Feb. 19, 1952 J. K. HODNETTE ET AL 2,586,429

CIRCUIT BREAKER OPERATING MECHANISM

Filed July 5, 1947 2 SHEETS—SHEET 1

FIG. 2.

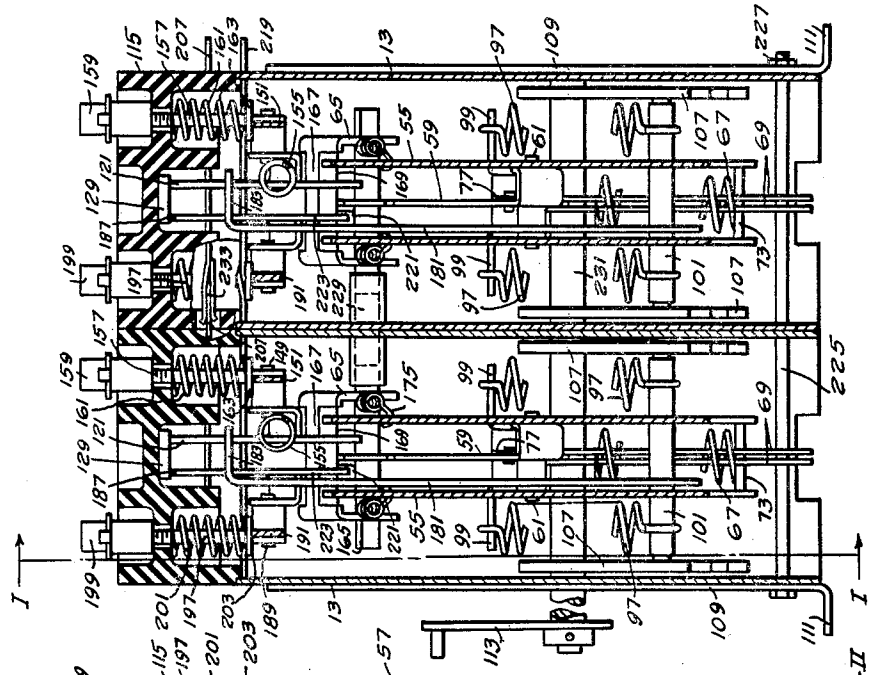
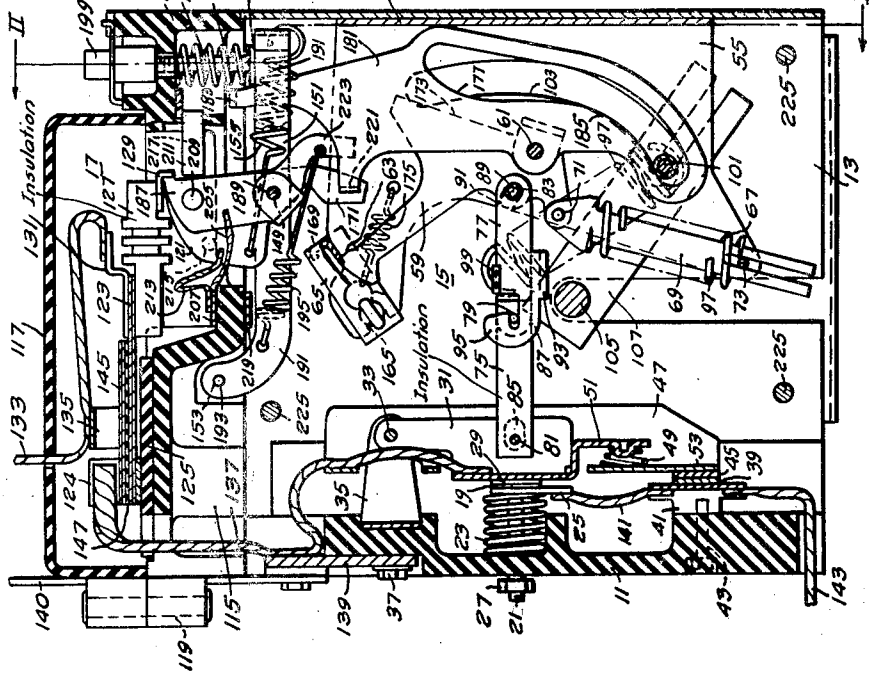


FIG. 1.



