June 2, 1936. S. H. KAST 2,042,901

RELAY SYSTEM

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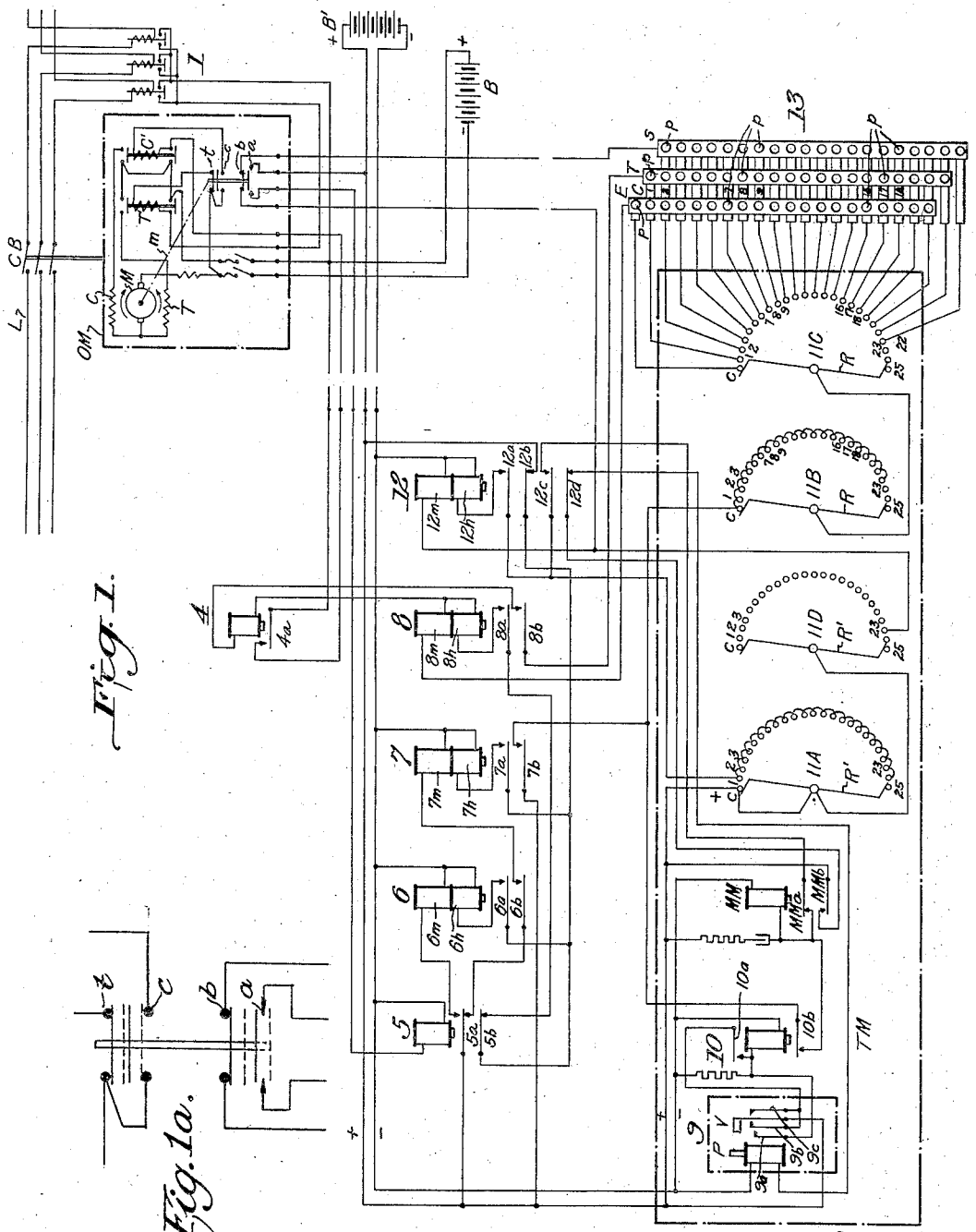


Fig. 1.

Fig. 1a.

