

Nov. 20, 1951

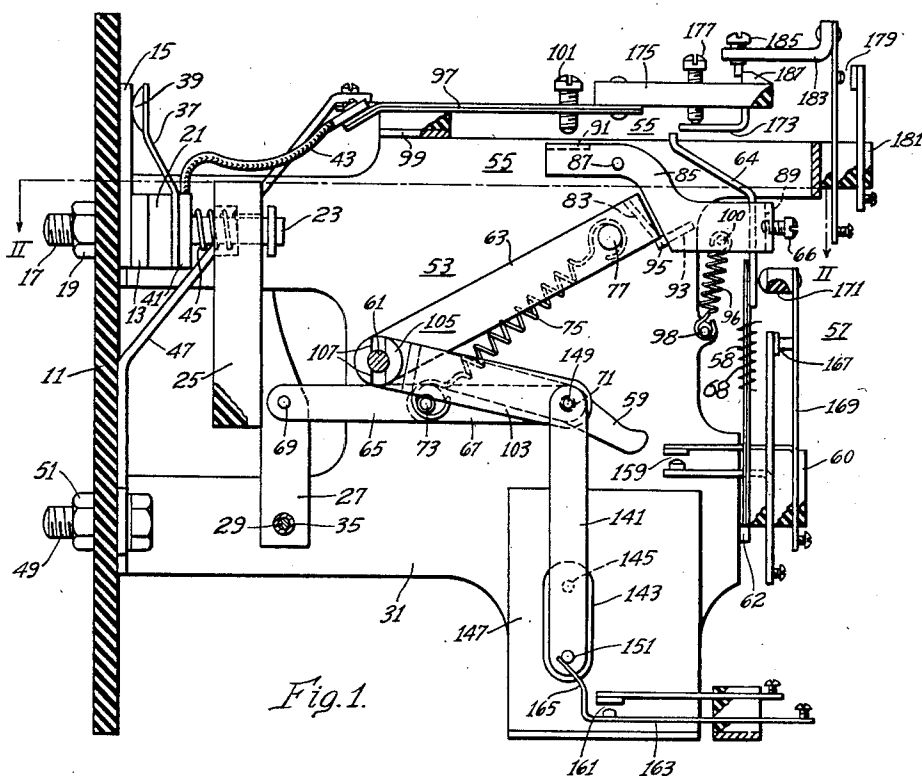
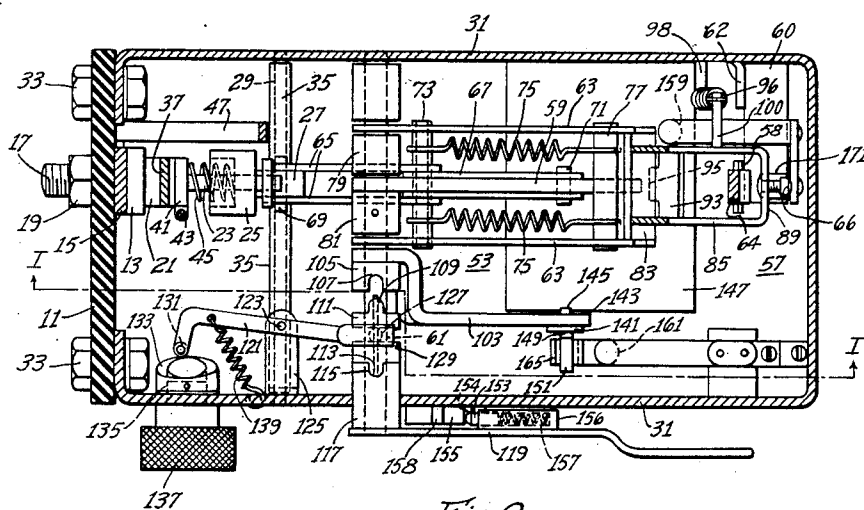
P. E. WARRINGTON

2,575,740

CIRCUIT BREAKER

Filed June 30, 1943

2 SHEETS--SHEET 1



Nov. 20, 1951

P. E. WARRINGTON

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CIRCUIT BREAKER

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2 SHEETS—SHEET 2

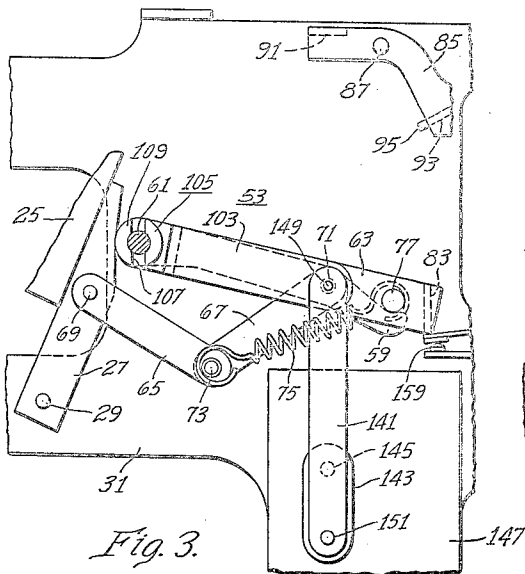


Fig. 3.

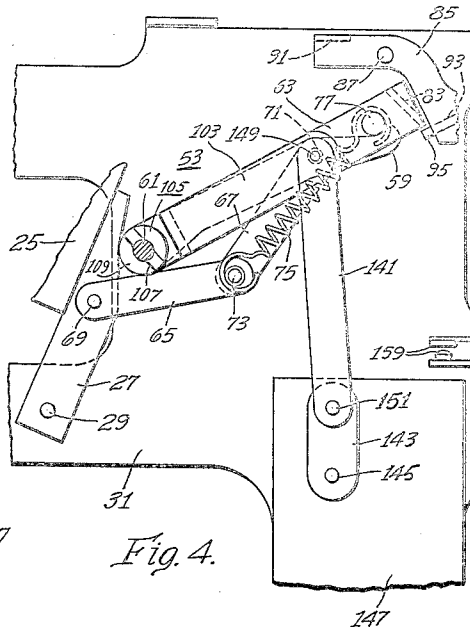


Fig. 4.