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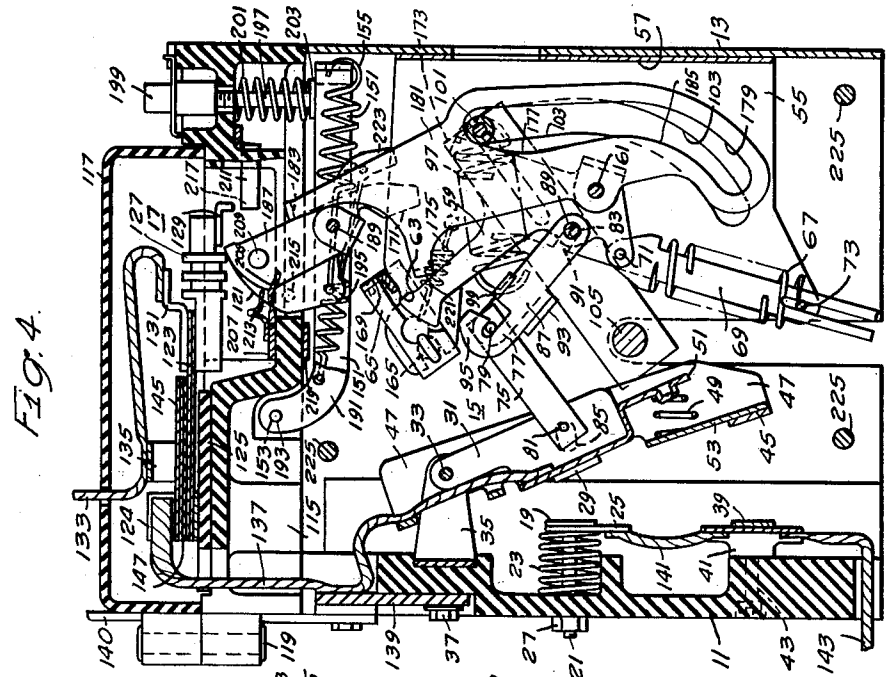


FIG. 4.

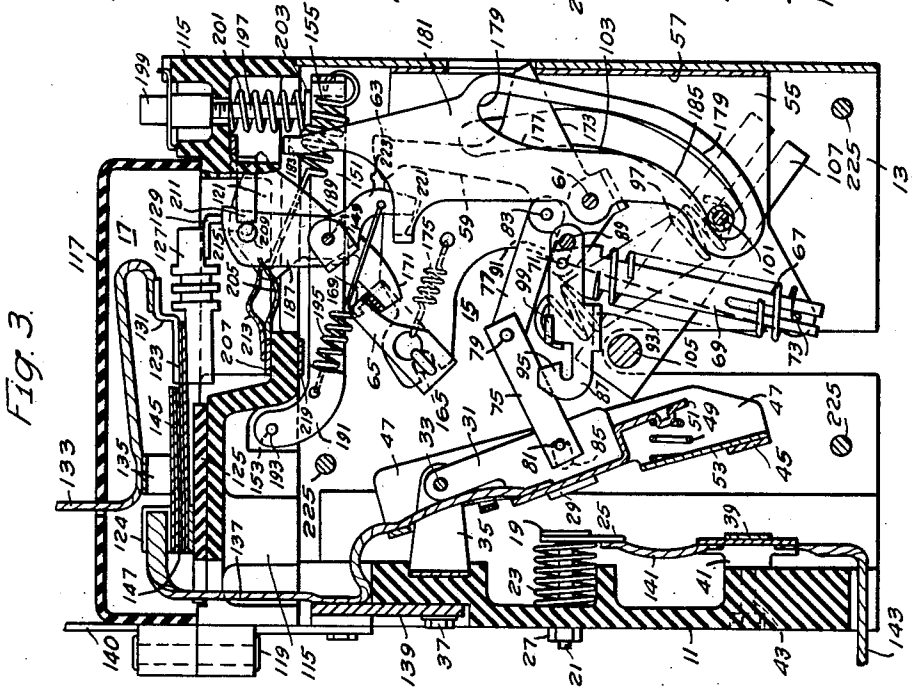


FIG. 3.

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Patented Feb. 19, 1952

2,586,429

UNITED STATES PATENT OFFICE

2,586,429

CIRCUIT BREAKER OPERATING MECHANISM

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Application July 5, 1947, Serial No. 759,272

5 Claims. (Cl. 200—116)

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This invention relates to circuit breakers, and more particularly, to operating and tripping mechanism therefor.

Certain features disclosed but not claimed in this application are fully disclosed and claimed in copending divisional applications, Serial No. 240,875 and Serial No. 240,876, filed August 8, 1951, by John K. Hodnette and Merrill G. Leonard, and assigned to the assignee of this application.

