Dec. 17, 1946. E. K. READ 2,412,934

CONTROL APPARATUS

Filed Dec. 12, 1942

Fig. 1.

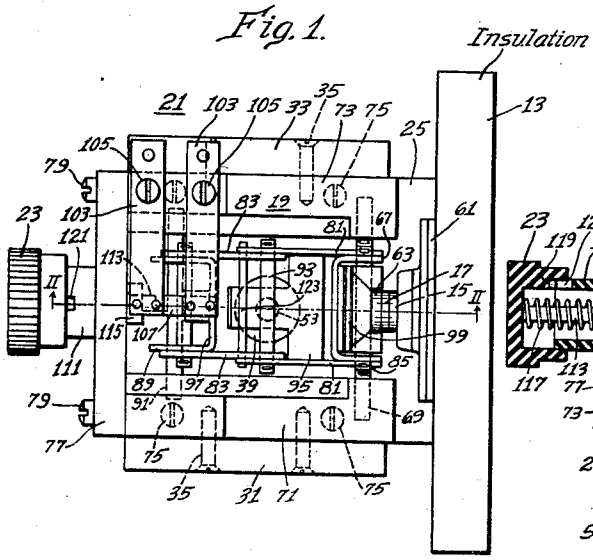


Fig. 2.

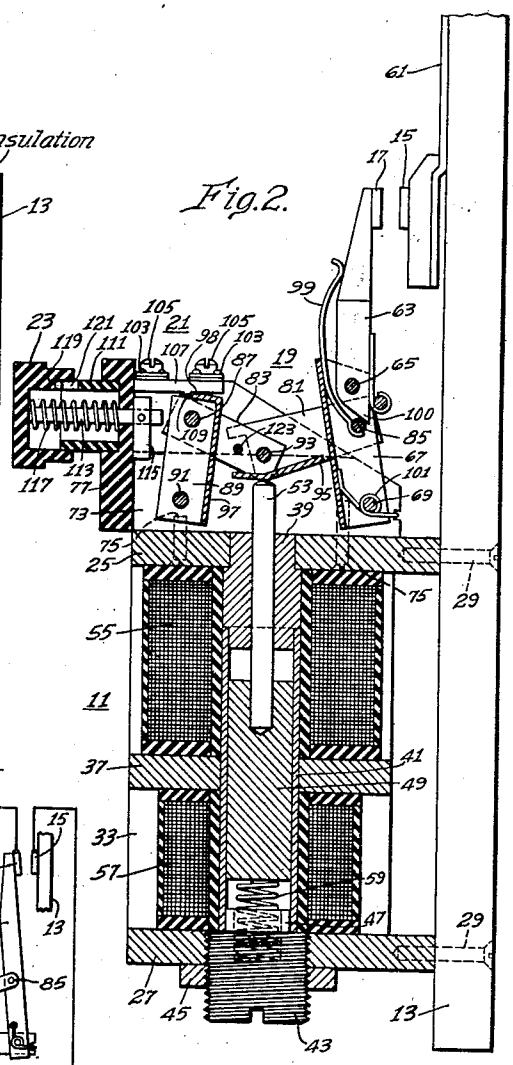
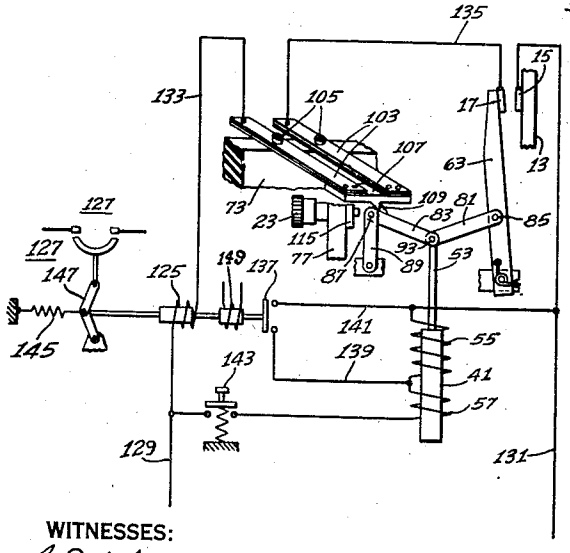


Fig. 3.