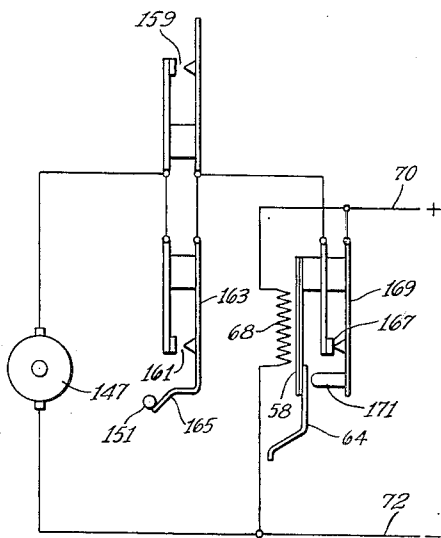


Fig. 5.

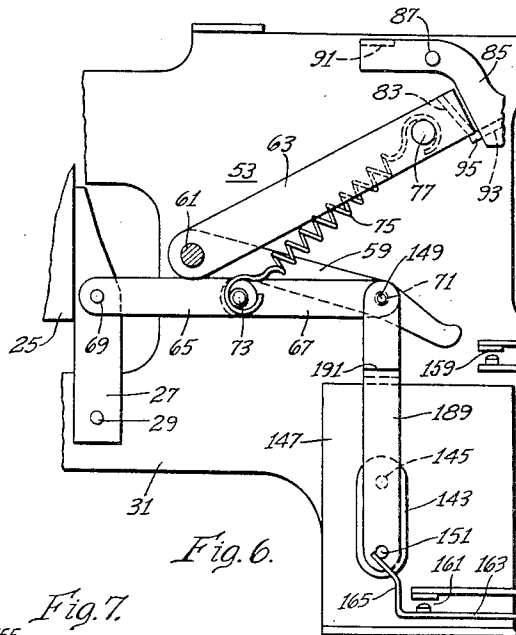


Fig. 6.

WITNESSES:
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Paul C. Harlow.

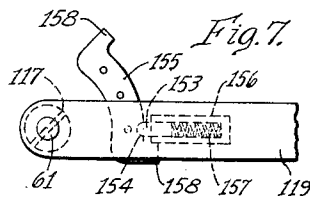


Fig. 7.

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2,575,740

CIRCUIT BREAKER

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Application June 30, 1943, Serial No. 492,910

21 Claims. (Cl. 200—92)

1

The invention relates to circuit breakers of the low-voltage class for controlling moderate amounts of electric power, and more particularly, to mechanism for operating and controlling such circuit breakers.

An object of the invention is the provision of an improved low-voltage circuit breaker having an improved construction which makes it capable of safely and reliably controlling relatively large amounts of electric power.

Another object of the invention is the provision of a circuit breaker having an improved operating mechanism which produces a quick positive break of the contacts, good high-pressure engagement of the contacts and in which the contacts are trip free of the closing means.

Another object of the invention is the provision of an improved circuit-breaker mechanism of the trip-free type which provides good high-pressure engagement of the contacts without excessively loading any of the operating parts particularly the latch and tripping mechanism.

Another object of the invention is to provide a circuit breaker of simple construction that may be employed as a transformer breaker or as a low-voltage network protector.

Another object of the invention is the provision of an improved circuit breaker with a manual closing means and an automatic reclosing means interlocked so that only one system is in operation at a time.

Another object of the invention is the provision of a circuit breaker with an improved operating mechanism including a member releasable to effect opening of the contacts and an automatic resetting and reclosing means operable under the control of the releasable member to effect automatic resetting of the mechanism and reclosing of the contacts.

Another object of the invention is the provision of a circuit breaker having a trip device operable to trip the breaker in response to predetermined conditions in the circuit controlled by the breaker, and a device operable in response to predetermined current flow in the circuit to prevent operation of the trip device.

Another object of the invention is to provide a circuit breaker having a device operable in response to predetermined low-voltage conditions in the circuit to trip the circuit breaker, a device operable in response to predetermined current conditions in the circuit, and means operable by said device to prevent operation of the undervoltage trip device when said predetermined current conditions exist.

2

Another object of the invention is the provision of an improved circuit breaker wherein the undervoltage trip device is effective, when operated, to prevent operation of the automatic reclosing means until the voltage is restored to normal value.

Another object of the invention is the provision of an improved circuit breaker wherein an interlocking device is operable in response to predetermined abnormal circuit conditions to prevent operation of a trip device in response to other predetermined circuit conditions occurring coincidentally with the abnormal conditions in said circuit.

Another object of the invention is the provision of an improved circuit breaker with an automatic reclosing mechanism and means responsive to predetermined conditions in the circuit to prevent operation of the reclosing mechanism.

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 description of one embodiment thereof when read in conjunction with the accompanying drawings, in which:

Figure 1 is a side elevational sectional view taken substantially on line I—I of Fig. 2, showing a circuit breaker embodying the principles of the invention;

Fig. 2 is a horizontal sectional view taken substantially on line II—II of Fig. 1;

Fig. 3 is an elevational view of a part of the operating mechanism showing the mechanism in the tripped open position.