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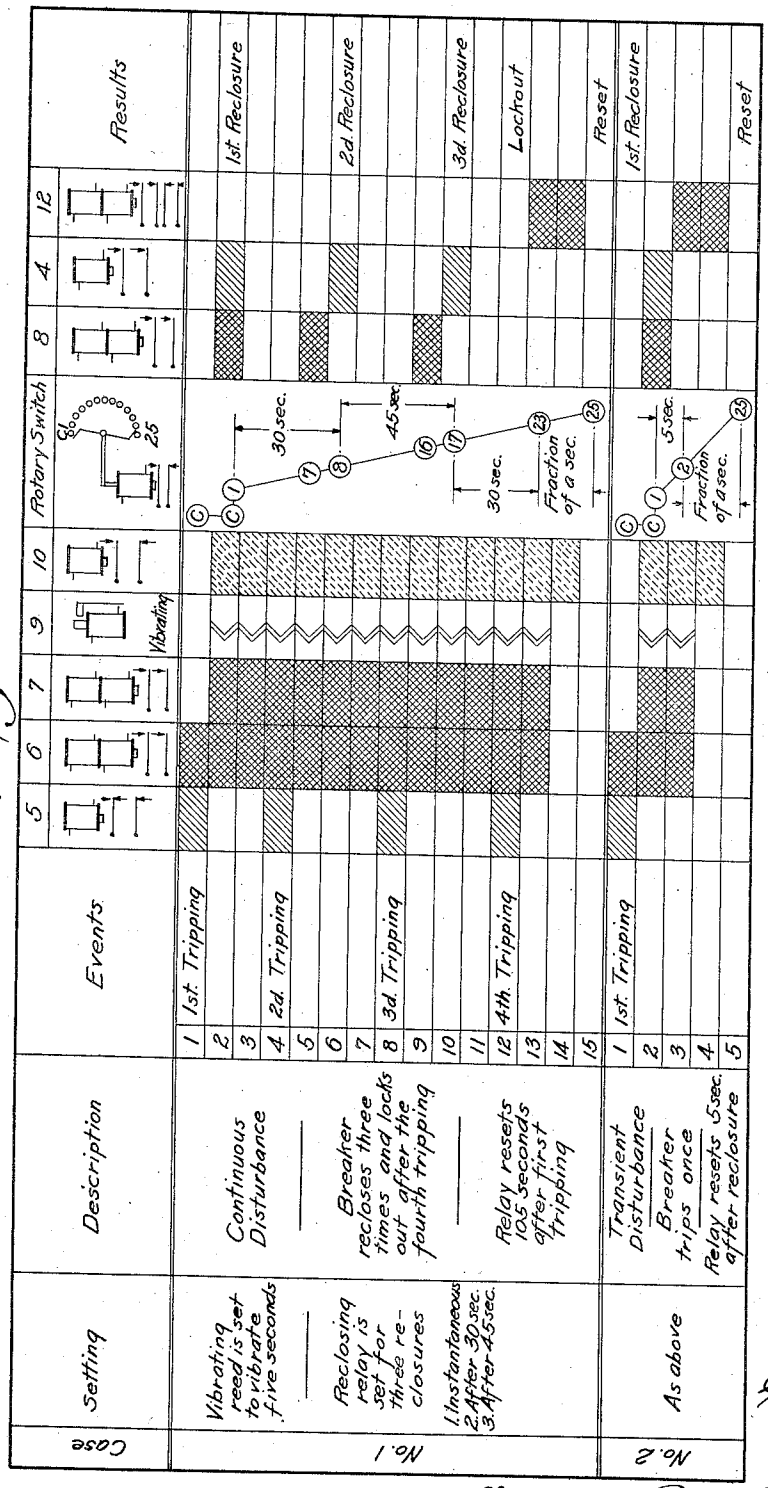
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Fig. 2.



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Patented June 2, 1936 2,042,901

UNITED STATES PATENT OFFICE

2,042,901

RELAY SYSTEM

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Application March 27, 1934, Serial No. 717,665

22 Claims. (Cl. 175—294)

This invention relates to relay systems and particularly to a relay system including a plurality of relays and a timing device for controlling a switch or switches in accordance with the occurrence, either simultaneously or in predetermined time relationship, of a plurality of predetermined control conditions.

