Patented June 6, 1933 1,912,610

UNITED STATES PATENT OFFICE

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ELECTRICAL DEVICE

Application filed November 7, 1927. Serial No. 231,601.

My invention relates to electrical devices and has particular reference to switches for controlling motor circuits and the like.

One object of my invention is to provide a switch for controlling an electric circuit comprising protective means responsive to a condition of the circuit to be controlled and means for readily varying the setting of the productive means to cause the same to control the operation of the switch in any desired manner.

Another object of my invention is to provide a switch of the above indicated character wherein protective means responsive to a condition of the circuit to be controlled are adapted to be returned to operative condition after an operation thereof, either automatically or in response to the operation of a manually operable device.

Other objects and advantages of my invention will be seen from a consideration of the following detailed description taken in connection with the accompanying drawings, in which:

Figure 1 is a perspective view of the switch embodying my invention with the cover member of a casing therefor in open position;

Fig. 2 is a sectional view taken along the line II—II of Fig. 1, with certain parts broken away;

Fig. 3 is a fragmentary sectional view taken along the same line as Fig. 2, and showing certain parts in different operative positions from those shown in Fig. 2;

Fig. 4 is a fragmentary sectional view taken along the line IV—IV of Fig. 1, and showing an auxiliary switch embodied in my invention;

Fig. 5 is a fragmentary sectional view taken along the line V—V of Fig. 2;

Fig. 6 is a fragmentary sectional view taken along the line VI—VI of Fig. 5;

Fig. 7 is a front elevational view of the switch embodying my invention;

Fig. 8 is a fragmentary front elevational view showing an indicating device utilizing in connection with the switch embodying my invention; and

Fig. 9 is a diagrammatical representation of the electrical circuits of a system with which my invention is adapted to be utilized.

Referring to the drawings, an electric switch 1 having stationary contact members 2 and movable contact members 3 is mounted on a base member 4 that is secured to the rear wall of a casing 5 by means of bolts 6 and nuts 7 and is separated therefrom by means of spacing members 8. The provision of the base member 4 permits ready assembly thereon of all the apparatus that is to be enclosed by the casing 5. Such apparatus may then be inserted in and removed from the casing 5 as a unit, and is adapted to be secured in position and released, as desired, simply by manipulating the nuts 7.

The stationary contact members 2 are secured by screws 9 to conducting members 10, which, in turn, are secured to individual insulating base members 11 by screws 12 and 13. Each of the contact members 2, may, therefore, be quickly removed by removing the proper one of the screws 9, and may be replaced by manipulating a single screw. Arc barriers 14 of suitable material, such as asbestos composition, are disposed between the several stationary contact members 2 and the base members 11 therefor. The several base members 11 and barriers 14 are assembled as a unit and secured together by means of a bolt or rod 15 and a nut 16 therefor. Rotatory displacement of the base members 11 with respect to the barriers 14 is prevented by projecting shoulder portions 17 of the base members 11 which extend over the ends of the barriers 14. The rod 15 also secures in position, with respect to the barriers 14 and the base members 11, bracket members 18 that are adapted to be secured to the base member 4 by screws 19. In this manner, it will be seen that the barriers 14 and the base members 11, together with the conducting members 10 and contact members 2 that are supported thereby, are mounted as a unit on the base member 4 by means of the brackets 18 and screws 19.

The movable contact members 3 are provided with supporting members 20 to which the contact members 3 are secured by rods 21, springs 22, and caps 23. The springs 22

are disposed around the rods 21 and the inner ends thereof are held in position by cap-shaped members 24. The outer ends of the springs 22 are held in position with respect to the rods 21 by the cap members 23. The cap members 23 are provided with slotted openings 25 and depressions 26, and the rod 21 is provided with relatively flat projecting portions 27. The openings 25 in the cap members 23 are of suitable size to permit the cap members 23 to be placed upon the rods 21. When the cap members 23 are so placed beyond the projecting portions 27, the cap members may be turned through an angle of approximately 90° and released. The depressed portions 26 of the cap members 23 will then be engaged by the projecting portions 27 of the rods 21 to secure the same in position. Thus it will be seen that the contact members 3 may be readily attached to the supporting members 20 without the use of tools or implements of any kind. It is only necessary to remove a single terminal screw and to release a spring cap to render any one of the contact members 3 instantly detachable.

The supporting members 20 are adapted to be secured to an operating member 28 of insulating material by screws 29. The operating member 28 is provided, at the end thereof, with pins 30 that are adapted to be pivotally supported by bracket members 31. The bracket members 31 are secured to the base member 4 by screws 32 or other suitable means. The operating member 28, being of solid insulating material, cannot warp or wear through and cause short circuits, and provides a rugged and reliable mounting for the movable contact members 3.

A lever arm 33 that is secured to the operating member 28 by screws 34 is pivotally secured to one end of link members 35, the opposite extremities of which are pivotally secured to a lever arm 36. The lever arm 36 is pivotally supported by a pin 37 which also engages a fixed supporting member 38. The supporting member 38 is secured to an electromagnetic core member 39 which is mounted on the base member 4 by screws 40 and is insulated therefrom by means of a sheet 41 and a washer 42 of any suitable insulating material.

A coil 43 is disposed around one leg of the core member 39 and is held in position by supporting members 44 that are secured by screws 45 to projecting wings 46 of the other leg of the core member 39.

An armature member 47 is fixedly secured to the lever arm 36 to provide a pivotal mounting for said armature member with respect to the pin 37. A member 48 that is also secured to the wings 46 by the screw 45 provides a stop for the armature member 47 to limit the movement thereof away from the core member 39. The magnet coil 43, when energized, is adapted to set up sufficient magnetic flux in the core member 39 and the armature member 47 to actuate the armature member 47 into engagement with the core member 39. When the armature member 47 is thus actuated, the movable contact members 3 are actuated into engagement with the stationary contact members 2 through the mechanical linkage comprising the lever arm 36, the link members 35, the lever arm 33, the operating member 28, and the supporting members 20 to which the movable contact members 3 are resiliently secured by the springs 22.