Fig. 4 shows the mechanism illustrated in Fig. 3 in the reset position;

Fig. 5 is a circuit diagram showing the control circuit for the breaker closing motor;

Fig. 6 is a modification of the mechanism shown in Figs. 1-4 showing the mechanism in the closed position and showing the reclosing motor connected directly to the operating arm; and

Fig. 7 is a detailed elevational view of the retaining device for the operating handle and the operating lever.

Referring to Fig. 1 of the drawings, the circuit breaker comprises a base 11 of insulating material upon which is mounted a main stationary contact 13 and a stationary arcing contact 15. Both the main stationary contact 13 and the arcing contact 15 are secured to the base 11 by means

of a bolt 17 and nut 19, the bolt 17 extending to the rear of the base 11 beyond the nut 19 to form a terminal connection. A main movable contact 21 cooperates with the stationary contact 13. The movable contact 21 is rigidly mounted on the end of a rod 23 which, in turn, is slidably supported with a slightly loose fit in an insulating bar 25 secured to a pivoted member or switch arm 27. The rod is square or otherwise specially shaped to prevent turning of the contact. The switch arm 27 is pivotally supported on a rod 29 supported in the two sides of a U-shaped main frame 31 which is rigidly secured to the base 11 by means of bolts 33 (Fig. 2). The pivoted member or switch arm 27 is spaced from the sides of the frame 31 by spacing sleeves 35. Also mounted on rod 23 and secured to the back of the contact 21 is a spring arcing contact blade 37 which, at its free end, carries a movable arcing contact 39. A connector 41, to which is attached one end of a flexible-shunt conductor 43, is secured to main contact 21 and spring contact blade 37. The contact 21, the arcing contact blade and the connector 41 are all suitably electrically secured together. A compression spring 45 seated in a recess in the bar 25 and compressed between the bar 25 and the connector 41 provides spring contact pressure when the contacts are closed. The other end of the shunt conductor 43 is connected to one leg of a flat U-shaped bimetal element 97 which will be more fully described later.

The contacts are adapted to be operated by means of an operating mechanism, indicated generally at 53, controlled by a device 55. If the circuit breaker is to be used as an overload-trip circuit breaker, the device 55 is adjusted to trip the circuit-breaker mechanism in response to overload current.

The operating mechanism comprises an operating lever 59 mounted on and secured to a shaft 61 rotatably supported in the main frame 31. The operating mechanism also includes a U-shaped releasable member 63 and a toggle comprising toggle links 65 and 67. Each of the toggle links 65 and 67 comprises a pair of parallel links disposed as clearly shown in Fig. 2. The toggle link 65 is pivotally connected by means of a pivot pin 69 to the switch arm 27. The toggle link 67 is pivotally connected to the operating lever 59 by a pivot pin 71, and the links 65 and 67 are pivotally connected together by means of a knee pivot pin 73. A pair of overcenter springs 75, tensioned between a pin 77 on the outer end of the releasable member 63 and the knee pin 73, biases the releasable member in releasing direction and biases the toggle 65-67 to a slightly overcenter position wherein the knee pin 73 is slightly above a center line drawn through the pivots 69 and 71. The upward or overcenter movement of the toggle is limited by the toggle links engaging a spacing sleeve 79 (Fig. 2) and a hub 81 on the operator 59.

Referring to Fig. 2, it may be seen that the two arms of the releasable member 63 are pivoted on the shaft 61 for rotary movement relative thereto. The outer ends of the member 63 are connected by an integral latch member 83 with which a pivoted latch 85 cooperates to normally restrain the releasable member 63 in operative position. The latch 85 forms part of the trip device 55 and is pivotally supported on a pin 87 mounted in the main frame 31. The latch 85 comprises a pair of parallel members connected at their right-hand ends (Figs. 1 and 2) by an integral cross-member 89, and at their left-hand

ends by a cross-member 91. The pivoted latch 85 is also provided with a cross-member 93 rigidly secured thereto and having a latching portion 95, which engages the latch member 83 to releasably restrain the releasable member 63 in operative position. A spring 96, tensioned between a pin 98 in the frame 31 and a pin in the latch member 85, biases the latch member 85 to latching position. The trip device also includes the flat U-shaped bimetal element 97 having its legs mounted on but insulated from a formed-over portion 99 of the frame 31. An adjusting screw 101 threadedly engages the bimetal element 97 near its free end and is disposed directly above the cross-member 91 of the latch 85.

The bimetallic element 97 is heated in response to the current of the circuit in any suitable manner; for instance, it may be heated by connecting it so that a portion of the current of the circuit through the breaker passes through the bimetal element, or it may be heated by conduction from a current carrying part or by a separate heater element. One leg of the bimetal element 97 is connected by means of the flexible-shunt conductor 43 to the movable contact 21 through the connector 41, as previously described. The other leg of the bimetal element 97 is connected by means of a conductor 47 to a terminal connector comprising a bolt 49 and a nut 51 which also serves to secure the terminal to the base 11. The circuit of the breaker extends from the terminal connector through the main stationary contact 13, main movable contact 21, connector 41, flexible-shunt conductor 43, the bimetal element 97, conductor 47 to the terminal connector 49. If the breaker is used in a transformer the bimetal element may also be heated by the temperature of the insulating liquid or some other medium of the transformer. When heated a predetermined amount, the bimetal element is disposed to deflect downwardly.

If it is desired to have the breaker trip open automatically in response to overload currents in the circuit, the screw 101 is adjusted so that when the bimetal 97 deflects upon being heated a predetermined amount by overload currents, the screw 101 engages the cross-member 91 and rotates the latch 85 counterclockwise to disengage the latch projection 95 from the latch member 83, and release the member 63. Upon release of the member 63, the springs 75 rotate the member 63 sharply clockwise until it is arrested by the pin 77 striking the operating lever 59.