The invention is particularly useful in protective control systems adapted to close (or to open) a switch when a given control condition occurs, but to open (or close) the same in the event that a second control condition is not established within a predetermined time, since the invention makes it possible to repeat this cycle of switch operations a predetermined number of times before definitely locking the switch in a predetermined safety position in the event that the second control condition cannot be established during the series of operations of the switch. Oil burner control systems and transmission line protective systems are typical applications of the invention but the relay systems contemplated by the invention are not limited to these fields of use. In an oil burner control, the invention provides a satisfactory system which will attempt to place the burner in operation a predetermined number of times and will then deenergize the entire system in the event that a flame is not established.

An object of the invention is to provide a relay system including a plurality of relays and a timing device, the system being capable of operation throughout a predetermined cycle and within a predetermined time but the actual operation of the system after its initial energization by the occurrence of a particular control condition or event being governed by one or more external events or conditions which are investigated or tested by circuits established by the relay system.

A further object is to provide a relay system responsive to a predetermined succession of events within predetermined, but adjustable, time intervals, the system being energized by a predetermined control condition repeatedly to attempt the establishment of a certain other condition and including a timing device which determines the maximum period of operation of the system in the event that the desired condition is not established or, alternatively, promptly resets the system for further operation in the event that the desired condition is established in less than the allotted time interval. More particularly, an object is to provide a relay system including a plurality of relays sequentially operated by electrical impulses, a timing device for closing one or more circuits at predetermined time intervals following the actuation of one relay, and devices responsive to conditions resulting from or existing in the circuits closed by the timing device for controlling the subsequent operation of the system.

A further object is to provide a relay system including a plurality of relays sequentially operated by repeated electrical impulses, each relay including a holding circuit for maintaining the energization thereof upon its initial energization and each closing contacts permitting the energization of a subsequent relay, a timing device for closing circuits at definite predetermined intervals, and switches in one or more holding circuits responsive to conditions affecting the circuits so established, whereby the energization of the system is dependent upon conditions or events outside of the system which are "investigated" by the circuits established by the timing device. A further specific object is to provide a simple reclosing relay system for a circuit breaker in a transmission line, the system reclosing the circuit breaker a predetermined number of times in the event that a faulty condition persists but preventing "pumping" or repeated actuations of a circuit breaker having an operating time interval less than the predetermined interval set for successive closures of the circuit breaker by the relay system.

These and other objects and advantages of the invention will be apparent from the following specification when taken with the accompanying drawings in which:

Fig. 1 is a circuit diagram of a relay system embodying the invention, the system controlling a reclosing circuit breaker;

Fig. 1*a* is an enlarged diagrammatic view of the auxiliary switch of the circuit breaker; and

Fig. 2 is a tabulation or graphic representation of the operation of various elements of the relay.

The type of control obtainable by relay systems embodying the invention can best be understood by first stating the sequence of operations to be effected in a reclosing circuit breaker. The majority of disturbances on transmission lines are of a transient nature and normal operating conditions are usually reestablished in less than a minute and frequently within the period required to trip a circuit breaker. Various systems have been designed to reclose the circuit breaker a predetermined number of times before definitely locking the circuit breaker in open position to isolate the faulty section from the remainder of the power transmission system. The relay system of

Fig. 1 provides a control of this general type, the system being energized for a predetermined maximum period when the automatic circuit breaker first trips out on an overload to make three timed reclosures of the circuit breaker in the event the disturbance persists beyond the period required for the second reclosure. If the fault remains on the line, the relay system is deenergized after the fourth tripping of the circuit breaker but, if the fault disappears before the first or second reclosure, the relay system is reset for a future cycle of operations within a few seconds after the circuit breaker closes on the cleared line.

The circuit breaker CB in the line L is actuated by operating mechanism OM which includes a reversible motor M having a tripping field winding T for effecting rotation in one direction and a closing field winding C for effecting rotation in the opposite direction. Current flow to the respective windings from an appropriate power source B, usually a storage battery, is controlled by two magnetically operated switches or relays T', C', respectively. The operating mechanism also includes an auxiliary switch having pairs of contacts *a*, *b*, *c*, *t*, respectively, which are bridged by contact strips which move as a unit and are actuated by the motor M, as is indicated by the dotted line *m*. When the circuit breaker is closed, as illustrated in Fig. 1, the contacts *b* and *t* are closed, and when the breaker is tripped only the contacts *c* are closed, it being particularly noted that the contacts *a* are momentarily closed, see Fig. 1*a*, as the auxiliary switch unit is moved during either the closing or the tripping of the circuit breaker.

