to permit contacts 8 to open. However it

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will be clear that t_4 must not be of such length as to interfere with the charging of condenser C upon the reception of the next pulse by triode V_1 from source "A."

It will be obvious that the separate control circuit including triode V_3 and relay 4' operates in a manner similar to that described above for the triode V_1 and relay 4. Resistor R_3 may have a value such that the time constant R_3C equals R_1C , or else it may have any other value desired so that contacts 7' will remain closed for longer or shorter intervals than contacts 7.

However, it is emphasized that, in order for all of the intervals during which contacts 7' are closed to be of equal duration, and in order for all of the intervals during which contacts 7 be closed to be also of equal duration, the pulses from sources "A" and "C" must not arrive simultaneously, and furthermore successive pulses, whether from the same or from different sources, must be spaced apart a sufficient distance to allow for the full discharging of condenser C.

It will be obvious that if desired additional circuits including relays 4' and triodes V_3 may be added in parallel relation with the one shown.

In Fig. 2 is illustrated a circuit incorporating a different type of condenser discharging means from that shown in Fig. 1. In this arrangement an additional stationary contact 6a is associated with contacts 6, so that condenser C is normally short-circuited when relay 4 is deenergized. When current flows through the coil of relay 4 as a result of the reception of a pulse from source "A," condenser C will charge in the manner previously described. When the flow of current through the relay coil ceases due to the attaining by C of its full charge through R_1 , contacts 6 will open. This opening of contacts 6 will short-circuit condenser C through contact 6a thereby discharging the condenser to ground. Thus the system is conditioned for another cycle of operation. It will be noted that in the arrangement as shown in Fig. 2 the separate discharging resistor R_2 of Fig. 1 is not required. However, this arrangement of Fig. 2 is suitable for only one relay 4.

From the above it will be seen that the present disclosure includes numerous features. Means are provided whereby a circuit breaking device may be held in closed position for a predetermined period of time that exceeds in duration that of any of the initiating pulses. This same predetermined holding period is maintained even though the width of succeeding received pulses may vary to a considerable degree. If it is desired to maintain the closed position of the device until such time as a clearing pulse is received, this may be accomplished through the act of closing a selector switch as shown in Fig. 1. In addition the system provides means whereby means such as a clearing pulse will be effective to deenergize the system regardless of whether the selector switch has been closed or not, and also without regard to the status at that time of the automatic clearing means.

While I have described above the principles of my invention in connection with specific circuit arrangements, it is to be clearly understood that this description is made only by way of example, and not as a limitation on the scope of my invention as set forth in the objects of my invention and in the accompanying claims.

I claim:

1. In an electrical circuit including an energy

source, an electro-responsive mechanism and a source of power, the combination of a normally inoperative control element in circuit relation with said source of power and said electro-responsive mechanism, means responsive to the initial reception of energy from said source, said energy being of a certain duration to render said element operative to energize said electro-responsive mechanism, a resistance-condenser combination having a time constant greater than the duration of said reception of energy said combination being serially connected across said source, and means under control of said resistance-condenser combination, whereby said mechanism is maintained energized for a predetermined time over a circuit independent of said control element.

2. An electrical circuit according to claim 1 in which the electro-responsive mechanism is energized by current flow to charge said condenser.

3. An electrical circuit according to claim 1, further comprising means for discharging the condenser of said resistance-condenser combination after deenergization of said electro-responsive mechanism following the energization thereof, and prior to the next succeeding reception of energy by said normally inoperative control element, said discharging means being connected in parallel with said condenser.

4. In an electrical circuit including a normally open relay and a source of power, a normally non-conductive element in series with said source of power and with the coil of said relay, a first source of pulse energy, means responsive to the initial reception of a pulse of energy of a certain duration from said first source by said element to render said element conductive and thereby close said relay, a time-delay circuit connected in operative relation with the relay coil over a path independent of the normally non-conductive element and having a predetermined delay interval greater than the duration of the pulse of energy received by said element, and means responsive to the closing of said relay to initiate the operation of said time-delay circuit, whereby said relay will open at the expiration of said delay interval.

5. An electrical circuit according to claim 4, further comprising a second normally non-conductive element, and means responsive to the reception of energy by said second element during the said time-delay interval to return said relay to open position irrespective of the electrical status of the said time-delay circuit at the time energy is received by said second element.

6. In an electrical circuit including a pair of relays and a source of current, the combination of a pair of normally non-conductive elements, two series circuits, each circuit including the source of current, the coil of one of the said relays, and one of the non-conductive elements, respectively, means for rendering one of said elements conductive to energize its series connected coil and operate the relay associated therewith to closed position, means responsive to the closing of said relay for maintaining said relay closed for a predetermined period of time, means for rendering said other element conductive during the said predetermined period to energize the series coil associated with said other element and to operate its respective relay to open position, and means whereby the opening of said last mentioned relay will cause said first mentioned relay to return to open position.

7. In an electrical circuit an electro-respon-

sive mechanism a source of successive pulses of a certain duration t_1 for controlling the closing of said electro-responsive mechanism, a condenser, means responsive to the initial reception of one of said pulses and connected to said electro-responsive mechanism to initiate the charging of said condenser, means whereby the latter maintains the said mechanism closed during a certain charging interval t_2 , and a circuit rendered operative by the opening of said mechanism following the closing thereof for discharging said condenser during a third interval t_3 , wherein $t_2 > t_1$, and the sum of t_2 and t_3 is equal to or less than the elapsed time between the beginnings of successive pulses.

8. In combination, a source of current, an electrically-controlled normally open circuit-breaking device connected to said current source, a circuit including a normally non-conductive element connected to said device, an energy source for energizing said element, means responsive to the initial reception of said energy, said energy being of a certain duration, to close said circuit-breaking device, a time-delay circuit serially connected with said current source having a predetermined delay interval, means responsive to the initial reception of energy by said element to initiate the energization of said time-delay circuit, said predetermined delay interval exceeding in duration the time during which energy is received by said element, whereby said time delay circuit will open at the expiration of said predetermined delay interval.

9. In an electrical circuit including a plurality of electro-responsive mechanisms, a source of power, a source of energy, a plurality of normally non-conductive elements, each of said normally non-conductive elements being respectively connected in series with one of said electro-responsive mechanisms and said source of power, means responsive to the initial reception of said energy by one of said elements to render said element conductive and thereby energize the electro-responsive mechanism in series therewith said energy being of a certain duration, a plurality of resistance condenser and deriving charging current from said power source combinations having a common condenser, the resistances of each of said combinations being respectively associated with respective non-conductive elements, each of said resistance-condenser combinations having a time constant greater than the duration of reception of energy by the normally non-conductive element associated therewith, and means responsive to the energization of one of said electro-responsive mechanisms to initiate the charging of said condenser whereby said last mentioned electro-responsive mechanism will be de-energized when said condenser is fully charged.

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