During its clockwise travel, the member 63 does two things. The two arms of the member 63 first strike the laterally extending ends of the knee pin 73 and positively move the knee of the toggle 65-67 overcenter below the center line 69-71. Shortly thereafter, the pin 77 carries the line of action of the springs 75 below the pin 71, whereupon the springs 75 cause complete collapse of the toggle 65-67 downwardly. When the toggle collapses, the switch arm 27 is rotated by the springs 75 in a clockwise or opening direction to effect opening of the contacts with a snap action. The operating mechanism is now in the open contact position as shown in Fig. 3.

In order to reset the operating mechanism, the operating lever 59 is rotated in a counterclockwise direction. This movement of the lever 59 acting through the pin 77 moves the releasable member 63 with the lever 59 to the position shown in Fig. 4. During the latter part of the resetting movement of the releasable member 63, the latch member 83 thereon wipes by the latch

projection 95, which thereafter resumes its latching position. Referring to Fig. 4, it will be seen that in the reset position the line of action of the springs 75 is below the pivot 71 by which the toggle link 67 is connected to the operator 59, and, therefore, the springs 75 in this position bias the contacts open. After the mechanism has been reset, the contacts can then be closed by moving the operator 59 from its Fig. 4 position clockwise to its Fig. 1 position. At this time, the contact arm 27 is held in open position against the hub 81 (Fig. 2) of the operator 59 by the springs 75, thus temporarily causing the pivot 69 for the toggle link 65 to remain stationary so that during the early part of the clockwise movement or closing movement of the operator 59 the toggle link 65 will swing idly clockwise about its pivot 69. As the clockwise movement of the operator 59 continues, the pivot 71 will cross the line of action of the springs 75 which then act to bias the toggle 65—67 toward its overset or in-toggle position. Continued clockwise movement of the arm 59 increases the biasing force of the springs until it is sufficient to move the toggle 65—67 to the in-toggle position where the link 65 is in contact with the fixed stop 79—81 (Fig. 2).

This movement of the toggle does not move the knee 73 of the toggle 65—67 overcenter since the operating lever has not yet completed the clockwise movement. The pin 71 connecting the toggle link 67 to the outer end of the lever 59 is, at this time, above the center line 69—73. The movement of the toggle 65—67, by the springs 75, is sufficient to close the contacts but does not provide full contact pressure. The final portion of the clockwise movement of the lever 59, after the springs 75 have moved the toggle link 65 into contact with the stop 79—81, acts through the link 67 to thrust the link 65 toward the left. This final action rotates the switch arm 25—27 further counterclockwise compressing the spring 45 to thereby provide the spring contact pressure, and the toggle completes its movement to the slightly overset position.

The construction of the toggle 65—67, the operating lever 59 and the location of the shaft 61 upon which the lever is mounted is such that in the closed position the major portion of the contact pressure is applied to the shaft 61. In the closed position of the linkage the knee 73 of the toggle 65—67 forms a fixed point and the springs 75 are tensioned between this point and the pin 77 thus biasing the releasable member 63 in opening direction. It will thus be seen that only a small component of the force of the spring 75 is the only load imposed upon the latch 95 when the breaker is in the closed position.

If the breaker is used as a conventional breaker or as a transformer breaker, the mechanism may be manually reset and the contacts closed by means of a handle 119 rotatably mounted on the portion of the shaft 61 extending outside of the frame 31. The handle 119 is provided with a hub 117 rigidly secured thereto which projects inside the frame 31 and is engaged by a clutch member 111. The clutch member is splined to the shaft 61 for rotary movement therewith and for movement axially of the shaft. It will be seen that the handle 119, the shaft 61 and the operating lever 59 are thus connected for unitary rotary movement.

In order to reset the releasable member 63 (Fig. 1) and close the contacts the handle 119 is first rotated in a counterclockwise direction (Figs. 2 and 7) to relatch the member 63, and then

clockwise to its closed position to close the contacts in the previously described manner.

In the closed position of the breaker (Fig. 1) the relatively light component of force applied to the operating lever 59 may tend to displace the lever in opening direction. In order to prevent this displacement, and to prevent accidental displacement due to shocks or jarring forces, the handle 119 is provided with a spring pressed retaining plunger 153 (Figs. 2 and 7). In the closed position of the mechanism the plunger 153 engages an aligning notch 154 in the arcuate surface of a plate 155 secured to the frame 31. The plunger 153 is slidably mounted in a housing 156 rigidly secured to the handle 119, and is urged into engagement with the notch 154 by a compression spring 157. The movement of the operating handle 119 in either direction is limited by engagement of the housing 156 with projections 158 on each end of the plate 155.

The breaker is trip free of the operating mechanism, that is, should the contacts be closed against an overload on the circuit, the trip device will function to release the member 63 which will be immediately actuated by the springs 75 to collapse the toggle 65—67 to effect opening of the contacts.

If the breaker is to be used as a network protector the resetting and closing movements of the operator 59 may be accomplished selectively either manually or automatically by the mechanism now to be described.