A group of overload relays **1** have their operating windings included in the several branches of the line L and their contacts in parallel to complete, when any one set of contacts is closed, a circuit from source B through the winding of switch T', thus energizing the same to close both the upper and lower set of contacts. The closure of these contacts completes the circuit from source B through the field winding T and the resulting operation of motor M trips the circuit breaker, opens contacts *b* and *t* momentarily closes contacts *a*, and leaves contacts *c* closed at the completion of the tripping operation.

The relay system includes a plurality of relays **4**, **5**, **6**, **7**, **8** and **12**, a timing device which includes the elements within the rectangle TM, and a plug panel or bus system **13**. The relay **5** is an impulsing relay having a contact **5***a* movable between two contacts and a contact **5***b* which is closed when the relay is deenergized. Relays **6**, **7**, **8** and **12** have main windings **6***m*, **7***m*, etc., and holding windings **6***h*, **7***h*, etc., the holding winding including a relay contact **6***a*, **7***a*, etc., which is closed when the relay is energized. Relays **6**, **7** and **8** are of like construction and include contacts **6***b*, **7***b*, **8***b*, respectively, which are closed when the relays are energized. Relay **12** is the resetting relay of the system and includes normally closed contacts **12***b*, **12***d* and a normally open contact **12***c*. The reclosing relay **4** does not include a holding winding and has a single normally open contact **4***a* which is included in the circuit of the reclosing winding C' of the operating mechanism OM.

The timing device TM may be, and is illustrated as, a known type of "stepping relay" having a vibrating reed relay **9**, a slow release relay **10** and a primary relay MM for actuating the double contact arms R, R' of a series of point switches **11A**, **11B**, **11C** and **11D**. While this particular timing system comprises known elements, a brief description at this point of the construction and operation of the stepping relay will facilitate an understanding of the operation of the complete system. The several electrically insulated levels or sets of switches **11A**, **11B**, etc., include 26 contacts which are swept over by the arms R, R' which are mounted on a common shaft and rotated by successive deenergizations of the relay or magnet MM. The relay MM is energized through a circuit including the normally closed contact **10***b* of relay **10**, and has a second energizing circuit including its own normally closed contact MM*a*. Relay MM has a normally open contact MM*b* which, upon energization of MM, closes a circuit to energize the winding about pole P of the vibrator 9. The vibrating reed V of the unit **9** moves between and alternately engages the joined contacts **9***b* and **9***c*, and closes contacts **9***a*, **9***b* when first strongly attracted to pole P. The vibrator arm V has a positive polarity from source B' and, when it closes contacts **9***a*, **9***b* a circuit is completed through the winding of relay **10** which has a short circuited sleeve for imparting a slow release characteristic. Current flow to relay **10** closes its holding contacts **10***a* and opens contacts **10***b*, thus deenergizing relay MM and thereby effecting an advance of the contact arms R, R' by one step. Dropping of the armature of relay MM also opens contact MM*b* to deenergize the vibrating reed relay **9**. The vibrating reed oscillates between and for a predetermined time, say five seconds, alternately engages contacts **9***b*, **9***c* to supply current impulses to relay **10** through the holding contact **10***a*. So long as these periodic contacts are made, the armature of relay **10** is held in, but the armature drops when the vibrating reed V fails to engage a contact, thus closing contacts **10***b* to energize the relay MM to start a second cycle of operations. When energized through contact **10***b*, the relay MM advances the radial arms one step for each cycle of vibration of the reed V but relay MM may be operated more rapidly when energized through a circuit including its own contact MM*a*. Upon such energization, the relay MM breaks its own supply circuit as its armature pulls in and this deenergization moves the radial arms one step as the armature drops out to close contacts MM*a*. The armature vibrates rapidly and steps the arms around in a small fraction of the period required when current flow to MM is controlled by the vibrating reed relay **9**. Arms R, R of switches **11B**, **11C** are electrically connected, and arms R', R' of switches **11A**, **11D** are both connected to the positive terminal of the current source B'. The contacts **1** to **24** of switch **11A** are all connected electrically and the initial contact *c* and final contact **25** on which the diametrically opposed branches of its arm R' normally rest receive a positive potential from the source of current B', as will be described in detail hereinafter. In switch **11B**, contacts *c* to **22** are all connected but contacts **23** to **25** are open.