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CONTROL APPARATUS

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This invention relates to switches for the control of electrical apparatus and particularly for the control of circuit interrupters.

An object of the invention is to provide an improved arrangement for controlling the closing of a circuit interrupter which also prevents repeated opening and closing or "pumping" of the breaker.

Another object of the invention is to provide an improved control relay wherein a toggle is operable by an electromagnet to effect closing of a control circuit, the toggle being rendered non-responsive to the action of said magnet by manually operable means.

Another object of the invention is to provide an improved control relay for controlling the closing of a circuit interrupter wherein manual means is provided to render the operating mechanism for the relay contacts inoperative.

Another object of the invention is to provide an improved control relay wherein the operating mechanism for the relay contacts is operated by an electromagnet with means for restraining the operating mechanism in operative position, and current-responsive means to effect opening of the contacts irrespective of the energized condition of the electromagnet.

Another object of the invention is to provide an improved control relay with means for latching the contact operating toggle in operative position and manual means for rendering said toggle inoperative at will.

Another object of the invention is to provide an improved control relay having a magnetically operated toggle for closing the relay contacts in which a thermal element is provided in the control circuit to effect opening of the contacts irrespective of the operation of the magnet, and manually operable means for resetting said toggle to operative position.

The novel features that are considered characteristic of the invention are set forth in particular in the appended claims. The invention itself, however, both as to structure and operation, together with additional objects and advantages thereof, will be best understood from the following detailed description of an embodiment thereof when read in conjunction with the accompanying drawing, in which:

Figure 1 is a top plan view of a relay embodying the principles of the invention showing the relay contacts in the closed position;

Fig. 2 is a vertical sectional view taken substantially on the line II—II of Fig. 1 showing the

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relay with both coils deenergized and in the normally open position; and

Fig. 3 is a diagrammatic view showing the relay connected in a control circuit for controlling the operation of a circuit interrupter.

Referring particularly to Fig. 2 of the drawing, the control relay comprises generally an electromagnet 11 mounted on a base 13 of insulating material, a stationary contact 15, a movable contact 17, an operating mechanism 19, a thermal trip device 21 and a manual operating device 23.

The electromagnet 11 includes a frame of magnetic material comprising an upper frame member 25 and a lower frame member 27, both frame members being rigidly secured to the base 13 by means of screws 29. Two side frame members also of magnetic material are provided comprising plates 31 and 33 (Fig. 1) which are secured by means of screws 35 to the frame members 25 and 27. An intermediate frame member 37 of magnetic material is suitably secured to the side members 31 and 33 by screws (not shown). It will be obvious that the frame of the electromagnet 11 may be a one piece casting if desired. A stationary core member 39 has a reduced upper end which fits in an opening in the upper frame member 25 of the magnet frame. The lower end of the core member 39 is also reduced and fits into the upper end of a tube 41 of non-magnetic material. The tube 41 extends downwardly through an opening in the intermediate member 37, and its lower end rests on a screw plug 43 threadedly engaging an opening in the lower frame member 27 of the magnet frame. A lock nut 45 is provided to lock the screw plug 43 in position. A portion 47 of the plug 43 projects into the tube 41 and serves as a lower stationary core member.

Disposed for reciprocable movement within the tube 41 is a movable core member 49 having an operating rod 53 secured to the upper end thereof and projecting upwardly through an opening in the stationary core 39. Energizing coils 55 and 57 surrounding the tube 41 and core members are disposed respectively between the intermediate frame member 37 and the upper member 25, and between the intermediate member 37 and the lower frame member 27. It may be noted here that the upper coil 55 has a greater number of turns than the lower coil 57, so that when the coils are energized simultaneously the upper coil exerts the greater pull and moves the movable core 49 upwardly against the stationary core 39. Also, when both coils are deenergized, the movable core 49 is biased to a neutral or intermediate

position by a relatively weak coil spring 59 disposed in a spring seat in the plug 43 and bearing against the bottom of the movable core member 49.