The resilient connection between the contact members 3 and the supporting members 20 is so arranged that the contact members 3 will engage the stationary contact members 2 before the armature member 47 has been actuated through its complete path of travel. As soon as the contact members 3 engage the contact members 2, the supporting members 20 are actuated away from the contact members 3 to compress the springs 22, thereby causing the contact members 3 to engage the contact members 2 with a firm wiping and rocking action. In this manner, perfect electrical contact between the members 2 and 3 is insured, and the members 2 and 3 are of such heavy material, that a current path of extremely low resistance is secured when the magnet coil 43 is de-energized, the armature member 47 returns to its initial position by the action of gravity and the force of the compressed springs 22, and the movable contact members 3 are thus actuated out of engagement with the stationary contact members 2.

An auxiliary base member 49, which is preferably of insulating material, is secured to the base member 4 by screws 50 and is provided with spacing portions 51 to maintain the main and auxiliary base members in spaced relation. Bracket members 52 are secured to the auxiliary base member 49 and are adapted to support thermostatic members 53 at one extremity of each of said thermostatic members. The opposite extremities of the thermostatic members 53 are adjacent each other and are adapted to be actuated in accordance with the temperature of the thermostatic members. The thermostatic members are of heavy material and large size, thus insuring positive deflection and relatively quick return to normal position, since a large heat radiating surface is obtained by this construction. Resistor elements 54 are supported by bracket members 55 of electrical conducting material that are suitably secured to the auxiliary base member 49. The resistor elements 54, which are preferably made in grid form of wire having suitable electrical resistance, comprise lug members 56 suitably secured thereto and are adapted to carry any desired identifi-

cation marks, such as an indication of the current-carrying capacity of the element or the like.

The resistor elements 54 are connected in series circuit relation with two of the movable contact members 3 by means of the bracket members 55, flexible conductor members 57, and a suitable insulated conductor 58. Since only two resistor elements are required for use in connection with a three-wire circuit, the remaining movable contact member 3 of the switch 1 is connected through a flexible conductor member 59 and a bus bar 60 to a connection post 61 to which a conductor 62 extending through the casing 5 is adapted to be connected. Other such conductors 63 and 64 are connected to the bracket members 55 by means of connection posts 65 and 66.

A protective device 67 for controlling the energization of the electromagnet 43 comprises an auxiliary electromagnet 68 and a core member 69 therefor secured to the auxiliary base member 49. An armature member 70 for the electromagnet 68 is secured to a switch operating member 71 that is pivotally supported by bracket members 72, which, in turn, are secured to the auxiliary base member 49. An upwardly extending portion 73 of the switch operating member 71 supports a contact point 74 that is adapted to engage a contact member 75 that is resiliently mounted by means of a supporting member 76 and a bracket member 77 secured to the auxiliary base member 49. The contact member 74 is preferably of silver to insure the making of perfect electrical contact at all times. Electrical connections to the contact member 74 is affected through a flexible conductor 78, permitting the main portion of the switch operating member 71 to be made of insulating material.

A downwardly extending portion 79 of the member 71 is adapted to be engaged by a latching member 80 that is pivotally mounted on a bracket member 81 secured to the base member 4. A tension spring 82 is connected at one end thereof to a hook member 83 secured to the base member 4, and at its other end to the latching member 80. The latching member 80 comprises a backwardly extending portion 84 that is adapted to engage the base member 4 to limit the upward movement of the latching member 80 under the influence of the spring 82.

The pivotally mounted latching member 80 and the spring 82 are so constructed and arranged that the member 80 may be manually actuated by means of an outwardly extending portion 85 into the position shown in broken lines in Fig. 2 of the drawings. When the member 80 is so actuated, the spring 82 passes over the pivotal axis of support of the member 80 to maintain said member in the position to which it is thus actuated. Thus, it will be seen that the mounting of the member 80 comprises a toggle mechanism. When the member 80 is manually actuated to the position shown in broken lines in Fig. 2, it is ineffective to accomplish the purpose for which it is provided, but when it is returned to the position shown in full lines, it is effective to latch the switch operating member 71 in the position to which this member is actuated when the electromagnetic coil 68 is energized, as hereinafter described.

When the magnet coil 68 is energized, the armature member 70 is attracted toward the core member 69 to actuate the contact member 74 out of engagement with the contact member 75. If the latching member 80 has not been manually actuated out of its operative position the spring 82 thereupon actuates the member 80 into the position shown in Fig. 3 of the drawings, in which position this member engages the downwardly extending portion 79 of the switch operating member 71 to prevent said member from returning to the position shown in Fig. 2. In this position the extending portion 84 of the member 80 is in engagement with the base member 4, thereby limiting the movement of the member 80.

As shown in Fig. 5 of the drawings, a laterally extending portion 86 of the member 80 is adapted to be engaged by a lever arm portion 87 of a rod 88 that is rotatably mounted by bracket members 89. The bracket members 89 are secured to the base member 4 by screws or rivets 90. The outer extremity of the rod 88 forms a crank arm 91 which projects through a slotted aperture 93 in an operating member 92. The operating member 92 is pivotally mounted by a pin 94 extending through the wall of the casing 5. A slotted aperture 95 in the wall of the casing 5 permits a handle member 96 that is secured to the operating member 92 to extend therethrough.

A tension spring 97 is connected at one end thereof to a hook member 98 that is secured to the casing 5 and at the opposite end thereof to a projecting portion 99 of the operating member 92. The operating member 92 and the handle member 96 are thus maintained in their uppermost positions by the spring 97, but are adapted to be actuated downwardly against the tension of the spring 97 by manipulation of the handle member 96. When the handle member 96 is thus manipulated, the rod 88 is turned in the bracket member 89, and the lever arm portion 87 is actuated downwardly into engagement with the projecting portion 86 of the latching member 80. The latching member 80 is thereby actuated downwardly against the tension of the spring 82 to cause the member 80 to disengage the downwardly

extending portion 79 of the switch operating member 71. The member 71 is thereupon permitted to return to the position shown in Fig. 2 by the action of gravity, and the contact member 74 again engages the contact member 75.