One object of the invention is to provide a circuit breaker embodying an improved operating mechanism wherein the load of the main operating spring is not imposed on the breaker latch.

Another object of the invention is to provide a circuit breaker embodying a trip member controlled by a thermal trip element to trip the breaker and to effect an indication of the condition of the breaker, and an indicating trip member controlled by said thermal trip element to effect an indication of the approach of a dangerous circuit condition.

Another object of the invention is to provide a circuit breaker embodying a trip member controlled by a thermal trip element to trip the breaker and to effect an indication of the condition of the breaker, an indicating trip member controlled by said thermal trip element to effect an indication of the approach of a dangerous circuit condition and means operatively relating the operating mechanism of the breaker and the indicating trip member to permit resetting of said indicating trip member without disturbing the breaker contact position.

Another object of the invention is to provide a circuit breaker embodying a thermal trip device responsive to overload current to trip the breaker and an auxiliary thermal element responsive to ambient temperatures to control the thermal trip device to trip the breaker after a relatively long time delay when the ambient temperature is low and after a relatively short time delay when the ambient temperature is high.

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 best be understood from the following detailed description thereof when read in conjunction with the accompanying drawings.

In said drawings:

Figure 1 is an elevational sectional view taken along line I—I of Fig. 2 showing a circuit breaker

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embodying the principles of the invention, the breaker being shown in the closed position,

Fig. 2 is a sectional view taken on line II—II of Fig. 1 and looking in the direction of the arrows,

Fig. 3 is an elevational view similar to Fig. 1 but showing the breaker in the tripped open position, and

Fig. 4 is an elevational view similar to Fig. 1 but showing the parts in the reset position.

Referring to Fig. 1 of the drawings, the circuit breaker comprises a base 11 of insulating material on which is mounted the breaker contact structure, a metal housing 13 secured to the base 11, an operating mechanism indicated generally at 15 and a trip device indicated generally at 17.

The contact structure comprises a main stationary contact 19 rigidly mounted on the inner end of a rod 21 slidably mounted in the base 11. A coil spring 23 surrounds the rod 21 and is compressed between the base 11 and a connector 25 secured to the rod 21 and to the contact 19 to provide contact pressure. A limit nut 27 is threadedly mounted on the rod 21 outside the base 11. A cooperating movable contact 29 is rigidly mounted on a channel-shaped switch arm 31 pivotally mounted on a pivot pin 33 supported in a U-shaped bracket 35. The bracket 35 is secured to the base 11 by means of a screw 37.

The contact structure also comprises a stationary arcing contact 39 rigidly mounted on a conducting support member 41 secured by means of a screw 43 to the base 11, and a cooperating movable arcing contact 45. The movable arcing contact 45 is rigidly mounted on a channel-shaped switch member 47 which straddles the switch arm 31 and is pivoted on the pivot pin 33. A compression spring 49 disposed between an extension 51 of the main switch arm 31 and the yoke portion 53 of the arcing contact switch arm 47 provides contact pressure for the arcing contacts 39–45 and also maintains the arcing contacts in closed position until after the main contacts 19–29 have separated on an opening operation.

The operating mechanism 15 is supported in a generally U-shaped frame 55 the bight 57 of which is rigidly secured to the housing 13. The operating mechanism comprises a releasable member or carrier 59 pivotally mounted on a fixed pivot pin 61 mounted in the side members of the frame 55. The carrier 59 has a latch portion 63 adapted to engage a latch member 65 forming part of the trip mechanism which will be more fully described hereinafter. The car-

rier 59 is biased in a clockwise direction by means of a spring 67 which surrounds a spring guide 69 pivotally connected at one end by means of a pivot pin 71 to the carrier. The spring 67 is compressed between a shoulder on the spring guide 69 and a rod 73 mounted on and extending between the side members of the frame 55. The carrier 59 is operatively connected to the switch arm 31 by means of a toggle comprising toggle links 75 and 77 pivotally connected together by a knee pivot pin 79. The toggle link 75 is of insulating material and is pivotally connected to the switch arm 31 by means of a pivot pin 81. The toggle link 77 is pivotally connected by means of a pivot pin 83 (Fig. 3) to the carrier 59. The pivot pin 83 is directly under and concentric with the pivot pin 89 (hereinafter described) when the carrier 59 is in its normal latched position, as shown in Fig. 2. The pivot pin 81 projects beyond the side members of the switch arm 31 and through elongated slots 85 (only one being shown) in the side members of the arcing contact switch arm 47.

