May 30, 1939. R. R. PITTMAN ET AL 2,160,562

CIRCUIT BREAKER

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Fig. 1

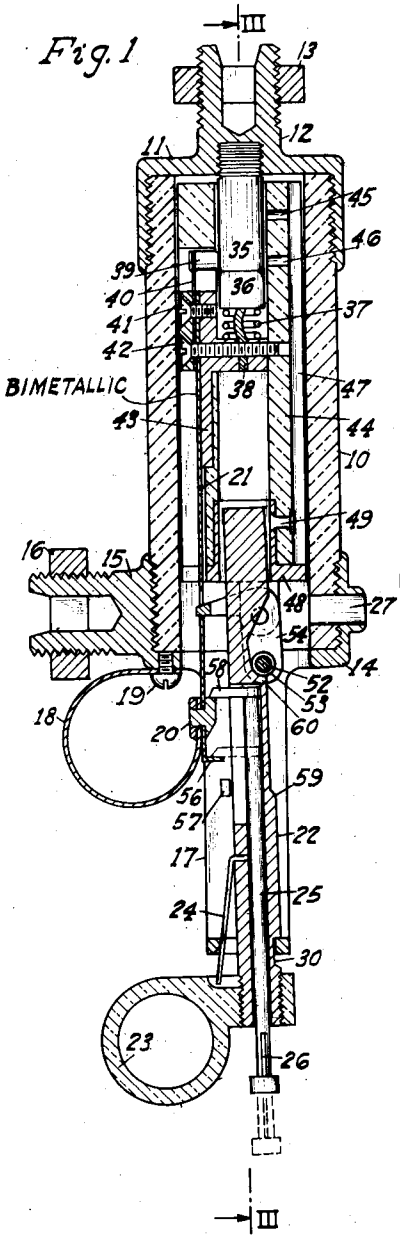


Fig. 2

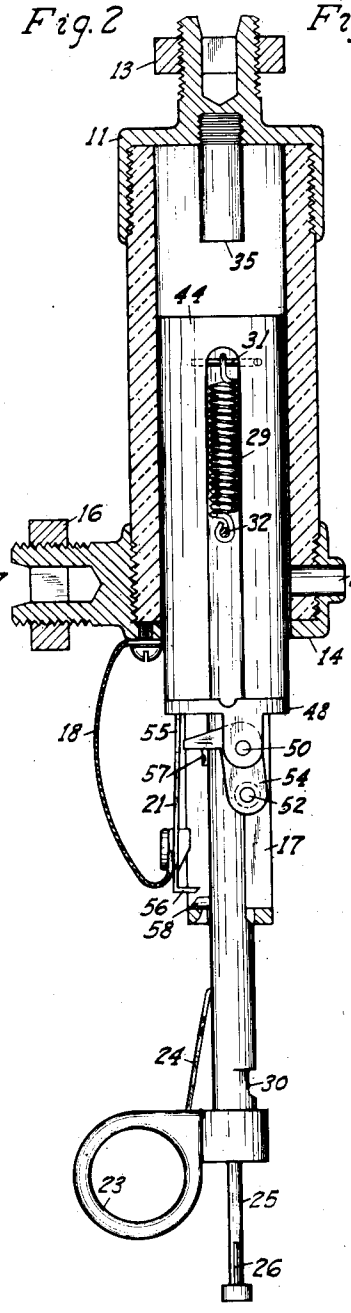
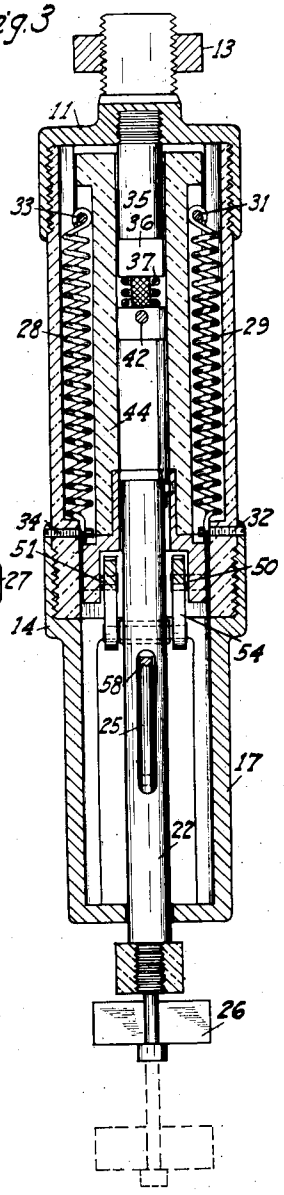