Returning to a description of the relay circuits, the energization of the second sequentially operated relay **7** closes contacts **7***b* to apply a positive potential from source B' both to the armature contact of contacts **10***b*, thus energizing relay MM of the timing mechanism, and to contacts *c* to **23** of the switch **11B**, which potential is thus applied to contact arm R, R of switches **11B** and **11C**. The positive side of the winding **8***m* of relay **8** is connected to the bar E of plug panel

13, the holding contacts 8a are in series with contacts 5b of relay 5 and contacts 12b of relay 12, and the contacts 8b are serially connected between bar T of the plug panel and relay 4.

The positive side of the main winding of the resetting relay 12 is connected to contact 23 of switch 11D and also to bar S of the plug panel through contacts b of the auxiliary switch operating mechanism OM. The holding contacts 12a of relay 12, and also the normally open contacts 12c which are in series with contact MMa of relay MM, are connected to the joined contacts 1 to 24 inclusive of switch 11A of the timing mechanism, and the normally closed contact 12d is serially connected between the positive terminal of source B' and contacts MMb to complete a circuit to the winding of the vibrating reed relay 9.

The points c to 22 inclusive of the switch 11C are individually connected to the short bars c, 1, 2, etc., which are arranged at right angles to and electrically insulated from the main bars E, T, S, respectively, of the plug panel. The intersecting sets of bars are provided with alined openings in which pins p may be inserted to connect the desired shorter bars to the main bars.

With the several pins p in positions shown in Fig. 1, the system is set to effect an immediate reclosure of the circuit breaker CB when it is tripped, with subsequent reclosures when contact R of switch 11C engages contacts 7 and 16, respectively. The sequence of operations of the elements of the system is shown graphically in Fig. 2 and is as follows.

In the case of a ground, one of the current relays 1 is actuated to energize relay T' from the source B and, in the case of a short, two or all three of the current relays 1 will be actuated. When relay T' is energized, the motor circuit is completed through the field winding T, and rotation of the motor M trips the circuit breaker CB, this operation including a momentary closure of the auxiliary switch contacts a. Closure of these contacts energizes relay 5 which closes the upper contact 5a to energize relay 6 which then locks in through its holding winding 6h and contacts 6a. As auxiliary contacts a open, the impulsing relay 5 is deenergized to close lower contacts 5a, thus energizing the second sequence relay 7 through contacts 6b. Closure of contacts 7b energizes relay MM of the timing device TM and applies a positive potential to contact arms R, R of switches 11B and 11C. Since the first pin p of bar E engages contact 11Cc, a circuit is immediately completed to winding 8m of relay 8, and its holding circuit is completed through contacts 12b, 5b and 8a. The energization of relay 8 closes contacts 8b and, when the relay MM steps the contact arms to point 1, a reclosing circuit is completed through contacts 7b, relay arm 11CR, bus contacts 1 and T, contacts 8b, auxiliary contacts c of OM, winding C' and source B. Motor M rotates to close the circuit breaker CB, and the further operation of the system depends upon the condition of line L. The complete cycle of operations in the event that the fault persists will first be described. In this case, the relays 1 effect an immediate opening of the circuit breaker and, assuming a five second timing of the reed relay 9, the next reclosure will occur thirty seconds later when the timing mechanism has moved arm 11CR into contact with point 8.

It is particularly to be noted that "pumping" or undesired reclosures of the circuit breaker are prevented during this interval since the momentary closure of contacts a of the mechanism OM during the closure of the circuit breaker energized relay 5 to open contacts 5b, thus breaking the holding circuit of relay 8 which, in turn, opens contacts 8b in the circuit of the reclosing relay 4. For convenience of the description, the relay 4 may be designated as the "reclosing relay" and relay 8 as the "antipumping relay".