The stationary contact 15 is mounted on the lower end of a conductor 61 secured to the upper portion of the base 13, the upper end of the conductor terminating in a connector (not shown) for connecting the contacts in an electrical circuit. The movable contact 17 is secured to a contact arm 63 pivotally supported on a pivot pin 65 mounted in a channel-shaped switch member 67. The switch member 67 is pivotally mounted on a pivot pin 69 supported in a frame comprising frame members 71 and 73 (Fig. 1) of insulating material secured by means of screws 75 to the upper magnet frame member 25, and rigidly connected at their left-hand ends (Figs. 1 and 2) by a cross member 77 also of insulating material. The cross member 77 is secured to the frames 71 and 73 by means of screws 79 (Fig. 1). The frame comprising the members 71, 73 and 77 may be of one piece moulded insulating material if desired.

The operating mechanism 19 includes a toggle comprising links 81 and 83 which has one end pivotally connected by means of a pivot pin 85 to the switch member 67, and the other end of the toggle is pivotally connected by means of a pivot pin 87 to a link 89 which is pivotally mounted on a pivot pin 91 supported in the frames 71 and 73. The toggle links 81 and 83 are pivotally connected together by a knee pivot pin 93. The toggle link 81 has spaced sides rigidly connected by a yoke 95, and the toggle link 83 comprises a pair of parallel links. The link 89 supporting the left-hand end of the toggle 81—83 is U-shaped having its sides connected by an integral cross portion 97, the upper end of which is formed over substantially as shown at 98 (Fig. 2).

Contact pressure is provided by a leaf spring 99 having an arcuate lower end bearing against the pin 85. The upper end of the spring 99 bears against the contact arm 63 and the mid-portion of the spring 99 is borne upon by the connecting part of the channel-shaped switch member 67 to tension the spring in a direction to bias the contact arm 63 in contact closing direction. When the switch arm 67 is in the open position (Fig. 2), the clockwise movement of the contact arm 63 about its pivot 65 is limited by a projection 100 thereon striking the pivot pin 85 which connects the toggle link 81 to the switch member 67.

The switch member 67 is biased in a counterclockwise or opening direction by a coil spring 101 having one end hooked over the right-hand end of the frame members 71 and 73 and the other end bearing against the switch member.

The thermal trip device 21 is provided to cause automatic separation of the contacts 15—17 in the event that the relay remains energized too long, or if the current traversing the circuit of the device is of too great a value. The trip device comprises a pair of bimetal elements 103 secured by means of screws 105 to the insulating frame 73 and extending inwardly therefrom (Fig. 1). At their inner ends, the bimetal elements 103 carry a latch member 107 of conducting material suitably rigidly secured thereto and having a latching projection 109 normally in engagement with the formed end 98 of the support link 89. The engagement of the end 98 of the link 89 with the latch 109 normally prevents counterclockwise rotation of the link. When the bimetal elements 103 are heated a predetermined amount in response to the flow of current therethrough, they deflect upwardly releasing the toggle support link 89 to effect opening of the contacts 15—17 as will be hereinafter described.

The manually operable member 23 is provided for the purpose of reengaging the toggle support link 89 with a latch 109 after the contacts have been opened under the control of the thermal trip device 21. The member 23 may also be operated to manually actuate the latch member 107 to thereby cause opening of the relay contacts 15—17 independently of the coils 55—57 and of the thermal elements 103.

The cup-shaped member or knob 23 is made of insulating material and is rotatably and slidably mounted on a sleeve 111 also of insulating material which is rigidly secured in a recess in the cross member 77. The knob 23 has a rod 113 (Fig. 2) rigidly secured to the inner wall thereof. The rod 113 projects through an opening in the cross member 77, and a cam 115 is secured to the rod on the inner side of the member 77. A coil spring 117 surrounding the rod 113 and disposed between the knob 23 and the cross member 77 biases the knob 23, the rod 113 and the cam 115 outwardly, which movement is limited by engagement of the cam 115 with the cross member 77.

After the contacts 15—17 have been operated to the open position by the action of the thermal trip device 21, releasing the support link 89, the link may be reengaged with the latch 109 by pressing the knob 23 inwardly. At this movement, the inner end of the rod 113 engages the pivot pin 87 and rotates the link 89 clockwise to reengage the end 98 of the link with the latch 109. Also during the inward movement of the knob 23, projection 119 on the inner part thereof engages a slot 121 in the sleeve 111 to prevent rotation of the knob 23 and consequently of the cam 115.