Referring to Fig. 2, it will be remembered that the operating arm 59 is provided with the hub 81 and this hub is rigidly secured to the shaft 61 for rotary movement therewith so that the operating lever 59 and shaft 61 always rotate together. Also mounted on the shaft but rotatable thereon is a motor operated arm 103 having secured thereto a hub 105. The hub 105 is rotatably mounted on the shaft 61 and is provided with a notch 107 (Figs. 1 and 2) which is adapted to be engaged by a projection 109 on the sliding clutch member 111. The other end of the clutch member is provided with a projection 113 adapted to engage a notch 115 in the hub 117 also rotatably mounted on the shaft 61. The hub 117 extends through the frame and has rigidly secured thereto the manual operating handle 119. The clutch member 111 is splined to the shaft 61 so that it rotates therewith and is slidable relatively thereto along the direction of the axis of the shaft. The clutch member 111 is normally in engagement with the hub 117 of the manual handle 119, but may be manually moved out of engagement with the hub 117 and into engagement with the hub 105 of the motor operated lever 103. This is accomplished by means of a clutch operating lever 121 pivotally supported at 123 on a bracket 125 secured to the frame 31. One end of the lever 121 comprises a yoke which carries a pair of diametrically opposed rollers 127 (only one being shown) engaging an annular groove 129 in the clutch member 111. The other end of the lever 121 carries a roller 131 which is engaged by a cylindrical cam 133 secured to the inner end of a short shaft 135. The shaft 135 is rotatably mounted in the frame 31, and at its outer end carries a knurled knob 137. A spring 139 is provided to bias the lever 121 in a counterclockwise direction to keep the lever in contact with the cam. Rotation of the cam 133 in either direction from the position in which it appears in Fig. 2 will permit the spring 139 to rotate the lever 121 counterclockwise to disengage the clutch member 111 from hub 117 of the man-

ual handle 119 and engage it with the hub 105 of the motor operated lever 103. Upon return of the knob 137 and the cam 133 to the position shown, the clutch member 111 is reengaged with the hub 117 of the manual handle 119.

The arm 103 (Fig. 1) is connected by means of a link 141 to a crank arm 143 secured to a shaft 145 which is driven, through a suitable gearing, by a motor 147 suitably supported on the frame 31. The link 141 is connected to the arm 103 by a pivot pin 149 and to the crank arm 143 by a pin 151. When the motor is energized it operates the crank arm 143 in a clockwise direction through one complete rotation. Acting through the link 141, arm 103, the hub 105 and the clutch member 111, the rotation of the crank arm 143 rotates the shaft 61, hub 81 and the operating lever 59 first counterclockwise to reset the releasable arm 63, and then clockwise to close the contacts in the previously described manner.

The operating mechanism may be manually operated by disengaging the clutch member 111 from the hub 105 and engaging it with the hub 117, after which the handle 119 can be manually operated to open and close the circuit breaker, and also to reset the releasable member after tripping of the breaker.

Referring to Figs. 1 and 5, the closing motor 147 is energized through the agency of a pair of contacts 159 which are engaged and closed mechanically by the releasable member 63 near the end of its opening stroke. In the early part of the resetting stroke, the member 63 moves away from the contacts 159 which, due to the resilience of the contact blades, immediately open. The motor 147 is maintained in its energized condition throughout its complete resetting and reclosing cycle by means of a pair of contacts 161 which are connected in parallel relation with the contacts 159. The resilient blade 163 of the contacts 161 has an upwardly projecting end 165 which is engaged by the pivot pin 151 to hold the contacts 161 open when the mechanism is in closed position. Shortly after the motor 147 is energized by the closing of the contacts 159, the pin 151 moves in a clockwise direction away from the projection 165 permitting the inherent resiliency of the contact blade 163 to close the contacts 161. This occurs shortly before the member 63 permits opening of the contacts 159 and thereby maintains the motor running until near the end of the reclosing operation, when the pin 151 engages the projection 165, opens the contacts 161, and deenergizes the motor. The motor mechanism may be provided with any conventional brake device (not shown) to stop the motor mechanism as soon as the motor is deenergized.

The circuit breaker is well adapted for use as a network protector in a low-voltage network system, for example, in a network system of the type disclosed in United States Patent No. 2,317,552, issued April 27, 1943, to John S. Parsons and assigned to the assignee of the instant application. If a fault occurs in the low-voltage network or loop circuit of such a network, it is allowed to burn itself clear without tripping any of the network switches. This is provided for by simply backing out the screw 101 (Fig. 1) from the bimetal element 97 which will then fail to trip the breaker when high currents are flowing in the circuit. When used as a network protector the breaker is arranged to trip open in response to a predetermined drop in voltage in the network or loop. This is ac-

complished by the provision of the low-voltage trip device 57. This low-voltage trip device comprises a bimetal element 58 (Figs. 1 and 5) having one end rigidly secured to an insulating block 60 supported on an ear 62 (Fig. 2) formed inwardly from the frame 31. A member 64 (Fig. 1) attached to the free end of the bimetal element 58 extends upwardly adjacent a screw 66 mounted in the cross-member 89 on the latch 85. At its upper end, the member 64 is formed to the left and upwardly (Fig. 1) for the purpose of preventing operation of the trip device 57 under certain conditions to be described later. A heater element 68 (Fig. 5) is disposed in heating relation to the bimetal 58. This heater is adapted to be heated in response to the voltage of the network circuit or loop. For this purpose the heater may be connected across the lines 70—72 of the motor energizing circuit on the network side of the motor control switches, since the motor circuit is connected across the low-voltage network conductors and is energized by the voltage of a portion of the network. The heater is such that the bimetal element 58 is heated to a predetermined temperature by the normal voltage of the corresponding portion of the network circuit. The bimetal element 58 is disposed to bend toward the left and assume substantially the position shown in Fig. 1 when heated by the flow of current through the heater when the voltage is normal. As long as normal voltage is maintained on the circuit 70—72, the bimetal element 58 will be heated sufficiently to hold its free end to the left of and clear of the screw 66 as shown in Fig. 1. When the voltage in the circuit 70—72 drops a predetermined amount below normal value, the bimetal 58 cools down and deflects toward the right (Fig. 1), engages the end of the screw 66, and operates the latch 85 to trip the breaker. So long as the voltage in the network circuit remains below the normal value, the latch 85 will be held in non-latching position, and the breaker mechanism cannot be reset to operative position. Restoration of normal voltage in the circuit, however, heats the bimetal 58 which then deflects toward the left (Fig. 1) permitting the latch 85 to resume its latching position.