For the purpose of controlling the energization of the electromagnet 68, a switch 100 comprising an adjustable fixed contact member 101 and a movable contact member 102 is provided. The contact members 101 and 102 are preferably constructed with silver tips. The contact member 101 is mounted upon a screw-threaded member 103 that is adapted to engage a correspondingly screw-threaded opening in a bracket member 104. A lock-nut 105 is provided for the purpose of securing the screw-threaded member 103 in any desired position with respect to the bracket member 104. The bracket member 104 is suitably secured to the auxiliary base member 49 and is of electrical conducting material to constitute a portion of the circuit extending through the contact members 101 and 102. A conductor 106 extends from a connection post 107 that is connected to the bracket member 104 to certain apparatus located outside the casing 5, which is hereinafter described. The conductor 78, which, as previously described, is connected to the movable contact member 74 through the upwardly extending member 73 associated with the switch operating member 71, is also connected to the connection post 107.

The movable contact member 102 is supported by the lower extremity of a channel-shaped member 108, the upper end of which is secured by rivets 109 to a resilient member 110. The resilient member 110 is similarly connected by rivets 111 to an upwardly extending portion 112 of a bracket member 113 that is secured to the auxiliary base member 49 by a screw 114. The bracket member 113 is of electrical conducting material and is provided with a screw 115 by means of which a conductor 116 is electrically connected through the bracket member 113, the resilient member 110 and the channel member 108 to the movable contact member 102. The conductor 116 extends from the screw 115 to one terminal of the magnet coil 68, as will more clearly appear by referring to the circuit diagram of Fig. 9, which is hereinafter described in detail.

A resilient member 117 is also secured by the rivets 109 to the channel member 108 and the resilient supporting member 110. The member 117 extends downwardly adjacent the member 108, but in slightly spaced relation thereto. At the lower extremity of the member 117 a hook portion 118 is provided and extends through an aperture 119 in the member 108. The member 117 is biased by its resiliency away from the member 108, but the movement thereof away from the member 108 is limited by the hook portion 118 which engages the member 108 below the aperture 119, through which the said hook portion extends. The lower extremity of the resilient member 117 also comprises a detent portion 120 that is adapted to cooperate with a latching member 121 that is secured to the switch operating member 71, as will be described presently.

The bracket member 113 comprises a downwardly bent portion 122 at the outer end thereof and two bent portions 123, in turn, extend outwardly from the portion 122. A resilient member 124 is provided with a vertically slotted aperture 125, through which the outwardly extending portions 123 and a screw 126 are adapted to extend to permit the resilient member 124 to be moved vertically with respect to the bracket member 113. A thumb screw or knurled nut 127 is provided with screw-threads whereby it may engage the outwardly extending screw-threaded portion of the screw 126 to secure the resilient member 124 in position with respect to the bracket member 113.

A calibrating member 128 is also provided with a vertical slotted aperture 129 whereby this member may be secured in fixed vertical position with respect to the bracket member 113 by means of the thumb screw 127. A series of substantially semi-cylindrical indentations 130 along one of the vertical edges of the calibrating member 128 are adapted to be engaged by a pin 131, whereby the vertical position of the calibrating member 128 with respect to the bracket member 113 may be adjusted as desired.

An index marking 132 on the calibrating member 128 serves in conjunction with a scale member 133 that is secured to the resilient member 124 and has graduated markings thereon, to indicate the position of the resilient member 124 with respect to the calibrating member 128. A handle member 134 of insulating material is secured to the upper portion of the resilient member 124 to facilitate adjustment thereof. It will be seen that the member 124 may be adjusted vertically with respect to the bracket member 113, simply by loosening the thumb screw 127 and manipulating the handle member 134 as desired. Since the calibrating member 128 is engaged at the indentations 130 by the pin 131, the position of this member may not be adjusted without removing the thumb screw 127 from the screw 126 to permit the member 128 to be moved outwardly out of engagement with the pin 131. By this means accidental displacement of the calibrating member 128 when the member 124 is being adjusted is prevented.

A portion 135 of the resilient member 124 near the lower extremity thereof is bent in-

wardly toward the channel member 108 and extends between the channel member 108 and the extremities of the thermostatic members 53. The extreme lower portion of the member 124 is again bent outwardly from an arcuate portion 136 that is adapted to engage the channel member 108.

The thermostatic members 53 are supported in relatively close proximity to the resistor elements 54, as previously described, and as shown in the drawings. Therefore, the temperature of the thermostatic members 53 is directly controlled by the temperature of the resistor elements 54, which, in turn, is dependent upon the value of the current traversing the circuit in which these elements are connected. As the temperature of the thermostatic members 53 increases by reason of an increase in the value of the current traversing the circuit in which the resistor elements 54 are connected, these members are deflected in such manner that the adjacent movable extremities thereof are actuated toward the inclined portion 135 of the resilient member 124. Lugs 137 of substantially hemi-spherical surface are secured to the adjacent inner extremities of the thermostatic members 53 and are adapted to engage the inclined portion 135 of the resilient member 124. It is preferable to provide members 138 of suitable heat resisting and electrical insulating material, such as asbestos composition, between the lugs 137 and the main portions of the thermostatic members 53 to prevent the lugs 137 from attaining an excessive temperature and transmitting such temperature to the resilient member 124. By making the members 138 of electrical insulating material, proper electrical spacing is obtained and the occurrence of short circuits by reason of accidental contact between the thermostatic members 53 and the resistor elements 54 is prevented.