Fig. 3



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Fig. 4

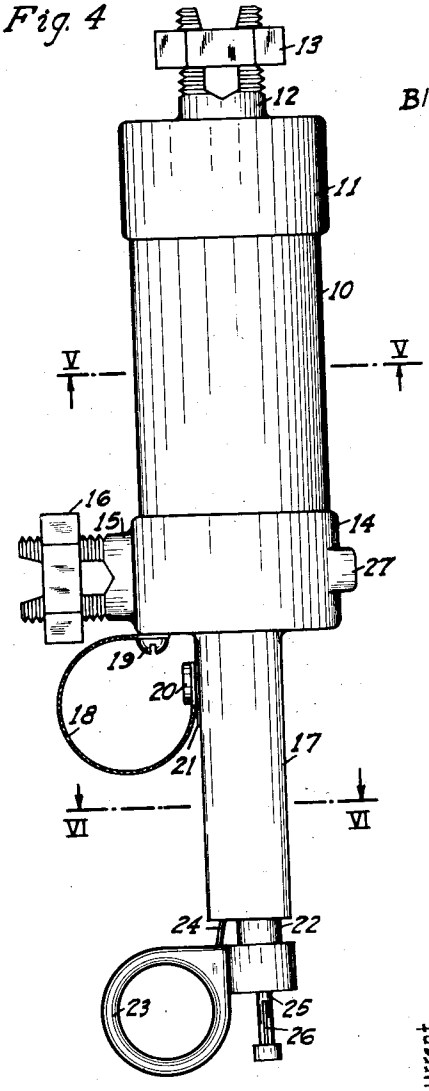


Fig. 5

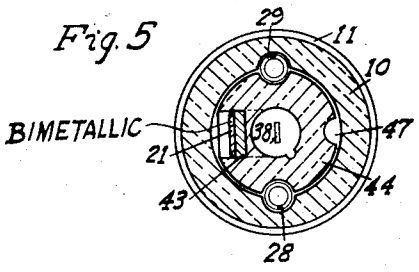


Fig. 6

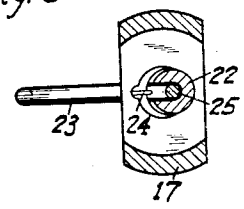
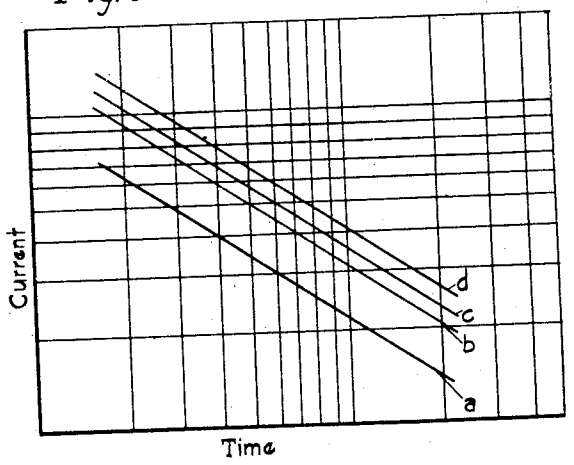


Fig. 7



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CIRCUIT BREAKER

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15 Claims. (Cl. 200—116)

This invention relates generally to circuit breakers for protecting electrical apparatus from damage due to excessive current, and particularly to thermo-responsive devices of this kind.

Among the objects of the invention are (*a*) the provision of a device adapted to open the connected circuit in response to a predetermined current therethrough; (*b*) the provision of a device which cannot be manually held in the closed circuit position, i. e., a "trip free" device; (*c*) the provision of a device which visibly indicates the passage of a predetermined current therethrough in response to a movement of a bimetallic strip prior to the opening of the circuit in response to a further movement of the bimetallic strip; (*d*) the provision of means for visibly indicating the open circuit, or "off" position of the device; and (*e*) the provision of means for so modifying the movement of the bimetallic strip of the device that its movement follows in time the heating of the apparatus it is intended to protect.