When contact arm 11CR is advanced to points 7 and 16 by the timing mechanism TM, the relay 8 is energized and sealed in by its holding winding. When arm 11CR engages points 8 and 17, respectively, the closing circuit is again completed by the energization of relay 4. After the fourth tripping of the circuit breaker, the continued operation of the timing mechanism brings contact arm 11DR' to point 23 and completes a circuit to the winding of relay 12, and the pulling in of its armature closes its holding circuit through 12a and contact arm 11AR' which then engages point 23. Contacts 12b and 12d open to break the holding circuits of the sequence relays 6, 7 and of the vibrating reed relay 9, respectively. The closing on contacts 12c completes a circuit to relay MM through MMa, which circuit is immediately broken as the armature pulls in to open contacts MMa. This advances contact arm R' of switch 11A to point 24 and the next operation of relay MM through closure of its contacts MMa steps the several contact arms R, R' to points 25, the opposite branch of each arm engaging the initial point c. Since point 25 of switch 11A is not connected to holding contacts 12a of relay 12, the relay is deenergized and the entire system is thus reset.

If the disturbance was of a transitory nature and disappeared before the first reclosure of the circuit breaker, the system is reset within approximately five seconds when the contact arm 11CR is advanced to point 2 which is connected to bar S of plug panel 13 by the first pin p of that bar. As contacts b of the auxiliary switch of mechanism OM are closed when the circuit breaker is closed, a circuit is thus completed to the main winding of relay 12 and the consequent closure of contacts 12c completes a circuit to contact MMa of the timing relay MM which effects rapid operations of that relay to step the contact arms R, R' through the remainder of a 180° rotation to restore the timing mechanism to its original position. A similar rapid resetting of the system is effected if the fault is removed before the second or third reclosure of the line.

This immediate resetting of the relay system for a complete cycle of three reclosures is particularly important as it prevents the complete isolation of the line in the event that a transient disturbance is followed by a second disturbance within the maximum operating time allowed for one complete cycle by the timing mechanism TM.

As applied to the control of a reclosing circuit breaker, the invention presents the decided advantages that rapid adjustment of the number and/or timing of the reclosures may be obtained by varying the position of pins p in the plug panel 13, and that an economical current source B' may be energized for energizing the system. Batteries of the type commonly employed for supplying the plate voltage of radio receivers may be employed as only a small current drain is required for the operation of the small relay units and the timing mechanism. A further adjustment of the oper-

ating time may be effected by adjusting the frequency of vibration of the reed V of relay 9.

I claim:

1. In a relay system, a switch to be controlled, means responsive to a predetermined condition for actuating said switch in one sense, means responsive to said actuation of said switch to produce a plurality of electrical impulses, a plurality of relays, certain of said relays being sequentially actuated by said impulses, each of said sequentially-actuated relays including holding means for retaining the same in actuated position upon actuation thereof and each when in actuated position closing contacts in the energization circuit of another relay, a timing device having an energizing circuit controlled by one of said sequentially-actuated relays, means for actuating said switch in a sense opposite that effected by said first switch-actuating means, and switch means actuated by said timing device for periodically energizing said second switch-actuating means.

2. A relay system as claimed in claim 1, wherein said timing device includes means for deenergizing the holding means of at least one of the sequentially-actuated relays upon the occurrence of a second and different predetermined condition.

3. A relay system as claimed in claim 1, wherein said timing device includes means for deenergizing the holding means of at least one of the sequentially-actuated relays in the event said predetermined condition is absent upon the completion of an actuation of said switch in the said opposite sense by said second switch-actuating means.

4. A relay system as claimed in claim 1, wherein said timing device includes means for deenergizing the holding means of at least one of the sequentially-operated relays in the event the said predetermined condition persists for a predetermined period after the initial occurrence thereof.

5. A relay system as claimed in claim 1, wherein said timing device includes means for deenergizing the holding means of at least one of the sequentially-actuated relays, in the event the said predetermined condition persists for a predetermined period after the initial occurrence thereof or, alternatively, in the event that said predetermined condition is absent upon the completion of an actuation of said switch in the said opposite sense by said second switch-actuating means.

6. In a switch controlling device, a switch, means for actuating said switch in one sense upon the occurrence of a predetermined condition, a timing device including a plurality of sets of switch arms and cooperating sets of contacts, means energizing said timing device for a fixed cycle of movement at a predetermined rate upon the occurrence of said predetermined condition, means for actuating said switch in an opposite sense, an energizing circuit for said second switch-actuating means and including a switch arm and the cooperating contacts of said timing device, means including a second switch arm and its cooperating contacts for deenergizing said second switch-actuating means upon the occurrence of a second and different predetermined condition, and means for increasing the rate of movement of said timing device upon the occurrence of the said second predetermined condition.