It is desirable to prevent energization of the motor 147 to automatically reset and reclose the breaker following an automatic opening operation in response to a drop in voltage in the circuit. This is effected by means of a pair of contacts 167 (Figs. 1 and 5). These contacts are suitably mounted on the insulating block 60 by means of contact blades, the outer one 169 of which is resilient and normally maintains the contacts closed. The contacts 167 are connected in the motor circuit in series with the motor 147. The blade 169 at its free end carries an insulating button 171. When the voltage in the control circuit drops a predetermined amount, the bimetal element 58 cools and, as previously stated, deflects toward the right. Under this condition, the bimetal engages the button 171 and opens the contacts 167 which remain open as long as the low-voltage condition prevails. This holds the motor circuit open, and the breaker cannot be automatically reset and reclosed until the normal voltage is restored and the bimetal 58 is heated sufficiently to deflect away from the button 171, thus permitting the contacts 167 to close.

Under certain conditions, it is desirable to prevent tripping of the breaker in response to a drop

in voltage in the circuit when high currents are flowing in the circuit. This is accomplished by an interlock comprising the previously described member 64 on the low-voltage bimetal 58 and an angular strip 173 mounted on an insulating block 175 rigidly secured to the free end of the current bimetal element 97. The left-hand end of the strip 173 is, under normal conditions, disposed to the right of and slightly above the upper end of the member 64. When the bimetal 97 deflects downwardly in response to excessive current flowing in the circuit, the projection 173 is moved into the path of travel of the member 64. Consequently should a drop in control voltage occur coincidentally with a flow of high current in the main circuit, the bimetal element 58 will be prevented from operating the latch 85 to trip the breaker. The bimetal 58 will also be prevented from opening the contacts 167. When the fault in the circuit has burned itself clear the bimetal 97 will cool and resume its normal position, freeing the member 64 and the bimetal 58. If at this time the control voltage has been restored to normal, the bimetal 58 will have again been heated and the breaker will not be tripped. But if the low-voltage condition persists when the bimetal 97 is restored to normal, the bimetal 58 will function to trip the breaker and open the contacts 167 as soon as the strip 173 moves out of the path of the member 64. An adjusting screw 177 is mounted in the insulating block 175 for the purpose of adjusting the location of the end of the strip 173 with respect to the end of the member 64, thereby adjusting the interlocking relation of the bimetals 97 and 58.

Means are provided for energizing a signalling device upon the occurrence of an overload in the main circuit. Any suitable signal device (none being shown) may be employed. In order to energize the signal device, a pair of contacts 179 is provided. These contacts are mounted on the usual contact blades supported on an insulating block 181 secured to the frame 31. The free end of the inner blade carries an angular member 183 which at its left-hand end carries an adjustable latch member 185 normally in engagement with a latch 187 mounted on the right-hand end of the insulating block 175. The latch 187 normally restrains the contacts 179 in open position against the tension of the contact blade. However, when the bimetal 97 deflects in response to an overload current, the latch 187 releases the latch 185 and permits the contacts 179 to close and energize the signal device (not shown) over a signal circuit (also not shown). Any suitable means may be employed to reset the signal contacts.

In certain installations, it is desirable that the circuit breaker be operated at all times automatically. Fig. 6 illustrates a modification of the invention in which the manual operating handle and the selecting clutch mechanism are omitted. In this modification, the motor crank arm 143 is connected directly to the operating lever 59 by means of a link 189 similar to the link 141 in the Fig. 1 embodiment. The link 189 is formed over as at 191 to clear the motor and align the upper end of the link with the pin 71 to which it is pivoted. The lower end of the link 189 is pivoted to the crank arm by means of the pivot pin 151. All other parts of the Fig. 6 modification are the same as the corresponding parts in Fig. 1 and have been given the same reference characters.

The operation of the Fig. 6 modification is identical with the automatic operation of the Fig. 1 modification previously described, and it is not

thought necessary to here repeat the description of the operation.

If the breaker is to be used as a transformer breaker or as a conventional manually operated breaker, the motor 147 and the parts connecting the motor to the shaft 61 may be omitted. In this case the clutch member 111 and its operating mechanism may also be omitted and the hub 117 of the handle 119 secured to the shaft 61.

From the foregoing description, it will be seen that there is provided a simple, low-cost circuit breaker adapted for use as a regular circuit breaker or as a network protector, the breaker being provided with an improved operating mechanism which may be selectively reset and the contacts reclosed either manually or automatically. The breaker may be tripped open in response to overloads occurring in the main circuit controlled by the breaker or in response to under-voltage conditions in the circuit. Interlocking mechanism is provided to prevent tripping the breaker upon the coincidental occurrence of an overload in the main circuit and a drop in the voltage of the control circuit.

Having described several embodiments 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.

I claim as my invention:

1. A circuit breaker comprising relatively movable contacts, operating mechanism therefor including closing power means for closing said contacts and a member operable when released to effect an opening operation of the circuit breaker irrespective of the position of said closing means, means at times preventing energization of said closing means, means operable by said releasable member to effect energization of said reclosing means to automatically reclose said contacts, a trip device operable in response to predetermined conditions in the circuit to release said releasable member, said trip device being operable to prevent energization of said reclosing means until normal conditions are restored to the circuit.

2. A circuit breaker comprising relatively movable contacts and operating mechanism for said contacts, a releasable member operable to effect an opening operation of said mechanism, power means for automatically reclosing said contacts, a current responsive device energized in response to overload currents in the circuit controlled by the breaker, a trip device operable in response to predetermined conditions in the circuit to release said releasable member, means operable by the trip device to prevent energization of said reclosing means, and means operable by said current-responsive device to at times prevent operation of said trip device.