An actuator comprising a pair of spaced actuating levers 87 is provided for operating the toggle 75—77 to manually open and close the contacts. The actuating levers 87 are disposed adjacent the inner sides of the U-shaped frame 55 and each of the levers carries a pivot pin 89 which is seated in a slot 91 in the adjacent frame. The actuating levers 87 are rigidly joined by an integral cross member 93 and each of the levers 87 is provided with a hook portion 95 which in the closed position of the mechanism engages an end of the knee pivot pin 79 to hold the toggle 75—77 in a slightly underset position to thereby hold the switch arms 31 and 47 in the closed contact position.

A pair of overcenter springs 97 is provided to operate the levers 87 and therethrough the toggle 75—77 in order to manually open and close the circuit breaker. The springs 97 have one end hooked over laterally projecting ears 99 on the levers 87 and the other ends of the springs are hooked over an operating rod 101 extending through guide slots 103 disposed in parallel alignment in the frame members 55. Secured to a shaft 105 for rotation therewith is a pair of operating arms 107 each having its free end bifurcated to embrace the rod 101 adjacent the ends thereof. The shaft 105 is pivotally supported in plates 109 secured to the outside of the housing 13 and provided with mounting feet 111 whereby the circuit breaker may be mounted on a suitable support (not shown). One end of the shaft 105 extends to the outside of the housing and has secured thereto an operating handle indicated at 113 (Fig. 2) for manually operating the shaft 105 and the arms 107.

The circuit breaker may be opened manually by rotating the handle 113 and consequently the shaft 105 and arms 107 approximately 90° in a counter-clockwise direction from the position shown in Fig. 1. During this movement the arms 107 cause the rod 101 to move upwardly in the slots 103 carrying therewith the ends of the springs 97 attached thereto. When the rod 105 moves the line of action of the springs 107 overcenter above the pivot 89 of the levers 87, they bias the actuator levers 87 in a clockwise direction. Continued movement of the arms 107 and the rod 101 increases the biasing force until a point is reached when the springs rotate the actuating levers 87 clockwise about the pivots 89. In the closed and latched position of the circuit breaker, the pivot 83 connecting the toggle link 77 to the releasable carrier 59 is in axial alignment with the pivot 89 of the actuating lever 87 and the knee pivot pin 79 remains in engagement with the hook 95, consequently, the toggle link 77 and the lever 87 will move as a unit during manual opening operation. The clockwise movement of the actuator lever 87, therefore, causes collapse of the toggle 75—77 and opening of the contacts. During the opening movement of the mechanism the switch arm 31 is first moved in a counterclockwise or opening direction to open the main contacts 19—29 while the spring 49 maintains the arcing contacts 39—45 closed until after the main contacts have separated. Shortly after the main contacts have separated, the pin 81 engages the outer end of the slot 85 in the switch arm 47 and thereafter moves both switch arms 31—47 to the full open position in unison in which position the parts are shown in Fig. 4.

The contacts are closed by rotating the shaft 105 and the arms 107 clockwise from the Fig. 4 position to the position in which they appear in Fig. 1. During this movement the arms 107 carry the rod 101 therewith moving the line of action of the springs 97 over center below the aligned pivots 83—89, whereupon the springs 97 bias the actuating lever 87 in a counterclockwise direction, and, since the knee pin 79 of the toggle 75—77 is in engagement with the hook 95, the toggle is biased to its underset position. Continued clockwise movement of the arms 107 increases the spring bias on the actuating lever 87 and the toggle until a point is reached where the springs 97 suddenly straightens the toggle 75—77 and closes the contact with a snap action.

The configuration of the slot 103 is substantially concentric with the ears 99 on the actuating levers 87 so the slot controls the springs 97 so as to produce as little change as possible in the length of the over center springs 97 until the toggle is broken, thereby reducing the energy required to operate the breaker. As will be more fully brought out later, the shape of the slots 103 also control the operation of a reset lever.