As the movable extremities of the thermostatic members 53, or either of them, are actuated inwardly in response to an increase in the temperature of the thermostatic members, the lower portion of the resilient member 124 is engaged by the lugs 137 and is likewise actuated inwardly to actuate the channel member 108 against the biasing action of the resilient member 110. The movable contact member 102 is thus actuated toward the fixed contact member 101, and, if the temperature of either of the thermostatic members 53 attains a predetermined value, the contact member 102 will be actuated a sufficient distance to engage the contact member 101. When such engagement occurs a circuit is completed for energizing the magnet coil 68, as will be fully described hereinafter with reference to the circuit diagram of Fig. 9. When the magnet coil is thus energized, the armature member 70 is attracted to the core member 69 to cause the movable contact member 74 instantaneously to disengage the resiliently mounted contact member 75. When these contact members are disengaged, the energizing circuit of the electromagnet 43 is interrupted, as will also be described hereinafter with reference to Fig. 9. De-energization of the magnet coil 43 permits the switch 1 to be opened, thereby interrupting the circuit extending through the resistor elements 54.

When the armature member 70 is actuated in response to energization of the magnet coil 68, the outer extremity of the latching member 121 that is associated with the switch operating member 71 is actuated upwardly and past the detent portion 120 of the resilient member 117. The resiliency of the member 117 permits the latching member 121 to move upwardly past the detent portion 120, but when the latching member 121 has been so actuated the detent portion 120 is again biased to the position in which the hook portion 118 thereof engages the channel member 108, as shown in Fig. 2 of the drawings. The various members referred to then occupy the positions illustrated in Fig. 3, in which it will be seen that the switch operating member 71 cannot return to the position in which the contact members 74 and 75 are engaged until both of the thermostatic members 53 have moved back a sufficient distance to permit the detent portion 120 to disengage the latching member 121. Before the thermostatic members 53 can move back such a distance, it is necessary that the temperature of these members be reduced to a predetermined value, and it is for this purpose that the detent portion 120 and the latching member 121 are provided. By reason of the operation of these members, the magnet coil 68 may be de-energized immediately after the armature member 70 has been actuated into engagement with the core member 69 and the disengagement of the contact members 101 and 102 will not affect engagement of the contact members 75 and 74. This construction insures quick and positive interruption and completion of the circuit of the main switch operating magnet 43 under all conditions, and thereby precludes chattering and burning of the contact members of both the main and auxiliary switches.

In order to provide emergency means for interrupting the circuits of the magnet coil 43 to open the switch 1 and to preclude reclosing thereof without opening the casing 5, a manually operable switch 139 is provided, as shown in Figs. 1 and 7 of the drawings, and is connected in series circuit relation with the magnet coil 43. The switch 139 is of the knife-blade type and is provided with a handle member 139a of insulating material to which a cord 140 or other suitable tensible means are connected. A

hooked rod 141 is connected to the lower extremity of the cord 140 and extends through an opening 142 in the casing 5. The lower extremity of the rod 141 outside the casing 5 is provided with a ring 143 whereby the switch 139 may be manually opened from without the casing 5. By reason of the nature of the connection between the rod 141 and the switch handle 139a, it will be seen that the switch 139 cannot be re-closed without opening the casing 5.

A closure member 144 is mounted on the casing 5 by means of hinges 145 whereby the apparatus within the casing may be completely enclosed. Suitable latching means 146 are provided for securing the closure member 144 in closed relation to the casing 5 and a member 147 having an opening 148 therein is also secured to the casing 5 and is adapted to co-operate with a corresponding member secured to the closure member 144 in such manner that locking means may be inserted through the openings in said members to preclude opening of the closure member 144 without the use of a suitable key or the like.

In order that the operative condition of the switch 1 may be ascertained from without the casing 5 while the closure member 144 is in closed relation thereto, an indicating member 149 is secured to an outwardly extending portion 150 of the lever arm 33. An aperture 151 is provided in the closure member 144, through which the indicating member 149 may be viewed, and this aperture is covered by a member 152 of suitable transparent material that is preferably secured to the inner surface of the closure member 144 as shown in Fig. 2 of the drawings. The fragmentary view shown in Fig. 8 illustrates the manner in which the position of the switch 1 is indicated by the member 149 while the closure member 144 is in closed relation to the casing 5.

Fig. 7 shows the arrangement of certain of the power and control conductors that are associated with the apparatus mounted within the casing 5. As previously described, the power conductors 62, 63, and 64 are connected to the circuit or apparatus to be controlled by the switch embodying my invention. Electrical energy is supplied to such circuit or apparatus through the switch and the conductors 62, 63, and 64 from any suitable source to which supply conductors 153, 154, and 155 are connected. The latter conductors are connected, respectively, to the conducting members 10 to which the stationary contact members 2 of the switch 1 are secured. A control conductor 156 is connected by a screw 157 to the conducting member 10 to which the power conductor 153 is connected and extends to a control station outside the casing 5, which will be described with reference to Fig. 9. A control conductor 158 is connected by a screw 159 to the conducting member 10 to which the power conductor 155 is connected and extends to one terminal of the electromagnet 43. The other terminal of the electromagnet 43 is connected through a control conductor 160 to one terminal of the manually operable switch 139, the other terminal of which is connected through a control conductor 161, the bracket member 77, and the resilient member 76 to the contact member 75, which was previously described.

An auxiliary switch 162, shown in detail in Fig. 4, comprises a resilient conducting member 163, the lower end of which is secured to and supported by the auxiliary base member 49 in electrical conducting relation to one end of a conductor 164, to which reference is made hereinafter. The member 163 extends upwardly and somewhat forwardly from its point of support on the base member 49, and is provided near its upper extremity with a contact member 165 to co-operate with a similar contact member 166. The latter contact member is secured to a resilient conducting member 167 near the lower extremity thereof. The upper extremity of the member 167 is secured to and supported by the left-hand one of the conducting members 10 in electrical conducting relation thereto and extends downwardly and somewhat rearwardly therefrom to support the contact member 166 in relatively close proximity to the contact member 165.

An auxiliary actuating member 168 of insulating material is secured to the operating member 28 and extends upwardly and rearwardly therefrom to engage the resilient member 163 when the operating member 28 is turned to close the main switch 1. When such operation takes place, the resilient member 163 is actuated rearwardly by the auxiliary actuating member 168 to cause the contact member 165 to engage the contact member 166. The positions of the contact members and operating members after such operation has taken place are indicated in broken lines in Fig. 4.