3. A circuit breaker comprising relatively movable contacts, operating mechanism for said contacts, a member releasable to effect opening of said contacts, power means for automatically resetting said releasable member and for closing said contacts, contact means operable by said releasable member to effect energization of said resetting and reclosing means, means comprising a thermal element responsive to predetermined conditions in the circuit to release the releasable member, and contact means operable by said thermal element to prevent energization of said resetting and reclosing means until normal conditions are restored in the circuit.

4. A circuit breaker comprising relatively movable contacts, operating mechanism for said contacts, a member releasable to effect opening of said contacts, power means for automatically resetting said releasable member and for closing said contacts, contact means operable by said releasable means to effect energization of said resetting and reclosing means, current responsive means energized in response to abnormal circuit conditions in the circuit of the breaker, means comprising a thermal element responsive to predetermined conditions in the circuit to release the releasable member, contact means operable by said thermal element to prevent energization of said resetting and reclosing means, and means operable by said current-responsive means to at times prevent operation of said thermal element.

5. A circuit breaker comprising relatively movable contacts, operating mechanism for said contacts including a member releasable to effect opening of said contacts, means for reclosing said contacts, a thermal device operable in response to certain conditions in the circuit of the breaker, a thermally responsive means operable in response to overload currents in the circuit to release said releasable member and effect opening of said contacts, and a mechanical interlock operable by said thermal device to at times prevent operation of said thermally responsive means.

6. A circuit breaker comprising relatively movable contacts, operating mechanism for said contacts comprising a releasable member operable to effect opening of said contacts, power means operable when energized to automatically close said contacts, current-responsive means operable in response to predetermined conditions in the circuit controlled by the breaker, means operated by said releasable member to effect energization of said closing means, a trip device operable to release said releasable member in response to predetermined conditions in the circuit, means operable by said trip device to prevent energization of said closing means, and means effective upon operation of said current-responsive means to prevent operation of said trip device.

7. In a circuit breaker, the combination of relatively movable contacts, a switch member movable to open and close said contacts, operating mechanism for said switch member including a pivoted operating member, means holding said operating mechanism in a fixed position at least during an automatic contact opening operation, a toggle connecting said operating member and said switch member, a releasable member pivoted coaxially with said operating member and operable when released to engage and move the knee of said toggle in a direction to effect automatic opening movement of said switch member, and power means for actuating said holding means to move said operating member to reset the releasable member and to move said switch member to close the contacts.

8. In a circuit breaker comprising relatively movable contacts and a switch member movable to open and close said contacts, operating mechanism for said switch member including an operating member, a linkage connecting said operating member and said switch member, said linkage being operable to effect opening movement of said switch member, said operating member positively holding one end of said linkage against movement during contact opening

movement, a releasable member operable to initiate an opening operation of said linkage, means comprising an overcenter spring operable by said releasable member for operating said linkage to cause opening movement of the switch member, and means for actuating said operating member to automatically reset the releasable member and move said switch member to closed position said means being effective in the closed position to positively hold the operating member against movement.

9. A circuit breaker comprising relatively movable contacts, a switch member movable to open and close said contacts, operating mechanism for said switch member including an operating member, a linkage connecting said operating member and said switch member, said linkage being operable to effect opening movement of said switch member, a releasable member operable to initiate an opening operation of said linkage, said operating member being effective to hold one end of said linkage in a fixed position at least during an opening movement of said switch member, and overcenter spring means operable by said releasable member for operating said linkage to cause opening movement of the switch member, power means for automatically resetting said releasable member and closing said contacts and for holding said operating members in against movement when the contacts are closed, and means operable by said releasable member to initiate a closing operation of said automatic closing means.

10. A circuit breaker comprising relatively movable contacts, operating mechanism for said contacts comprising an operating member operable to close said contacts, a linkage operatively relating said contacts and said operating member, said operating member holding one end of said linkage in a fixed position during contact opening operation, said linkage being operable to effect automatic opening of said contacts irrespective of the position of said operating member, a releasable member operable to initiate an opening operation of said linkage resilient means comprising an overcenter spring connecting said linkage to the releasable member for operating said releasable member and for operating said linkage to automatically open the contacts, power operated means for automatically actuating the operating member in one direction to reset the releasable member and in the opposite direction to close the contacts, and means connecting said power operated means and said operating member for positively holding said operating member in closed position when the breaker is closed.

11. A circuit breaker comprising relatively movable contacts, operating mechanism for said contacts comprising a member releasable to cause opening of the contacts, an operating member, means comprising a toggle operatively relating said operating member and said contacts and operable by said releasable member to initiate operation of said toggle, resilient means connecting the toggle and the releasable member, said resilient means operable by said releasable member upon release of said releasable member to operate said toggle to cause automatic opening of the contacts, power means operable to actuate said operating member to reset the releasable member and to close the contacts, said power means holding said operating member against movement when the breaker is closed

and means actuated by said releasable member to initiate an operation of said power means.

12. A circuit breaker comprising relatively movable contacts, operating mechanism for said contacts comprising a pivoted operator, a releasable member pivoted coaxially with said operator, said releasable member being movable relative to said operator to cause opening of said contacts, a toggle operatively relating said operator and said contacts, said toggle being operable by said releasable member to initiate an opening of said contacts, an overcenter spring connecting the knee of said toggle to the releasable member operable by said releasable member to open said contacts, said operator being movable to one position to reset the releasable member and being movable to a second position to close the contacts.