The circuit breaker may be tripped open automatically by operation of the trip device 17 in response to overload currents. The trip device comprises a base 115 of insulating material secured to the housing 13, a cover 117 also of insulating material secured to the base 115 by means of rivets 119 (only one being shown), a biased member 121 releasable to actuate the latch 65 and a tripping bimetal element 123 which is operable to release the member 121. The bimetal element is secured at one end to a metal bracket 124 supported on insulating plate 125 mounted on the base 115 and at the other end carries an insulating block 127 to which is secured a metal latch 129. A connector 131 is electrically connected to the free end of the bimetal element and a flexible terminal conductor 133 is connected to the connector. The flexible conductor 133 extends to the left and is supported on a bracket 135 mounted on the base 115. Thereafter the conductor 133 extends out through an opening in the cover 117 where it serves to connect the breaker in an electrical circuit. The bracket 124, and hence, the fixed end of the bimetal element is connected by means of a flexible conductor 137 to the switch arms 31 and 47, the conductor 137 extending downwardly through an opening in the base 115 where it is mechanically and elec-

trically secured to a connector 139, and to the switch arms 31 and 47. The connector 139 provides a point where a terminal strip 140 may be connected to provide a third terminal between the bimetal and the controls. The main stationary contact 19 is connected by means of a flexible conductor 141 to the stationary arcing contact 39 and the circuit through the breaker is completed by means of a flexible terminal conductor 143 also connected to the fixed arcing contact 39 and extending out through an opening in the base 11. An auxiliary bimetal element 145, disposed above the tripping bimetal 123 but insulated therefrom by a strip 147 of insulating material, is fixedly mounted at its left-hand end and adapted to deflect, when heated, in the same direction as the tripping bimetal 123.

The releasable member 121 is pivotally mounted at 149 on an adjusting arm 151 which, in turn, is pivotally mounted on a pivot pin 153 which is supported in a suitable opening in the base 115. The pivot 149, adjusting cam 151 and pivot pin 153 are directly behind pivot 189, a second adjusting cam 191, and pivot pin 143, as hereinafter described. The member 121 is biased by means of a spring 155 in a clockwise or tripping direction. The spring 155 has one end hooked into an opening in the member 121 and the other end anchored to the free end of the adjusting arms 151. Secured to the adjusting arm 151 at a point adjacent its free end is a rod 157 (Fig. 2) which extends upwardly through an enlarged opening in the base 115 and has its upper end threaded to receive an adjusting nut 159. A spring 161 coiled about the rod 157 and compressed between the bottom surface of the base 115 and a washer 163 biases the free end of the arm 151 downwardly. By turning the nut 159 in one direction the rod 157 may be moved upwardly rotating the arm 151 in a counterclockwise direction. Turning the nut 159 in the opposite direction permits the spring 161 to lower the rod 157 and rotate the arm 151 in a clockwise direction. Since the releasable member 121 is pivotally supported at 149 on the arm 151, it will be thus moved up or down relative to the latch 129 to thereby vary the overlap of the member 121 with the latch.

The latch member 65 is U-shaped and the two legs thereof are mounted on a shaft 165 for movement therewith, the shaft 165 being mounted for rotation in openings in the side members of the frame 55. The yoke portion 167 of the latch member is shaped inwardly to form a latch portion 169 which engages the latch portion 63 of the carrier 59 to normally restrain the latter in the position shown in Fig. 1.

The bimetal element 123 has its high-expansion side facing downwardly so that, when heated a predetermined amount in response to overload currents, the bimetal element 123 will deflect upwardly to disengage the latch 129 from the releasable member 121. When this occurs, the spring 155 rotates the member 121 clockwise about its pivot 149 and the lower end 171 thereof strikes the latch member 65 a blow to disengage the latch portion 169 thereof from the latch portion 63 of the carrier 59 thereby releasing the carrier. Upon release of the carrier 59, the spring 67 rotates the carrier in a clockwise direction about its pivot 61 to the position in which it appears in Fig. 3, thus moving the switch members 31 and 47 to the open position. During the early portion of this movement the knee pin 79 of the toggle 75—79 moves out of the hook portion 95 of the actuator levers 87 and shortly thereafter the end of the spring

guide 69 strikes the toggle link 77. This action causes collapse of the toggle and rotates the toggle link 77 clockwise about its pivot 83 to effect movement of the switch arms 31—47 to the open position. The mechanism is shown in Fig. 3 in the tripped open position.