It will be seen that when the contact members 165 and 166 are engaged, as above described, the conductor 164 is electrically connected to the supply conductor 153 through resilient member 163, contact members 165 and 166, resilient member 167 and conducting member 10. The conductor 164, as shown in broken lines in Fig. 7, extends downwardly on the rear surface of the auxiliary base member 49 to be connected to a connection post 171, whence connection is made to the control station outside the casing 5 by means of a control conductor 172.

One terminal of the electromagnet 68 is connected by the conductor 116 and screw 115 to the conducting bracket member 113, as described with reference to Fig. 2. The

other terminal of the electromagnet 68 is connected by a conductor 116a to a connection post 116b, to which the conductor 58 and the right-hand one of the conductors 57 are connected. The connection post 116b is, therefore, electrically connected to the supply conductor 155 when the switch 1 is closed.

Referring now to the diagram shown in Fig. 9, it will be seen that the control conductors 106, 156, and 172 extend to a control station comprising a normally open starting switch 173 and a normally closed stopping switch 174. For the purpose of describing the operation of the device embodying my invention, it will be assumed that the main switch 1 is open, that the supply conductors 153, 154 and 155 are properly energized and that it is desired to energize the circuit or apparatus to which the power conductors 62, 63 and 64 are connected. When these conditions obtain, the starting switch 173 will be closed by an operator to effect energization of the electromagnet 43 through a circuit extending from the supply conductor 153 through the control conductor 156, the starting switch 173, the control conductors 106 and 78, the contact members 74 and 75, the resilient member 76, the control conductor 161, the manually operable switch 139, the control conductor 160, the operating coil of the electromagnet 43, and the control conductor 158 to the supply conductor 155.

The main switch 1 is closed in response to the energization of the electromagnet 43 this circuit, and the auxiliary switch 162 is simultaneously closed to complet a holding circuit for the operating coil of the electromagnet 43. This holding circuit is connected in parallel relation to the starting switch 173 and extends from the supply conductor 153 through the auxiliary switch 162, the control conductors 164 and 172, and the normally closed stopping switch 174. Thus, it will be seen that energization of the electromagnet 43 is maintained to maintain the switch 1 in closed position as long as the supply conductors 153, 154, and 155 are normally energized, the manually operable switch 139 and the stopping switch 174 are permitted to remain in closed position, and the contact members 74 and 75 remain in engagement. An abnormal reduction of the voltage between the supply conductors 153 and 155 will automatically result in opening of the switch 1, since the operating coil of this switch is energized from these conductors. Inherent low voltage protection is thus obtained at all times.

The switch 1 may be opened at any time by opening the stopping switch 174 momentarily to interrupt the holding circuit for the operating coil of the electromagnet 43, or by opening the manually operable switch 139. stopping switch 174 is utilized to effect opening of the switch 1, but in the event of an emergency the manually operable switch 139 may be opened by manipulating the ring 143, as previously described. When the switch 139 is thus opened, it is necessary for the casing 5 to be opened before the apparatus can be restored to operative condition. An emergency requiring the operation of the switch 139 might be caused by reason of a short circuit between the control conductor 106 and either of the control conductors 156 and 172. In the event of such a short circuit, the opening of the stopping switch 174 would be ineffective to interrupt the energizing circuit of the electromagnet 43. The switch 139, may also be opened when it is desired to protect persons working on the circuit to which the conductors 62, 63 and 64 are connected in which case the closure member 144 of the casing 5 would preferably be locked in closed position to preclude premature reclosing of the switch 139.

The switch 1 may also be opened in response to the operation of the protective device 67, which is effective to cause disengagement of the contact members 74 and 75 when the temperature of the thermostatic members 53 becomes excessive by reason of an excessive current traversal of the power conductors with which the resistor elements 54 are associated. In the event of such excessive current traversal of the power conductors and the resistor elements 54, which might be caused either by a fault in the circuit or apparatus to which the power conductors are connected or by a failure of one phase of the supply circuit, either or both of the thermostatic members 53 will be deflected inwardly to cause the corresponding lug or lugs 137 to engage the inclined surface portion 135 of the resilient member 124. The channel member 108 is thereupon engaged by the arcuate portion 136 of the member 124 to cause the contact member 102 to be actuated into engagement with the contact member 101 against the biasing action of the resilient member 110.

When the contact members 101 and 102 are thus engaged, a circuit is completed from the supply conductor 153 through the auxiliary switch 162, the control conductors 164 and 172, the stopping switch 174, the contact members 101 and 102, the channel member 108, the resilient member 110, the bracket member 113, the screw 115, the control conductor 116, the operating coil of the electromagnet 68, the control conductor 116a, and the switch 1 to the supply conductor 155. The electromagnet 68 is thus energized from the supply conductors 153 and 155 to cause the armature member 70 to be actuated into engagement with the core member 69. The contact member 74 is thereby actuated out of engagement with the con-

tact member 75, to interrupt the energizing circuit of the electromagnet 43, and the main switch 1 and the auxiliary switch 162 are permitted to open, the latter switch opening by reason of the resiliency of the member 163 when said member is disengaged by the actuating member 168 in response to the opening of the main switch 1.

When the armature member 70 is actuated in the manner described, the latching member 121 is actuated upwardly past the detent member 120, which is then biased back under the latching member 121 to maintain the armature member 70 in closed relation to the core member 69, although the electromagnet 68 has been deenergized by reason of the opening of the main switch 1. Reengagement of the contact members 74 and 75 is thus prevented until the thermostatic members 53 have cooled sufficiently to permit the channel member 108, under the biasing influence of the resilient member 110, to actuate the detent member 120 out of engagement with the latching member 121.

In the event of operation of the protective device 67 in the manner described, it is necessary that the starting switch 173 be closed by an operator before the main switch 1 can be reclosed. If the latching member 80 is in its operative position it is also necessary that the handle member 96 extending through the wall of the casing 5 be depressed to permit the contact members 74 and 75 to be re-engaged. If the latching member 80 has been manually actuated out of operative position, however, the switch 1 may be reclosed simply by closing the starting switch 173 as soon as the thermostatic members 53 have cooled sufficiently to permit the channel member 108 to actuate the detent member 120 out of engagement with the latching member 121, thereby permitting the contact members 74 and 75 to be engaged.