13. A circuit breaker comprising relatively movable contacts, operating mechanism for said contacts comprising an operator, a toggle operatively relating said contacts and said operator, said toggle being operable to effect opening of said contacts, a releasable member operable to engage said toggle to initiate an opening operation of said toggle, an overcenter spring movable by said releasable member to operate said toggle and open said contacts, and power operated means for positively restraining said operator in a static position to thereby restrain one end of said toggle against movement during a contact opening operation and also when the breaker is closed, said power operated means being operable to actuate the operator to reset the operating mechanism and reclose the contacts.

14. A circuit breaker comprising relatively movable contacts, operating mechanism for said contacts comprising an operator, a toggle operatively relating said contacts and said operator, said toggle being operable to effect automatic opening of said contacts, a releasable member operable to initiate an opening operation of said toggle, an overcenter spring connecting the knee of said toggle to said releasable member for actuating said toggle to effect automatic opening of said contacts, power operated means operatively related with said operator for positively holding said operator against movement when the breaker is closed and also during an opening operation, said power operated means being operable to actuate the operator to reset the operating mechanism and reclose the contacts, and means operable by the releasable member to initiate an operation of said power operated means.

15. A circuit breaker comprising relatively movable contacts, operating mechanism for said contacts comprising an operator, a linkage operatively relating said operator to said contacts, said linkage being operable to cause opening of said contacts, a releasable member operable to initiate an opening operation of said linkage, an overcenter spring connecting said linkage to said releasable member and operable to complete the operation of said linkage, power operated means operatively related with said operator, circuit means for energizing said power operated means, said power operated means normally preventing movement of said operator and when energized being operable to reset the releasable member and to reclose the contacts, means operable by said releasable member during a contact opening operation to effect energization of said power operated means, and a trip device operable in re-

sponse to predetermined conditions to release said releasable member and to prevent energization of said power operated means until normal conditions are restored in said circuit.

16. A circuit breaker comprising relatively movable contacts, operating mechanism therefor, tripping mechanism for tripping said circuit breaker, a voltage responsive device adapted to be energized in response to a voltage of the circuit, said device being operable in response to a predetermined decrease in said voltage to cause said tripping means to trip said breaker, power means for automatically reclosing said breaker, and means operated by said voltage responsive device for preventing energization of said reclosing means until normal voltage is restored.

17. A circuit breaker comprising relatively movable contacts and operating mechanism therefor, tripping mechanism for tripping said breaker, a bimetal element operable in response to predetermined conditions to cause said tripping mechanism to trip said breaker, and thermal means disposed in mechanical interlocking relation with said bimetal element and operable when heated a predetermined amount in response to abnormal current conditions in the circuit to prevent operation of said bimetal element and opening of said circuit device until normal conditions are restored in the circuit.

18. A circuit breaker comprising relatively movable contacts, a switch member movable to open and to closed position to open and close said contacts, a pivoted operating lever, a toggle pivotally connected at one end to said switch member and at its other end to said operating lever, a normally restrained releasable lever pivoted coaxially with said operating lever and operable upon release to strike the knee of said toggle and cause collapse of said toggle and opening of said contacts irrespective of the position of said operating lever, a latch for restraining said releasable lever, electro-responsive means operable in response to predetermined abnormal conditions in the circuit to cause said latch means to release said releasable lever, and an overcenter spring connecting the knee of said toggle to said releasable lever for actuating said releasable lever and for actuating said switch member.

19. A circuit breaker comprising relatively movable contacts, a pair of pivoted toggle members movable to open and close said contacts, operating mechanism comprising a pivoted operator manually movable to effect opening and closing movement of said contacts, one of said toggle members being pivotally connected to said manual operator, a releasable member operable to effect automatic operation of said pivoted toggle members, an overcenter spring connecting said releasable member to the knee of said pivoted toggle members and being movable across the pivot of said one toggle member upon release of said releasable member, said overcenter spring constituting the sole biasing means for actuating said releasable member to move said overcenter spring across said pivot upon release of said releasable member, a trip device operable to release said releasable member, and said manual operator being movable to engage and reset said releasable member and to actuate said pivoted toggle members to close said contacts.

20. A circuit breaker comprising stationary and movable contacts, a pair of pivoted toggle members movable to open and close said contacts, operating mechanism for said pivoted

15

member including a manually movable operator, one of said toggle members being pivoted on said operator and the other toggle member being pivotally connected to said movable contact, a releasable member operable when released to initiate an automatic opening operation of said pivoted toggle members, a latch mounted at a fixed point and releasably restraining said releasable member, an overcenter spring connecting said releasable member to the knee of said pivoted toggle members and normally biasing said releasable member upon release thereof to move said overcenter spring across the pivot of said pivoted toggle member on said operator, said latch being operable in response to overload currents to release said releasable member, said manually movable operator being operable to engage said releasable member and move said releasable member back to relatching engagement with said latch and to actuate said pivoted toggle members to both open and close said contacts.

21. A circuit breaker comprising stationary and movable contacts, a pair of pivoted toggle members movable to open and close said contacts, operating mechanism for said pivoted member including a manually movable operator, one of said toggle members being pivoted on said operator and the other toggle member being pivoted on said movable contact, a releasable member operable when released to initiate an automatic opening operation of said pivoted member, a latch pivoted on a fixed pivot releasably restraining said releasable member, an overcenter spring connecting said releasable member to the knee of said pivoted toggle members and normally biasing said releasable member to move said overcenter spring across the pivot of said one pivoted toggle member on said operator

16

upon release of said releasable member, said overcenter spring comprising the sole biasing means for moving said releasable member to effect automatic opening movement of said pivoted toggle members, a trip device operable in response to overload currents to actuate said latch and release said releasable member, said manually movable operator being operable to engage said releasable member and move said releasable member to relatching engagement with said latch and to move said pivoted toggle members to both open and close said contacts.

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