During the automatic opening operation, the knee pivot pin 79, as previously set forth, escapes from the actuating levers 87 and before the breaker can be reclosed it is necessary to reengage the actuating levers with the knee pin 79 and also to reset and relatch the carrier 59. Both of these operations are accomplished by moving the rod 101 upwardly in the slots 103 from the Fig. 3 position to the position shown in Fig. 4. This is done by rotating the shaft 105 and the arms 107 in a counterclockwise direction as far as they will go, the movement of the rod being limited by engagement with the upper end of the slot 103. During this movement the rod 101 carries the line of action of the springs 97 over center above the pivot 89 (Fig. 3) of the levers 87 whereupon the springs 97 actuate the levers in a clockwise direction until they engage the knee pin 79. Next in its upward travel, the rod 101 engages a projection 173 on the carrier 59 and rotates the carrier counterclockwise about its pivot 61. Near the end of this movement of the carrier 59 the latching end thereof wipes by the latch portion 169 of the latch member 65 which is then restored clockwise to latching position by means of a spring 175, the clockwise movement of the latch 65 being limited by engagement with the frame 55. During the counterclockwise movement of the carrier 59 the pivot 83 for the toggle link 77 moves back slightly beyond the normal position in which it is aligned with the pivot 89 of the levers 87. This movement thrusts the knee pin 79 into the hook portion of the levers 87, and provides a slight overthrow for the latching portion 63 of the carrier beyond latched position.

The rod 101 in its upward travel, next engages a cam surface 177 in one wall of a slot 179 in a resetting lever 181 which is pivotally mounted on the pivot pin 61, and in cooperation with the slots 103, moves this lever counterclockwise about its pivot. During this movement, an ear 183 (Figs. 2 and 4) formed at right angles to the upper end of the resetting lever engages the releasable tripping member 121 and rotates it counterclockwise past its latched position as shown in Fig. 4. The parts are now in the reset position as shown in Fig. 4, in readiness for a contact closing operation which is effected in the previously described manner by movement of the arms 107 and the rod 101 in a clockwise direction to the Fig. 1 position, during which movement the actuating levers 87 acting through the knee pin 79 straightens the toggle 75—77 and moves the switch arms to their closed positions. As the rod 101 nears the lower end of its movement, it engages a portion 185 of the slot 179 in the resetting lever 181 and restores this lever to its initial position, as shown in Fig. 1.

The circuit breaker is designed for use in an oil insulated transformer, and it is the purpose of the auxiliary bimetal element 145 to modify the tripping time of the current-carrying tripping bimetal element 123 in accordance with the temperature of the surrounding medium. The bimetal element 145 is similar to the tripping bimetal 123 and also has its high-expansion side facing downwardly, hence, when heated, will deflect in the same direction as the tripping bimetal 123.

If the transformer temperature rises gradually

so that the mass of copper, oil insulation, etc., tend to reach their maximum safe temperatures, the auxiliary bimetal 145, which is heated by the oil temperature rise and to some extent by conduction and convection from the tripping bimetal 123, will deflect in the same direction and at approximately the same rate as the tripping bimetal 123 which is heated by both current flow and oil temperature rise, hence the bimetal 145 will not appreciably change the trip-time curve of the tripping bimetal 123. If the transformer temperature is low and heavy overload occurs, the tripping bimetal 123 will be heated rapidly, whereas the temperature of the auxiliary bimetal 145 will rise very little and will, therefore, exert a restraining force on the tripping bimetal 123. It will be seen, therefore, that for a given value of overload current, the circuit breaker will be tripped open after a relatively short time delay when the transformer temperature is high and after a relatively long time delay when the transformer temperature is low. By use of the auxiliary bimetal 145 heavier overloads may be carried for a short time without tripping, and the greater temperature rise required to trip on such overloads will give faster cooling and thereby the time for resetting is reduced.

The trip-time curve of the trip device may be varied by substituting bimetal elements having different characteristics for the auxiliary bimetal element, by varying the space between the tripping bimetal and the auxiliary bimetal and by varying the thermal insulation between and around the bimetal elements and also by varying the characteristics of the tripping bimetal.

Means is provided for indicating a partial overload condition which is not of sufficient magnitude to trip the breaker open but which indicates that the current in the circuit is approaching a dangerous overload condition or that a dangerous overload condition has been approached and then cleared itself without tripping the breaker, also to indicate that the breaker has been tripped open in response to a dangerous overload condition.