With these and other objects in view which will appear from the description, our invention resides in the novel combination, construction, and arrangement of parts, to the end that a minimum of space is occupied by the completed device, and that its small size makes possible a relatively inexpensive construction.

In the drawings:

Fig. 1 is a side elevational view of the device in the closed circuit position.

Fig. 2 is a side elevational view of the device in the open circuit position, with the casing cut away to show the internal parts.

Fig. 3 is a front elevational view of the device in the closed circuit position, taken along the line III—III in Fig. 1.

Fig. 4 is a side elevational view of the device, illustrating its external appearance.

Fig. 5 is a sectional view of the device, taken along the line V—V in Fig. 4.

Fig. 6 is a sectional view of the device, taken along the line VI—VI in Fig. 4.

Fig. 7 is a diagram of a curve showing the current-time characteristic of our device, in comparison with the current-time heating characteristic of a piece of electrical apparatus.

Referring to the drawings, the device includes the hollow tubular insulator 10, the upper end of which is closed by means of the upper terminal member or cap 11. For convenience in connecting a conductor, the upper terminal member 11 is provided with a slotted upstanding portion 12, on which, by means of cooperating threads, the nut 13 may be screwed. Within the hollow of the tubular insulator 10 the conducting cylindrical upper contact 35 is rigidly secured to the upper terminal member 11, in coaxial relation with the bore of the insulator 10, by means of cooperating threads on the respective members. The lower terminal member 14 is provided with the outwardly extending slotted portion 15, on which the nut 16 may be screwed. For reasons shortly to appear, the lower terminal member 14 is provided with the integral downwardly extending yoke portion 17.

The movable assembly support 44, of some suitable insulating material, is loosely fitted within the hollow of the tubular insulator 10, and adapted for longitudinal reciprocatory movement therein. Between the ends of the support 44 is secured, by means of the screw 42, the substantially T-shaped metal member 43. On the top of the horizontal portion of the member 43, and within a cylindrical opening extending downwardly from the top of the support 44 coaxially with the tubular insulator 10, is the lower contact spring 37, which, in the closed circuit position, is arranged to urge the lower contact 36 against the upper contact 35. The conducting braid 38, in shunt circuit relation with the contact spring 37, is a well known means of preventing thermal damage to the latter.

A bimetallic strip 21 is secured, at its upper end, by means of the screws 41 and 42, to the metal member 43, and extends downwardly in abutting relation therewith for a substantial portion of the length of the strip. To eliminate burning or pitting of the contacts 35 and 36, an auxiliary arcing contact 39 is arranged to laterally abut the upper contact 35, and is supported in position by the upwardly extending metal strip 45, the latter being also conductively secured to the metal member 43 by the screws 41 and 42.

At the lower end of the movable assembly support 44, and having a central opening therethrough, is secured, by means of the rivet 49, the latch member support 48, having a pair of opposing downwardly extending ears in which the pivots 50 and 51 are rigidly pressed. A latch member 54, having parallel arms and a laterally extending portion joining the arms, is pivoted, near the ends of the respective arms, for rotative movement on the pivots 50 and 51. The lower ends of the parallel arms of the latch member 54 are joined by means of the pin 52, on which is mounted, for free rotation thereon, a loosely fitted sleeve or roller 53.

A hollow operating rod 22, arranged for verti-

cal reciprocatory movement through an opening through the lower horizontal portion of the yoke portion 17, is provided, near its upper end, with the shoulder 60, for registration with the roller 53 of the latch member 54. The shoulder 60 is positioned so that the center line of the pivots 50 and 51, and the center line of the roller 53, are almost but not quite in the same vertical plane, and so that an upward force on the roller 53 tends to rotate the latch member 54 in a counter-clockwise direction about the pivots 50 and 51. In the normally closed position, such rotation is prevented by the engagement of the laterally extending portion of the latch member 54 with the lower surface of the opening 55 of the bimetallic strip 21.

A pair of springs 28 and 29 are constantly urging the contact 36 downwardly away from the contact 35, along with the remainder of the movable assembly including the bimetallic strip 21. The lower ends of the springs 28 and 29 are attached to the tubular insulator 10 by the pins 32 and 34, and the upper ends to the support 44 by the pins 31 and 33. The above mentioned downward movement is normally prevented by the engagement of the notch 30 of the operating rod 22 with the upper surface of the horizontal portion of the yoke 17. The spring 24 abuts the side of the opening through the yoke portion 17 through which the operating rod 22 passes, and is constantly urging the rod in a direction to prevent its disengagement from the yoke 17.