The purpose of the cam 115 is to manually disengage the latch 109 from the support link 89 to thereby render the device non-responsive to the electromagnet 11. The manual operation of the latch 107 is effected by rotation of the knob 23 and, therefore, of the cam 115 in either direction. During this rotation, the cam 115 engages and raises the latch member 107 to disengage the latch 109 from the end 98 of the link 89, thus rendering the relay inoperative to close the contacts or to hold the contacts closed. In this manner, the relay contacts may be opened and held in the open position irrespective of the energization of the coils 55—57 and operation of the rod 53.

When the knob 23 is rotated in order to render the closing mechanism ineffective to close the contacts, the projection 119 on the knob is moved away from the slot 121 in the sleeve in order to prevent inward movement of the rod 113. This prevents movement of the rod to actuate the link 89 to relatching position while the latch 107 is held in unlatching position by the cam 115. In order to reset the device, the knob 23 is first rotated to align the projection 119 with the slot 121. This moves the cam 115 out of engagement with the latch member 107, and the resilience of the bimetal elements 103 moves the latch member 107 downwardly until the latch 109 rests upon the top of the projection 98. The knob 23 may now be thrust inwardly to actuate the link 89 to relatching position.

The relay is shown in Fig. 2 with the coils 55 and 57 deenergized and the contacts in the nor-

tively movable relay contacts, an operating toggle operatively associated with said contacts, a pair of electromagnets having an armature for actuating said toggle to close said relay contacts, a control circuit, said electromagnets being connected to be energized by said control circuit, one of said electromagnets having a greater attractive force than the other, means operated by the closing of the circuit interrupter to deenergize said one electromagnet and permit the other of said electromagnets to attract and restrain the armature in inoperative position, and a thermal element releasably restraining said toggle in operative position, said thermal element being heated in response to the current in the control circuit and operable to release said toggle to thereby cause opening of said relay contacts and deenergization of said closing means irrespective of the energized condition of said electromagnets.

2. An electrical apparatus, the combination of a circuit interrupter having closing means, a relay for controlling the energization of said circuit interrupter closing means including relatively movable relay contacts, operating mechanism for said relay contacts, a pair of electromagnets having an armature for actuating said operating mechanism to close said relay contacts, one of said electromagnets when energized having a greater attractive force than the other, a control circuit, said pair of electromagnets being connected to be energized by said control circuit, means operated by the closing of said circuit interrupter for deenergizing said one electromagnet to permit the other of said electromagnets to attract and restrain the armature in inoperative position, a trip device including a thermal element heated in response to the current in the control circuit and operable when heated a predetermined amount to cause opening of said relay contacts irrespective of the energized condition of said pair of electromagnets, and manually operable means for resetting said trip device.

3. In an electrical apparatus, the combination of relatively movable relay contacts for controlling the energization of an operating device, a control circuit for energizing said operating device, operating mechanism for said relay contacts including a toggle operable to close said relay contacts, means for releasably restraining one end of said toggle in operative position, means comprising an electromagnet having an armature for actuating said toggle to close the relay contacts, a trip device including a bimetal element heated in response to the current of said control circuit, said bimetal being operable to effect opening of the relay contacts irrespective of the energized condition of said electromagnet, and manual means for resetting said restraining means, said manual means being settable to a position to permanently render the toggle ineffective to close the relay contacts.

4. In an electrical apparatus, the combination of an operating device, a control circuit for energizing said operating device, relatively movable relay contacts for controlling said circuit, operating mechanism for said contacts including a toggle having one end operatively associated with said contacts, the other end of said toggle being supported on a releasable member, electromagnetic means for operating said toggle to close the contacts, means comprising a bimetal element for restraining said releasable member in fixed position, said bimetal element being heated by the current of the control circuit and operable when heated a predetermined amount to release said releasable member to effect opening of the relay contacts irrespective of the energized condition of said electromagnet, and manually operable means to reset said releasable member.