The degree of overload which will effect operation of the protective device 67 may be predetermined by selecting the desired rating of interchangeable resistor elements 54, as may be indicated on the members 56 that are associated therewith, as previously described, and also by adjusting the vertical position of the resilient member 124 as desired. The scale member 133 that is associated with the member 124 is preferably graduated in percentages of the rating of the resistor elements 54.

Thus, when the member 124 is so adjusted that the index marking 132 on the calibrating member 128 is in alignment with the 100 percent. marking on the scale member 133, the protective device 67 will function in the manner described when either or both of the resistor elements 54 are traversed by current of the rated capacity of such elements. When the member 124 is raised above this position by loosening the thumb-screw 127 and manipulating the handle member 134 to bring a higher percentage marking on the scale member 133 into alignment with the index marking 132, the thermostatic members 53 must be deflected inwardly a greater distance before the lugs 137 will engage the inclined surface of the member 124, and, therefore, a greater current traversal of the resistor elements 54 is required to effect operation of the protective device 67. The opposite is true, of course, when the member 124 is moved downwardly.

The calibrating member 128, which carries the index marking 132, is adjusted when the device is assembled or put into service by so adjusting the position of the member 124 that the protective device 67 will function when the resistor elements 54 are traversed by currents corresponding to their rated capacities. When this position is determined, the member 124 is held in such position while the thumb-screw 127 is removed to permit the calibrating member 128 to be placed in position with the projecting portions 123 of the bracket member 113 extending through the aperture 129 in the calibrating member, and with the pin 131 engaging the proper indentation 130 to cause the index marking 132 to be brought into alignment with the 100 per cent. marking on the scale member 133. The thumb-screw 127 is then replaced and the position of the calibrating member 128 cannot thereafter be changed without removing the said thumb-screw again. The position of the member 124 may be adjusted as desired, however, by simply loosening the thumb-screw 127 slightly and manipulating the handle member 134. The setting of the device is always accurately indicated by the index marking 132 cooperating with the scale member 133, because the device is accurately calibrated when put into service, as described.

From the foregoing description it will be seen that I have provided a simple and effective remotely controlled switch for controlling the energization of an electric circuit. Under normal conditions the electric circuit is energized and de-energized in response to the operation of starting and stopping switches, respectively. Readily adjustable protective means are operative at all times when the main switch is closed to effect opening thereof in response to abnormal circuit conditions, and latching means are provided for precluding reclosing of the main switch in response to actuation of the starting switch until the latching means have been manually reset. If desired, these latching means may be rendered inoperative to accomplish this result. Emergency means are also provided for opening the main switch and for precluding reclosure thereof without opening the casing within which

the switch and the protective means are enclosed.

While I have shown and described only one specific embodiment of my invention, it will be understood that various changes and modifications may be made in the devices and circuits utilized in connection therewith without departing from the spirit and scope of my invention. Therefore, I desire that my invention be limited only by the scope of the appended claims and the prior art.

I claim as my invention:

1. A device for controlling an electric circuit comprising a switch, holding means for maintaining the switch in closed position, means actuable in accordance with a condition of the circuit to be controlled for rendering the holding means ineffective, means for controlling said actuable means to maintain the holding means ineffective subject to a condition of the circuit to be controlled, and means capable of being rendered effective at will to prevent the holding means from being rendered again effective subject to the exercise of an external influence.

2. A device for controlling an electric circuit comprising a main switch normally biased to open position, electromagnetic means for actuating said main switch to and maintaining it in closed position, an auxiliary switch in circuit with the electromagnetic means, means for opening the auxiliary switch in accordance with a condition of the circuit to be controlled by the main switch, means for precluding reclosing of the auxiliary switch subject to the exercise of an external influence, and means whereby operation of said precluding means may be prevented.

3. A device for controlling an electric circuit comprising a main switch normally biased to open position, electromagnetic means for actuating said main switch to and maintaining it in closed position, an auxiliary switch in circuit with the electromagnetic means, means responsive to a collection of the circuit to be controlled by the main switch for opening the auxiliary switch, latching means for maintaining the auxiliary switch in open position and means for precluding the operation of said latching means.

4. A device for controlling an electric circuit comprising a main switch, closing means therefor, means for rendering said closing means ineffective, means for preventing said closing means from being rendered again effective, and means for precluding the operation of said preventing means.

5. A device for controlling an electric circuit comprising a main switch, closing means therefor, means for rendering said closing means ineffective, latching means for maintaining said closing means ineffective, and means for precluding operation of said latching means.

6. A device for controlling an electric circuit comprising a main switch, closing means therefor, means for controlling the operation of said closing means in accordance with predetermined conditions of the circuit to be controlled by the main switch, means for limiting the operation of said controlling means and means for preventing operation of said limiting means.

7. A device for controlling an electric circuit comprising a main switch, electromagnetic closing means therefor, an auxiliary switch for controlling the energization of said electromagnetic means, means for opening said auxiliary switch in response to predetermined conditions in the circuit to be controlled by the main switch, means requiring the exercise of an external influence before said auxiliary switch can be reclosed and means whereby operation of said last-mentioned means may be prevented.

8. A device for controlling an electric circuit comprising a main switch, electromagnetic closing means therefor, an auxiliary switch in circuit with said electromagnetic means, electromagnetic means for opening said auxiliary switch, a member adapted to be actuated in accordance with the predetermined condition of the circuit to be controlled by the main switch, a second auxiliary switch actuated by said member and connected in circuit with the electromagnetic means for the first-mentioned auxiliary switch and latching means actuated by said member for maintaining said first-mentioned auxiliary switch in open position.