From the above description, it will be seen that the downward force due to the springs 28 and 29 is transmitted through the support 44 to the roller 53 of the latch member 54, and thence through the operating member 22 to the yoke 17. It will also be seen that the bearing pressure on the roller 53 is greater than the tension of the thermal strip 21 in the ratio of the distance from the bearing point of the latch member 54 on the thermal strip 21 to the amount of offset from the vertical of the bearing point of the roller 53 to the center line through the pivots 50 and 51. This is a very important consideration in the construction of our invention, as a relatively small force is required to prevent the bending of the bimetallic strip when heated. We have found that a ratio of 20 to 1 may be used with our construction with definite and consistent operation.

The current path through the device in the closed circuit position is serially through the terminal member 11, the upper contact 35, the lower contact 36, the contact braid 38, the metal member 43, the bimetallic strip 21, and the flexible conductor 18, one end of which is riveted to the lower end of the bimetallic strip 21, and the other secured to the lower terminal member 14 by means of the screw 19.

Assuming that the device is connected in an electrical circuit, and is in the closed position indicated by Fig. 1, we will now explain the operation of the device. Upon the passage of a predetermined current for a predetermined time through the bimetallic strip 21, the heating effect of the current causes the strip to bend laterally away from the latch point of the latch member 54. When the strip has moved laterally away from the latch point, the downward force due to the springs 28 and 29 on the latch roller 53 causes the latch member 54 to rotate in a counter-clockwise direction. This movement of the latch member 54 causes the roller 53 to move away from the shoulder 60, and the latch member 54, the lower contact 36, the bimetallic strip 21, together with the other parts of the movable assembly, are urged downwardly under the bias of the springs 28 and 29. In the course of its downward movement, the latch roller strokes the shoulder 59 of the operating rod 22, urging the latter in a laterally downward direction, thus releasing the operating rod 22 from the yoke portion 17, and visibly indicating the position of the device. Just prior to the end of the downward stroke, the rigid detent 57 of the yoke 17 engages the laterally extending portion of the latch member 54, so that the latter is rotated in a clockwise direction to a position in which it will again register with the opening 55 of the bimetallic strip 21. The position of the device following the opening movement just described is illustrated by Fig. 2.

For convenience in closing the breaker, the eye 23, of any suitable insulating material, may be attached in any suitable manner to the lower end of the operating rod 22, so that an upward movement of the eye 23 will close the breaker provided the bimetallic strip is in the normal position.

It may be observed that it is impossible to manually hold the breaker in the closed position if the latch member 54 is not engaged with the bimetallic strip 21, because the lower contact 36 will under this condition move downwardly away from the upper contact 35 for the distance between the latch roller 53 and the shoulder 59 of the operating rod 22.

To vent the flame and gaseous products attending the interruption of relatively high currents, a vent 27 is provided in the lower terminal member. A pair of vent passages 45 and 46, adjacent the upper contact 35, are in communication with the vent 27 through the vertically extending passageway 47 during the opening motion of the breaker. The latch member support 48 prevents the blowing of flame or gases upon the operating mechanism at the lower end of the tubular insulator 10.

It is desirable, in connection with certain types of apparatus, particularly transformers, to obtain some indication of the amount of current in the circuit prior to its disconnection. To accomplish this result, a metal indicating member 25 extends upwardly into the hollow of the operating rod 22, and is provided with a detent 58 at its upper end for normally engaging the rear horizontal portion of the rivet 20. A semaphore 26 is rigidly secured to an outwardly extending portion of the member 25. A predetermined movement of the bimetallic strip 21 in a direction to trip the breaker, but prior to doing so, releases the detent 58 from the rivet member 20, permitting the member 25 and the semaphore 26 to move downwardly until the detent 58 engages the inwardly bent lower end portion 56 of the bimetallic strip 21. This position is illustrated by the broken lines in Fig. 1. A further movement of the strip 21 releases the detent 58 from the position just described, and permits a further downward movement of the member 25 and the semaphore 26 to the position indicated by the broken lines in Fig. 3. A further movement of the strip 21 trips the breaker to the open position, as before described.