5. In a control relay, the combination of relatively movable relay contacts, a toggle having one end operatively associated with said relay contacts, a releasable member supporting the other end of said toggle, electromagnetic means comprising an electromagnet for operating said toggle to close the contacts, a bimetallic latch normally engaging and restraining said releasable member in a fixed position, said bimetallic latch being operable in response to predetermined abnormal conditions to release said releasable member to thereby effect automatic opening of the relay contacts irrespective of the energized condition of said electromagnetic means, and manually operable means movable to one position to engage and reset said releasable members and settable to another position to engage and render said bimetallic latch permanently ineffective to restrain said releasable member.

6. In a control relay, normally open contact means, a toggle operatively associated with said contacts, electromagnetic means for operating said toggle to close the contacts, thermally responsive means for engaging and releasably restraining said toggle in operative position, said thermally responsive means being operable in response to predetermined abnormal conditions to release said toggle, and manual means operable on one direction to engage and reset said toggle to operative position and operable in another direction to actuate said thermally responsive means to release said toggle.

7. In an electrical apparatus, the combination of a switch member movable to a closed and an open position for controlling the energization of a circuit interrupter operating device, a control circuit for energizing said operating device, operating mechanism for said switch member including a toggle operatively associated with said switch member, means comprising a current responsive element for engaging and restraining said toggle in operative position, electromagnetic means comprising a pair of windings operable when energized to operate said toggle to an underset position to move said switch member to closed position, and to hold said switch member in closed position only when said magnetic means is energized, said current responsive means operable in response to the current of the control circuit to release said toggle and thereby effect movement of said switch member to open position to deenergize the operating device, and a rotatable member for operating the current responsive element to release the toggle.

8. In a control relay, the combination of relatively movable contacts for closing and opening a control circuit, a switch member movable to close and open said contacts, operating mechanism for said switch member including a toggle, means comprising a thermal element for engaging and releasably restraining said toggle in operative position, electromagnetic means for operating said toggle including a pair of windings, one of said windings when energized exerting a greater force than the other of said windings, means for deenergizing said one winding to permit the other of said windings to effect opening movement of the toggle and said switch member, said thermal element being operable in response to predetermined conditions in the control cir-

mally open position. When both coils are energized the attractive force produced by the upper coil predominates and moves the core 49 upwardly against the stationary core 39, thereby thrusting the rod 53 upwardly to straighten the toggle 81—83. Since at this time the link 89 is latched against counterclockwise movement, the thrust of the toggle rotates the switch arm 67 clockwise to close the contacts. The upward or straightening movement of the knee of the toggle 81—83 is limited by the yoke 95 engaging a pin 123 mounted in and extending between the toggle links 83 to the left of the knee pin 93. The limiting stop 123 limits upward movement of the toggle to a slightly underset position in which the knee pin 93 is slightly below a line joining the pivot pins 85—87. Consequently, when the coils 55—57 are deenergized and the core 49 and rod 53 resume their normal position, the spring 101 acts to move the switch arm 67 to open position, the toggle 81—83 collapsing to the position shown in Fig. 2.

Referring to Fig. 3, the operating winding 125 of a circuit interrupter, shown schematically at 127 is connected in series with a control circuit 129—131, the circuit extending from the conductor 129 through the winding 125, over a wire 133, thru the bimetal elements 103 and latch member 107, a flexible shunt conductor 135 connecting one of the bimetals 103 to the movable contact 17, the contact 15 to the conductor 131. The coils 55 and 57 are connected in series relation across the conductors 129—131. An auxiliary switch 137 is operated by the circuit interrupter 127 and is employed to short circuit the upper or relay closing coil 55 when the circuit interrupter 127 is in closed position, the contacts of the auxiliary switch 137 being connected to opposite sides of the coil 55 by means of wires 139 and 141. A control switch 143 is connected in series with the coils 55—57.

The circuit breaker 127 may be tripped open by means of a trip coil 149 energized by any suitable means, for instance, a protective relay (not shown), in response to abnormal conditions in the circuit controlled by the breaker 127. With the circuit interrupter 127 in open position and the control relay contacts 15—17 open, as shown in Fig. 3, it is necessary to close the contacts 15—17 of the relay in order to energize the interrupter operating winding 125. This is effected by closing the control switch 143 to simultaneously energize the coils 55—57. Because the coil 55 produces a greater magnetic force than the coil 57, the movable core 49 will, upon energization of the coils, be attracted upwardly to effect closing of the contacts 15—17 in the previously described manner to complete the circuit to the operating winding 125. Upon energization of the winding 125, the circuit interrupter 127 is operated to its closed position where, under normal conditions, it remains latched against an accelerating spring 145 which biases the interrupter to open position due to the overcenter condition of an operating toggle 147.