7. In a relay system, the combination with an impulsing relay having an energizing circuit responsive to a condition exterior to said system, a relay for controlling an external circuit, a timing device. and means energized by said impulsing relay for initiating the operation of said timing device; said timing device including a stepping relay controlling a plurality of contact arms each movable over a series of contacts, a vibrating reed relay and a slow release relay for controlling current flow to said stepping relay; of a resetting relay for restoring said timing device to its normal condition, an energizing circuit for said resetting relay including one of the contact arms and associated contacts of said timing device, and a second energizing circuit for said resetting relay; said second energizing circuit including another contact arm of said timing device, a contact associated with said other contact arm, and a circuit external to said relay system.

8. In a relay system, a relay having an actuating winding included in a circuit having means for automatically closing the same upon the occurrence of a predetermined condition, holding means for retaining said relay in actuated position upon the actuation thereof, a timing device having an energizing circuit adapted to be closed upon the energization of said relay, said timing device including a contact arm progressively movable over a plurality of contacts, a plug panel including a set of main panel bars and a set of bars arranged transversely of said panel bars and connected to the respective contacts, said sets of bars having alined openings for receiving connecting pins, and circuits including translating devices connected between said contact arm and the respective main panel bars, whereby said circuits are progressively closed when said timing device moves said contact arm progressively into engagement with the respective contacts.

9. In a relay system, a timing device including a plurality of switch arms simultaneously and progressively movable over a series of contact points, relay means responsive to a condition external to said system for initiating the operation of said timing device, a set of apertured bars connected to the respective contact points associated with one contact arm, a plurality of apertured panel bars arranged transversely of said first set of bars, pins removably mounted in the apertures of said bars for establishing electrical connections between bars of said sets, and a plurality of circuits each including one of said panel bars and thereby controlled by the adjustment of the contact arm associated with the point contacts associated with said first set of apertured bars.

10. A relay system as claimed in claim 9, in combination with means for resetting the said several contact arms of said timing device to their initial positions, and an energizing circuit for said resetting means including a contact arm of said timing device other than the contact arm movable over the contact points connected to said first set of apertured bars.

11. A relay system as claimed in claim 9, in combination with means for resetting the said several contact arms of said timing device to their initial positions, and a plurality of circuits for the alternative energization of said resetting means, each of said energizing circuits including a contact arm of said timing device other than the contact arm movable over the contact points connected to said first set of apertured bars.

12. In a relay system, a pair of relays adapted to be sequentially operated by successive electrical impulses, each relay including holding means for retaining the same in actuated condition upon actuation thereof and the first of said relays controlling contacts in the energizing circuit of the

second relay, a timing device including a plurality of switches, an energizing circuit for said timing device including contacts closed by said second relay when the same is actuated, and means energized through a circuit including a switch of said timing device for rendering one of said holding means inoperative.

13. In a relay system, a pair of relays adapted to be sequentially operated by successive electrical impulses, each relay including holding means for retaining the same in actuated condition upon actuation thereof and the first of said relays controlling contacts in the energizing circuit of the second relay, a timing device including a plurality of switches, an energizing circuit for said timing device including contacts closed by said second relay when the same is actuated, means energized alternatively through a pair of circuits each including a switch of said timing device for rendering one of said holding means inoperative and for resetting said timing device.

14. In a relay system, a pair of relays adapted to be sequentially operated by successive electrical impulses, each relay including holding means for retaining the same in actuated condition upon actuation thereof and the first of said relays controlling contacts in the energizing circuit of the second relay, a timing device including a plurality of switches, an energizing circuit for said timing device including contacts closed by said second relay when the same is actuated, means energized through a circuit including a switch of said timing device for closing a circuit external to said relay system, and means responsive to a condition existing in said external circuit for resetting said timing device to its original normal condition and for rendering both of said holding means inoperative.