9. A device for controlling an electric circuit comprising a main switch, electromagnetic operating means therefor, an auxiliary switch in circuit with said electromagnetic means, electromagnetic means for opening said auxiliary switch, means for energizing the electromagnetic means for the auxiliary switch in accordance with a predetermined condition of the circuit to be controlled by the main switch and mechanical latching means also adapted to be actuated in accordance with said predetermined condition of the circuit to be controlled by the main switch for maintaining the auxiliary switch in open position.

10. A device for controlling an electric circuit comprising a main switch, electromagnetic operating means therefor, an auxiliary switch in circuit with said electromagnetic means, means for opening said auxiliary switch, latching means for maintaining said auxiliary switch in open position, manually operable releasing means for said latching means, and means for rendering said latching means ineffective to maintain said auxiliary switch in open position.

11. A device for controlling an electric

circuit comprising a main switch, electromagnetic actuating means therefor, an auxiliary switch in circuit with said electromagnetic means, a casing enclosing said main switch, electromagnetic means and auxiliary switch, said casing comprising an openable closure member, a handle member associated with the auxiliary switch whereby said switch may be manually closed while the closure member is in open relation to the casing, a manually operable member extending through said casing, and tensible means connecting said handle member and said manually operable member whereby said auxiliary switch may be opened but not closed by manipulating said manually operable member from without the casing while said closure member is in closed relation to the casing.

12. A protective device for an electromagnetically operated switch comprising a member actuable in response to a condition of the circuit to be controlled by said switch, electromagnetic means energized in response to the actuation of said member to interrupt the energizing circuit for the operating electromagnet of said switch and mechanical means actuated by said member to preclude re-energization of said operating electromagnet.

13. A protective device for an electromagnetically operated main switch comprising an auxiliary switch in circuit with the operating electromagnet of the main switch, electromagnetic means for opening said auxiliary switch, mechanical means for holding said auxiliary switch in open position and means responsive to a condition of the circuit to be controlled by the main switch for controlling said electromagnetic means and said mechanical means.

14. In combination, an electric circuit, a main switch for controlling said circuit, an auxiliary switch for controlling the operation of the main switch, electromagnetic means for opening said auxiliary switch, mechanical means for precluding reclosure of said auxiliary switch and means responsive to a condition of said circuit for controlling said electromagnetic means and said mechanical means.

15. An electrical protective device comprising a switch, electromagnetic means for opening said switch, mechanical means for precluding reclosure of said switch and a single means for controlling both said electromagnetic means and said mechanical means.

16. In combination, an electric circuit, a main switch for controlling said circuit, an auxiliary switch for controlling the operation of said main switch, electromagnetic means for opening said auxiliary switch, mechanical latching means for precluding reclosure of said auxiliary switch and an actuable member for effecting energization of said electromagnetic means in response to a predetermined thermal condition of said electric circuit and for releasing said mechanical latching means in response to another thermal condition of said electric circuit.

17. In combination, an electric circuit, a main switch for controlling said circuit, an auxiliary switch for controlling the operation of said main switch, electromagnetic means for opening said auxiliary switch, mechanical latching means for precluding reclosure of said auxiliary switch and thermo-responsive means associated with said electric circuit for controlling the operation of said electromagnetic means and said mechanical latching means.

18. In combination, an electric circuit, a main switch for controlling said circuit, an auxiliary switch for controlling the operation of said main switch, electromagnetic means for opening said auxiliary switch, mechanical latching means for precluding reclosure of said auxiliary switch and thermo-responsive means associated with said electric circuit for effecting energization of said electromagnetic means and for rendering said mechanical latching means ineffective.

19. A device for controlling an electric circuit comprising a switch, holding means for maintaining the switch in closed position, means actuable in accordance with a condition of the circuit to be controlled for rendering the holding means ineffective, means for controlling said actuable means requiring the exercise of an external influence before the holding means can be rendered again effective and further means for controlling said actuable means in accordance with a condition of the circuit to be controlled, said first-mentioned controlling means being capable of ready disablement whereby said actuable means may again render said holding means effective solely in accordance with said last-mentioned condition of the circuit to be controlled.

20. A device for controlling an electric circuit comprising a main switch normally biased to open position, electromagnetic means for actuating said main switch to and maintaining it in closed position, an auxiliary switch in circuit with the electromagnetic means, means for opening the auxiliary switch in accordance with a condition of the circuit to be controlled by the main switch, means for precluding reclosing of the auxiliary switch subject to the exercise of an external influence, and a mounting for said precluding means including parts that may be readily manipulated to render said precluding means ineffective.

21. A device for controlling an electric circuit comprising a main switch normally

biased to open position, electromagnetic means for actuating said main switch to and maintaining it in closed position, an auxiliary switch in circuit with the electromagnetic means, means responsive to a condition of the circuit to be controlled by the main switch for opening the auxiliary switch and for controlling the reclosing thereof, interengaging latching members for maintaining the auxiliary switch in open position and means for supporting one of said latching members so arranged that said member may be readily removed from effective position to render the reclosing of said auxiliary switch subject to the control of said means responsive to a condition of the circuit to be controlled by the main switch.

22. A device for controlling an electric circuit comprising a main switch, closing means therefor, means for rendering said closing means ineffective, means automatically operative upon said closing means being rendered ineffective for preventing said closing means from being rendered again effective, and means for supporting said preventing means in such manner that the latter may be readily manipulated to remove the same from operative position.

23. A device for controlling an electric circuit comprising a main switch, closing means therefor, means for rendering said closing means ineffective, interengaging latching members for maintaining said closing means ineffective, and means for supporting one of said latching members so arranged that said member may be readily removed from effective position.

24. A device for controlling an electric circuit comprising a main switch, closing means therefor, means for controlling the operation of said closing means in accordance with predetermined conditions of the circuit to be controlled by the main switch, and means for limiting the operation of said controlling means, said limiting means being readily manipulable to remove the same from effective position and thereby to prevent the same from functioning in any way.