Toward the end of the closing movement of the circuit interrupter 127, the auxiliary switch 137 closes the circuit that shunts out the relay closing coil 55. Shunting out the coil 55 causes the magnetic flux of the core 39 to fall to a point where the still energized coil 57 will attract the movable core 49 and move the core 49 and the rod 53 to the lowermost limit of their downward travel wherein the movable core 49 is held against the stationary core 47 (Fig. 2). The downward movement of the rod, as previously described, permits the spring 101 to actuate the switch member 67 to the open contact position. The movable core 49 will be held against the lower stationary core 47 as long as the control switch 143 is held closed, energizing the coil 57, thus holding the energizing circuit for the interrupter operating winding 125 open.

If the circuit interrupter 127 is closed while an abnormal circuit condition is present in the main circuit, the circuit interrupter will be tripped to open position, thereby opening the auxiliary switch 137. If the control switch 143 is in closed position at this time, the coil 55 is again energized, but the attractive force of the coil 55 is not great enough to move the core 49 from the coil 57 and the stationary core 47, and the relay contacts 15—17 will remain open as long as the control switch 143 is held closed.

When the control switch 143 is opened, both of the coils 55 and 57 are deenergized and the spring 59 moves the core 49 to its neutral position as shown in Fig. 2.

By the use of the toggle 81—83, a mechanical advantage is gained which permits the use of less force for closing the relay contacts. The relay is, therefore, of a design which provides a longer interval of time before the magnetic flux falls to the point where the relay contacts will open. This is a desirable advantage because is provides sufficient time delay after the relay closing coil 55 is shunted out to permit the circuit interrupter to be moved to full closed position and latched closed before the operating winding 125 is deenergized by opening of the control relay contacts 15—17.

Another advantage of the invention resides in the provision of the thermal trip device which functions to cause opening of the relay contacts, if the relay stays closed too long or if the current is too great in the control circuit. The relay contacts will be tripped open in response to operation of the thermal trip device irrespective of the position of the closing mechanism, and irrespective of energization of the relay closing coil 55, thus protecting the operating winding 125 from damage resulting from abnormal circuit conditions in the contact circuit. The bimetal element 103 is calibrated to deflect and release the toggle in response to prolonged flow of normal current in the control circuit.

In addition, there is provided manually operable means for resetting the trip device following an automatic opening of the contacts in response to abnormal conditions. The manually operable means is also operable to effect opening of the relay contacts irrespective to the position or energized condition of the relay closing coil 55 and also to render the operating mechanism of the relay non-responsive to the coil 55 to close the contacts so that the relay cannot be operated to close the contacts as long as the knob 23 is in locking position.

Having described a preferred embodiment of the invention in accordance with the patent statutes, it is to be understood that various changes and modifications may be made therein without departing from some of the essential features of the invention. It is, therefore, desired that the language of the appended claims be interpreted as broadly as the prior art permits.

I claim as my invention:

1. In an electrical apparatus, the combination of a circuit interrupter having closing means, a relay for controlling the energization of said circuit interrupter closing means including rela-

cuit to release the toggle to thereby effect opening movement of the toggle and the switch member irrespective of the energized condition of said windings.

9. In a control relay, the combination of relatively movable contacts, a switch member operable to close and open said contacts, operating mechanism for said switch member, means for releasably restraining the operating mechanism in operative position, a movable core member operable to actuate the operating mechanism to move said switch member to closed position, electromagnetic actuating means for said movable core member including a pair of windings, one of said windings when energized exerting a greater force than the other winding on said movable core member, means for deenergizing said one winding to permit the other winding to attract and restrain the movable core member in inoperative position, and manually operable means for operating the restraining means to permit movement of the operating mechanism and the switch member to open position irrespective of the energized condition of said windings.