The indicating mechanism comprises a releasable member 187 (Figs. 1 and 2) pivotally supported by means of a pivot pin 189 on an adjusting lever 191. The lever 191 is pivotally mounted on the pivot pin 153 which supports the lever 151 on the base 115 of the trip device. A spring 195 having one end hooked in an opening in one arm of the releasable member 187 and the other end hooked in an opening in the lever 191 biases the member 187 in a clockwise direction about its pivot 149. The member 187 is normally restrained against clockwise movement by engagement with the latch 129. An adjusting rod 197 (Fig. 1), similar to the rod 157 (Fig. 2) for the lever 151, is secured to the lever 191 at a point near its free end and extends upwardly through an opening in the base 115. The upper end of the rod 197 is threaded to receive an adjusting nut 199 and a compression spring 201 coiled about the rod 197 is disposed between the base 115 and a washer 203 bearing against the lever 191. By this means the lever 191 can be moved up and down about its pivot 193 to thereby shift the pivot 189 for the member 187 and vary the amount of overlap between the member 187 and the latch 129. The member 187 is adjusted to be released by the latch 129 before the bimetal element 123 deflects far enough to release the member 121 to trip the breaker. The releasable member 187 is electrically connected by means of a flexible conductor 205 to a conductor 207 extending transversely through the breaker and secured to the base 115 of the trip device. The member 187 is made of conducting material and carries a stud or contact 209 also of conducting material which, upon release and clockwise movement of the member 187 is adapted to make butt engagement with the end of a fixed contact 211 to thereby close an electrical circuit and energize an indication device (not shown) but preferably a signal light to give visual indication.

The releasable trip member 121 is also electrically connected by means of a flexible conductor 213 to the conductor 207 and carries a contact 215 which, upon release of the member to effect tripping of the breaker, engages the end of a fixed contact 217 directly behind the fixed contact 211 and closes an electrical circuit to energize an indicating device. The fixed contacts 211 and 217 may be connected together and connected in a circuit (not shown) to energize a single indicator or they may be connected in separate circuits to energize separate indicators. The return circuit (not shown) from the indicators is connected to a supply conductor 219 also secured to the base 115 but insulated from the supply circuit 207. The supply conductors 207 and 219 extend outside of the housing 13 (Fig. 2) to be connected to a supply circuit, or to be connected to similar conductors in another circuit breaker assembled adjacent the first breaker in a manner to be more fully described later.

As previously stated, the releasable signal member 187 is adjusted by means of the lever 191 and the adjusting rod 197 (Figs. 1 and 2) to trip and close the circuit to the indicator before the releasable trip member 121 is released to trip the breaker. Hence, if an overload current occurs which approaches a dangerous value and trips the signal member 187, but which is cleared before it releases the trip member 121, the member 187 will close its circuit and energize the indicating means. Under this circumstance, it is desirable to reset the member 187 without opening or otherwise disturbing the main breaker contacts. This is accomplished by a partial stroke of the arms 107 and the rod 101 in opening direction which is effected by a partial opening stroke of the handle 113 (Fig. 2). During this partial stroke, the rod 101 engages the cam portion 185 of the resetting member 181 and rotates this member in a clockwise direction from its Fig. 1 position causing an ear 221 on the member 181 to engage an arm 223 on the member 187 to rock the latter in a counterclockwise or resetting direction to its relatched position as shown in Fig. 1. After the release signal member 187 is relatched, the arms 107 and the rod 101 are restored clockwise to their normal positions and since the rod 101 was not moved far enough to carry the springs 97 over center, the main contacts remain in their closed position. If a single indicating device is utilized which is energized by both the releasable member 121 and 187 with their contacts electrically connected in parallel, and this indicator remains energized after the member 187 has been reset, it indicates that the breaker has been tripped open and must be reset and reclosed. However, with two indicators operated independently by the member 187 and the trip member 121, a single energized indicator would inform the attendant that an overload had occurred but had cleared without tripping the breaker, in which event it would only be necessary to reset the member 187 without opening the breaker. If both in-

dicators were energized the attendant would know immediately the breaker was tripped open and must be reset and then reclosed.

As previously stated, two or more circuit breakers may be assembled and tied together for unitary operation to control a multi-phase circuit. While only a single circuit breaker has been described, the breakers to be assembled are identical, hence, only the means for providing unitary operation of two or more circuit breakers will be described. When two or more breakers are assembled together, the plates 109 together with the mounting feet 111 are omitted except those on the outside of the end breakers and the breakers are secured together by means of a plurality of bolts 225 (Figs. 1 and 2) passing through all of the assembled breakers and having nuts 227 threadedly engaging the ends thereof. The trip shafts 165 and the latch members 65 are tied together for unitary movement by means of a sleeve 229 (Fig. 2) which couples the shafts 165 so that a tripping operation of the latch member 65 for one of the breakers in response to an overload current occurring in the related phase circuit will operate the latch members for all of the breakers. The operating shaft 125 described for the single pole breaker is replaced by a similar shaft 231 (Fig. 2) which extends through all of the breakers and has secured thereto for movement therewith the operating arms 107 for each breaker. Operation of the shaft 231 will effect manual opening and closing of the contacts of all of the breakers, reset and relatch the mechanism and reclose the contacts of all the breakers in the same manner as was described for the single pole unit.