25. A device for controlling an electric circuit comprising a main switch, electromagnetic closing means therefor, an auxiliary switch for controlling the energization of said electromagnetic means, means for opening said auxiliary switch in response to predetermined conditions in the circuit to be controlled by the main switch, and means requiring the exercise of an external influence before said auxiliary switch can be reclosed, said last-mentioned means being readily manipulable to remove the same from effective position.

26. A device for controlling an electric circuit comprising a main switch, electromagnet operating means therefor, an auxiliary switch in circuit with said electromagnetic means, means for opening said auxiliary switch, interengaging latching members for maintaining said auxiliary switch in open position, manually operable releasing means for one of said latching members, and means for supporting said one of said latching members so arranged that said member may be readily manipulated to remove the same from effective position.

27. A device for controlling an electric circuit comprising a main switch, electromagnetic operating means therefor, an auxiliary switch in circuit with said electromagnetic means, and means actuable in accordance with a predetermined condition of the circuit to be controlled by the main switch for opening said auxiliary switch, a portion of said actuable means serving, when said auxiliary switch is opened, to prevent reclosing of said auxiliary switch until a predetermined change has occurred in said predetermined condition of the circuit to be controlled by the main switch.

28. A device for controlling an electric circuit comprising, a main switch, electromagnetic operating means therefor, an auxiliary switch in circuit with said electromagnetic means, and means actuable in accordance with the thermal condition of the circuit to be controlled by the main switch for opening said auxiliary switch, a portion of said actuable means serving, when said auxiliary switch is opened, to prevent reclosing of said auxiliary switch until a predetermined change has occurred in the thermal condition of the circuit to be controlled by the main switch.

In witness whereof, I have hereunto subscribed my name.

JULES A. WIDMER.

CERTIFICATE OF CORRECTION.

Patent No. 1,912,610. June 6, 1933.

JULES A. WIDMER.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, line 47, for "utilizing" read "utilized"; page 7, after line 64, insert the words "In the normal operation of the device the"; page 9, line 23, claim 1, before "at" insert "or ineffective"; and line 46, claim 3, for collection" read "condition"; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 29th day of August, A. D. 1933.

M. J. Moore.

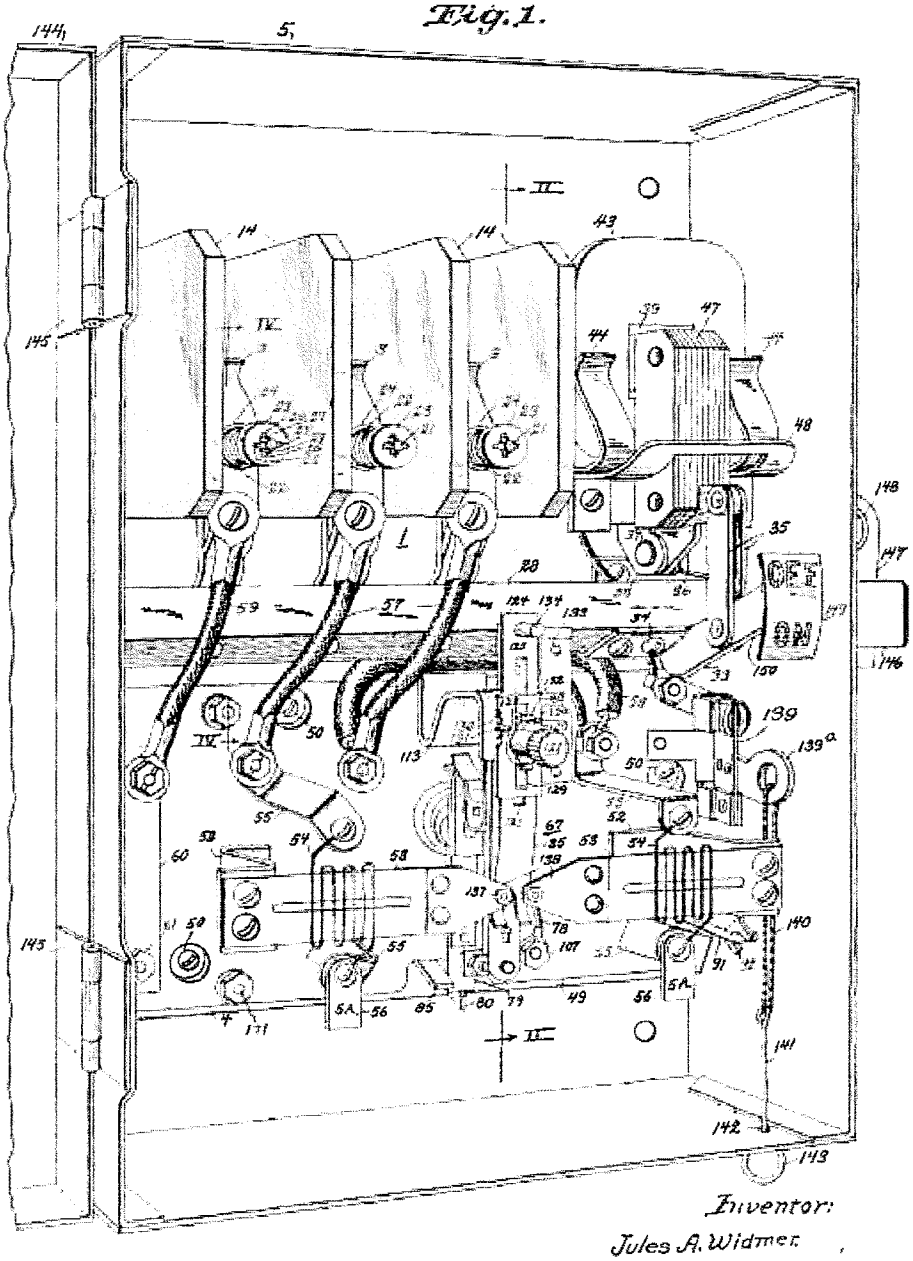
(Seal) Acting Commissioner of Patents.

June 6, 1933. J. A. WIDMER 1,912,610

ELECTRICAL DEVICE

Filed Nov. 7, 1927 3 Sheets-Sheet 1

Fig. 1.



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