10. In a control relay, the combination of relatively movable contacts, a switch member movable to close and open said contacts, operating mechanism for said switch member including a toggle operable to an underset position to move the switch member to close the contacts, electromagnetic means for actuating said toggle to move said switch member to closed position, said toggle holding said switch member in closed position only when the electromagnet is energized, and manual means operable to render said electromagnetic means permanently ineffective to move the switch member to close the contacts irrespective of the energized condition of said electromagnetic means.

11. In a control relay, contact means, operating mechanism for said contacts, electromagnetic means operable when energized to actuate said operating mechanism to close the contacts, said operating mechanism being capable of holding said contacts closed only when said electromagnetic means is energized, thermally responsive means releasably restraining said operating mechanism and operable in response to predetermined abnormal conditions to release the operating mechanism and effect opening of the contacts irrespective of the energized condition of the electromagnetic means, and manually operable means movable in one direction for actuating said thermally responsive means to effect release of the operating mechanism and opening of the contacts irrespective of the energized condition of the electromagnetic means, said manually operable means being movable in another direction to reset said operating mechanism to operating position.

12. In a control relay, the combination of relatively movable contacts, a switch member movable to close and open said contacts, operating mechanism for said switch member including a linkage, electromagnetic means for operating said linkage to an underset position to move said switch member to close the contacts, said linkage holding the contacts closed only when said electromagnet is energized, a thermal element releasably restraining said operating mechanism and operable in response to predetermined abnormal conditions to effect movement of said linkage and said switch member to open the contacts irrespective of the energized condition of the electromagnet, and manual means operable

to actuate said thermal element to a permanent non-restraining position.

13. In a control relay, the combination of relatively movable contacts, a toggle movable to an underset position to close said contacts, electromagnetic means for moving said toggle to close said contacts and hold said contact closed only when said electromagnet is energized, means for causing energization of said electromagnet, said electromagnet comprising a pair of windings one of said windings having a greater force than the other for moving said toggle to close the contacts, switch means operable upon closure of said contacts for effecting deenergization of said one winding, said other winding upon deenergization of said one winding attracting and moving said armature to permit movement of said toggle to open said contacts.

14. In a control relay, the combination of relatively movable contacts, a linkage movable to an underset position to close said contacts, an armature for moving said linkage to said underset position, and an electromagnet comprising a pair of windings for actuating said armature, means for effecting simultaneous energization of said windings, one of said windings having a greater attractive force than the other winding for operating the armature to close the contacts, means operable upon closure of said contacts to effect deenergization of said one winding, said other winding upon deenergization of said one winding attracting and moving the armature to thereby permit movement of said linkage to open the contacts.

15. In a control relay, the combination of relatively movable contacts, a toggle movable to an underset position to close said contacts, an armature for moving said toggle to said underset position, electromagnetic means including a pair of windings, switch means for energizing said windings, one of said windings exerting a greater attractive force than the other for operating said armature to close the contacts, switch means for deenergizing said one winding, said other winding upon deenergization of said one winding moving the armature to a position to permit movement of the toggle to open the contacts, a thermally responsive element operable to effect opening of said contacts irrespective of the energized condition of said windings.

16. In a control relay, the combination of relatively movable contacts, a toggle movable to an underset position to close said contacts, an armature for moving said toggle, electromagnetic means including a pair of windings, switch means operable to energize said pair of windings, one of said windings exerting a greater attractive force than the other winding for operating said armature to close the contacts, a switch operable to cause deenergization of said one winding, said other winding upon deenergization of said one winding moving the armature to permit movement of said toggle to open said contacts, a thermally responsive element operable to effect movement of said toggle to open said contacts irrespective of the energized condition of said windings, and manual means for resetting said toggle.

17. In a control relay, the combination of relatively movable contacts, a toggle movable to an underset position to close said contacts, an armature for moving said toggle, electromagnetic means including a pair of windings, a switch for effecting energization of said windings, one of said windings exerting a greater attractive force than the other winding for operating said armature

to close the contacts, a switch operable to deenergize said one winding, said other winding upon deenergization of said one winding operating the armature to a position to permit movement of said toggle to open said contacts, a thermally responsive element operable to effect movement of said toggle to open the contacts

irrespective of the energized condition of said windings, and manual means operable to reset said toggle, said manual means being also operable to effect movement of said toggle to an inoperative position.

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