The purpose of this arrangement may be understood from Fig. 7. The line *d* may represent the heating limit curve of a transformer. The line *c* may represent the conditions under which

the breaker opens. The line *b* may represent the conditions under which the semaphore is released to its lowermost position, which may indicate that any substantial increase in load will cause the breaker to open. The line *a* represents the conditions under which the semaphore is released to the intermediate position, which may indicate that sufficient load is being carried to be uneconomical to replace the existing transformer with a smaller size unit. No movement of the semaphore indicates that little or no load is being supplied from the transformer, and that some more economical arrangement may be considered.

We have found it necessary to provide some means of retarding the motion of the bimetallic strip **21** when it is heated due to passage of current therethrough, in order to make its lateral movement follow in time with the heating of the apparatus it is intended to protect. This we have accomplished by means of the metal member **43**, placed normally in lateral abutting relation with the strip. The metal member **43** conducts a portion of the heat away from the strip, and thus retards its temperature rise and consequent deflection, particularly on relatively low currents continued for relatively long periods of time. In the case of relatively high currents, the heating of the strip is so rapid that the time is insufficient to conduct any substantial amount of heat from the strip, and the strip therefore deflects rapidly under this condition. In this manner, the opening of the breaker may be timed to occur only when the hot spot temperature of the connected apparatus reaches a dangerous value.

It may be observed that the bimetallic strip in our device is under tension when the breaker is being closed, and when latched in the closed position. Because of the fact that the bimetallic strip deflects due to elongation in response to heating, any lengthening of the strip in our circuit breaker tends to loosen the latch member **54**, so that the tensioned strip makes possible quick and definite action under all conditions of tripping.

It will be apparent to those skilled in this art that various modifications may be made in the invention disclosed herein, and it will be understood that the description of the specific embodiment herein disclosed is illustrative rather than limiting.

What we claim is new, and desire to secure by Letters Patent, is:

1. In a circuit breaker, relatively reciprocable upper and lower contacts for opening and closing a circuit, resilient means urging said contacts to the open circuit position, a bimetallic strip bodily movable with the lower contact, a reciprocable operating rod, means including a latch mechanically connecting said rod to said strip for urging said contacts to engagment, latch means combined with said rod for normally maintaining said contacts in engagement, and means responsive to a downward movement of said first-named latch for unlatching said operating rod.

2. A circuit breaker comprising a hollow tubular insulator, upper and lower terminal members secured adjacent the respective ends of said insulator, an upper contact conductively mounted on the upper terminal member within said insulator, a reciprocably movable lower contact arranged to engage and disengage said upper contact, a longitudinally movable bimetallic strip connecting said lower contact to the lower terminal, a reciprocable operating rod for urging said contacts to engagement, a latch member normally mechanically connecting said rod with said bimetallic strip, retaining means normally maintaining the mechanical connection and also maintaining said contacts in engagement, and means operable on overload in the circuit to release the mechanical connection and subsequently to release said retaining means.

3. In a circuit breaker, relatively reciprocable contacts for opening and closing a circuit, resilient means urging said contacts from the closed to the open position, a reciprocable operating rod for urging said contacts to the closed position, a bimetallic strip in series circuit relation with said contacts, a latch mechanically connecting said operating rod with said bimetallic strip for maintaining said contacts in the closed position, said latch including a latch member rotatively mounted on a pivot, said pivot being so positioned with respect to the bearing points of said latch member on said strip and said rod that the bearing pressure due to said resilient means is substantially less on said bimetallic strip than on said rod.

4. In a circuit breaker, relatively movable contacts, a vertically reciprocable hollow operating rod for actuating said contacts to the closed and open position, resilient means urging said contacts to the open position, means including a bimetallic strip for normally latching said contacts in the closed position, means responsive to a movement of said bimetallic strip for unlatching said contacts, and a member extending upwardly into the hollow of said operating rod, said member cooperating with said bimetallic strip to indicate the position of the latter prior to the unlatching of said contacts.

5. In a circuit breaker, relatively movable contacts, a vertically reciprocable hollow operating rod for actuating said contacts to the closed and open position, resilient means urging said contacts to the open position, means including a bimetallic strip for normally latching said contacts in the closed position, a member extending upwardly for a portion of its length into the hollow of said operating rod, a semaphore secured at the lower end of said member, and means dependent upon a predetermined lateral movement of said bimetallic strip in a direction to unlatch said contacts for establishing the position of said semaphore.