The supply conductor 207 for the indicator device of each phase breaker is provided at one end with a spring clip 233 (Fig. 2) for releasably receiving the externally projecting end of the conductor of the adjacent phase breaker so that the supply circuit extends through all of the breakers. The supply conductors 219 are grounded to their respective metallic housings.

From the foregoing description, it will be apparent that there is provided a circuit breaker embodying a tripping mechanism controlled by a thermally responsive element for opening the breaker contacts under certain overload current or temperature conditions and for effecting an indication of the condition of the breaker operating mechanism. There is also provided a second trip mechanism controlled by the thermally responsive element for effecting an indication of the approach of a dangerous overload or temperature condition of a lesser magnitude than that required to trip the breaker. The arrangement of the trip mechanisms being such that in the event the condition which caused operation of the second trip mechanism disappears without having tripped the breaker, the trip mechanism may be reset by partial operation of the breaker operating mechanism without disturbing the position of the breaker contacts. There is also provided independent adjusting means for adjusting the trip mechanism to vary the amount of overload current required to trip the breaker and for independently adjusting indicating trip mechanism to vary the amount of overload and/or temperature rise required to effect an indication without tripping the breaker.

Having described the invention in accordance with the patent statutes, it is to be understood that various changes and modifications may be made in the structural details thereof without departing from some of the essential features of the invention.

We claim as our invention:

1. In a circuit breaker comprising relatively movable contacts, operating mechanism for said contacts comprising a manually operable member, an actuating member, an overcenter spring operable by said manually operable member to operate said actuating member, cam means for controlling the tension of said overcenter spring during an operation thereof, a toggle normally engaging the actuating member and operable thereby to open and close said contacts, and a trip device operable to effect operation of said toggle to open said contacts irrespective of the position of the manually operable member and said actuating member.

2. In a circuit breaker comprising relatively movable contact means, operating mechanism for said contact means comprising a manually operable member, an actuating member, an overcenter spring operable by said manually operable member to operate said actuating member, fixed cam means disposed to effect radial movement of one end of said overcenter spring relative to said manual operable member during an operation thereof, a toggle separably engaging said actuating member and operable thereby to open and close said contact means, and trip means operable in response to overload currents to effect operation of said toggle independently of said actuating member to cause automatic opening of said contact means.

3. In a circuit breaker comprising relatively movable contacts, operating mechanism for said contacts comprising an actuating member, an overcenter spring having one end connected to said actuating member, a manually operable member related to the other end of said overcenter spring for operating said spring to effect operation of said actuating member, cam means supporting said other end of said overcenter spring for causing movement of said other end of said overcenter spring relative to said manually operable member during an operation to keep the tension of said overcenter spring substantially constant until it moves overcenter, a toggle normally engaging said actuating member and operable thereby to open and close said contacts, and a trip device operable to effect disengagement of said toggle from said operating mechanism and spring of said contacts irrespective of the position of said actuating member.

4. In a circuit breaker comprising relatively movable contact means, operating mechanism for said contact means comprising an actuating member, a manually operable member, an overcenter spring having one end associated with said manually operable member and the other end connected to said actuating member, said overcenter spring being operable by said manually operable member to operate said actuating member, cam means disposed to effect movement of said one end of said overcenter spring relative to said manually operable member during an operation thereof to keep said one end of said overcenter spring at substantially the same distance from the other end thereof connected to said actuating member until it moves overcenter near the end of a closing operation, a toggle normally engaging said actuating member and operable thereby to open and close said contact means, said toggle at times being disengaged from said actuating member to effect automatic open-

ing of said contact means irrespective of the position of said actuating member.

5. In a circuit breaker comprising relatively movable contact means, operating mechanisms for said contact means comprising an operating shaft, manual means for operating said shaft, a pair of spaced arms on said shaft, said arms being provided with radially extending parallel slots, an actuating member, an overcenter spring having one end connected to said actuating member and operable to operate said actuating member, an element engaging said parallel slots for supporting the other end of said overcenter springs, cam means disposed adjacent said spaced arms to effect radial movement of said element relative to said arms upon operation of said arms, a toggle operable by said actuating member to open and close said contact means, and trip means operable at times to effect operation of said toggle independently of said actuating member to effect automatic opening of said contacts.

JOHN K. HODNETTE.
MERRILL G. LEONARD.

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