15. In a reclosing circuit breaker, a circuit breaker, means for automatically opening said circuit breaker upon an overload condition, means for periodically reclosing said circuit breaker in the event that said overload condition persists, timing means for deenergizing said reclosing means after a predetermined number of reclosures of said circuit breaker, means operative upon the initial opening of said circuit breaker to energize said timing means for a fixed cycle of movement in a predetermined time interval, and means operative in the event that said overload condition disappeared prior to a reclosure of said circuit breaker for completing the said fixed cycle of movement of said timing means in a time interval less than said predetermined time interval.

16. In a relay system for reclosing a switch of the type which includes means automatically operative upon the occurrence of a predetermined condition for opening the same and means for reclosing the same, said system comprising an impulsing relay, a pair of relays sequentially operated by successive electrical impulses delivered by said impulsing relay, a timing device including a plurality of simultaneously and progressively actuated switches, a reclosing relay adapted to be connected in circuit with the reclosing means of the switch, said reclosing relay having an energizing circuit including a timing device switch which includes a plurality of periodically closed contacts, a resetting relay in a circuit including a second timing device switch, and an anti-pumping relay included in a circuit of a third timing device switch and having contacts included in the energizing circuit of said reclosing relay.

17. In a reclosing circuit breaker, the combination with a circuit breaker, means for actuating the same to open and to closed position, a pair of control means for determining the alternative operations of said circuit breaker, and means automatically energizing the means for opening the circuit breaker in the event of an overload, of an impulsing relay, a circuit for energizing said relay and including contacts momentarily closed upon each opening and each closing of said circuit breaker, a pair of relays sequentially operated by impulses delivered by said relay upon energization and deenergization thereof, each of said relays including holding means for retaining the same in actuated position upon the actuation thereof, a timing device having an energizing circuit including contacts closable by the second of said relays, a reclosing circuit including a reclosing relay having an energizing circuit including normally open contacts controlled by an anti-pumping relay, a contact arm movable by said timing device over a plurality of point contacts, connections from a plurality of said point contacts to the energizing circuit of said anti-pumping relay, whereby the movement of said contact arm over said point contacts energizes the anti-pumping relay a plurality of times, to set said reclosing relay for actuation, means controlled by said timing device for actuating said reclosing relay, and a holding circuit for said anti-pumping relay including contacts of said impulsing relay, whereby said impulsing relay is deenergized upon the reclosure of said circuit breaker following energization of said reclosing relay, thereby deenergizing said reclosing relay to prevent repeated operations thereof in the event said circuit breaker opens upon the said reclosure thereof.

18. A reclosing circuit breaker as claimed in claim 17 in combination with a resetting relay, a circuit controlled by said resetting relay and including means for deenergizing said pair of sequentially-operated relays, a circuit controlled by said resetting relay for restoring said timing device to its initial normal condition, and means controlled by said timing device for energizing said resetting relay.

19. In a relay system, a switch to be controlled, a relay for closing a circuit to actuate said switch, a series of relays, means operative in response to a succession of predetermined conditions to effect the successive actuation of the relays of said series, a timing device including a plurality of sets of switch arms and cooperating sets of contacts, means including contacts closed by one of the first relays of said series for energizing said timing device, and means actuated by said timing device for rendering said series of relays inoperative in the event that the last of said predetermined conditions does not occur within a predetermined period after the energization of that relay which energizes said timing device.

20. In a repeating switch unit, the combination with a switch, means for actuating said switch in one sense from a normal position upon the occurrence of a predetermined condition, and restoring means for actuating said switch in the opposite sense to return the same to its normal position, of a source of power for energizing said restoring means, timing means energized for one fixed cycle of movement at a predetermined rate upon the initial actuation of said switch by said first actuating means, switch mechanism comprising a series element in an energizing circuit connecting said restoring means to said source of

energy, said switch mechanism being closed a predetermined number of times by said timing mechanism during one cycle of movement thereof, whereby said switch will be returned to its normal position a predetermined number of times within a fixed period of time in the event said predetermined condition continues throughout that period, and means operative in the event said condition is absent upon any one return of said switch to its normal position to increase the rate of movement of said timing means to complete its cycle of movement substantially immediately.

21. A repeating switch unit as claimed in claim 20, wherein said switch mechanism includes means manually adjustable to control the time interval between successive closures of said switch mechanism by said timing means.

22. A repeating switch unit as claimed in claim 20, wherein said switch mechanism includes means manually adjustable to control the number of times said switch mechanism is closed during one cycle of operation of said timing mechanism.

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