6. In combination, a circuit breaker having relatively movable contacts, resilient means urging said contacts to the open circuit position, latch means including a vertically extending hollow operating rod in cooperation with an upwardly extending bimetallic strip for maintaining said breaker in the closed position, and means for visibly indicating the occurrence of a predetermined movement of said bimetallic strip prior to the unlatching of the contacts, said means including a vertically movable member extending upwardly into the hollow of said operating rod, a semaphore secured to the lower end of said member, a detent member secured to the upper end of said movable member, and a plurality of detents carried by said bimetallic strip for sequentially engaging and disengaging said detent member in response to a lateral movement of said bimetallic strip.

7. In a circuit breaker, coaxially reciprocable contacts for opening and closing a circuit, resilient means urging said contacts to the open cir-

cuit position, latch means including a longitudinally bodily movable bimetallic strip under tension for normally preventing the movement of said contacts to the open circuit position, said latch means permitting the actuation of said contacts to the open position in response to a bending movement of said bimetallic strip due to heating thereof, and means for delaying the movement of said bimetallic strip, said last-named means comprising a body of metal in physical contact with said bimetallic strip for a substantial portion of the length thereof.

8. A circuit breaker comprising a hollow tubular insulator, upper and lower conducting terminal members secured adjacent the respective ends of said insulator, an upper contact conductively mounted on the upper terminal member within said insulator, a longitudinally movable lower contact aranged to engage and disengage said upper contact, resilient means opposing the engagement of the contacts, a longitudinally movable operating rod associated with the lower contact, means including a bimetallic strip bodily movable with said lower contact for electrically connecting the latter to the lower terminal member, said bimetallic strip cooperating with said operating rod to latch said contacts in engagement, and to unlatch said contacts in response to a bending movement of said bimetallic strip, and delay means comprising a body of metal in physical contact with said bimetallic strip for retarding the bending movement thereof.

9. In a circuit breaker, relatively reciprocable contacts for opening and closing a circuit, resilient means urging said contacts to the open position, a reciprocable operating member for urging said contacts to the closed position, a bodily movable thermal strip in series circuit relation with said contacts, said thermal strip being arranged for longitudinally reciprocable movement along said operating member a latch mechanically connecting said operating member with said thermal strip for maintaining said contacts in the closed position, said latch including a latch member rotatively mounted on a pivot so as to tension said thermal strip and compress said operating member, said pivot being so positioned with respect to the bearing points of said latch member on said strip and said operating member that the tensile stress in said thermal strip is substantially less than the compressive stress on said operating member.

10. In a circuit breaker, relatively movable contacts, means for actuating said contacts to the closed and open position, resilient means urging said contacts to the open position, means including a bimetallic strip for normally latching said contacts in the closed position, means responsive to a movement of said bimetallic strip for unlatching said contacts, an indicating member cooperating with said bimetallic strip, said indicating member being movable to a plurality of indicating positions, and means dependent upon a predetermined movement of said bimetallic strip in a direction to unlatch said contacts for sequentially establishing said positions prior to the unlatching of said contacts.

11. In a circuit breaker, relatively reciprocable upper and lower contacts for opening and closing a circuit, resilient means urging said contacts to the open circuit position, a bimetallic strip bodily movable with the lower contact, a reciprocable operating rod, means including a latch mechanically connecting said rod to said strip for urging said contacts to engagement, latch means combined with said rod for normally maintaining said contacts in engagement, an indicating member cooperating with said bimetallic strip, said indicating member being movable to at least one indicating position, and means responsive to a predetermined movement of said bimetallic strip in a direction to unlatch said contacts for establishing said indicating position prior to the unlatching of said contacts.

12. In a circuit breaker, relatively reciprocable upper and lower contacts for opening and closing a circuit, resilient means urging said contacts to the open circuit position, a bimetallic strip bodily movable with the lower contact, a reciprocable operating rod, means including a latch mechanically connecting said rod to said strip for urging said contacts to engagement, latch means combined with said rod for normally maintaining said contacts in engagement, an indicating member associated with said bimetallic strip, said indicating member being movable to a plurality of indicating positions, and means dependent upon a predetermined movement of said bimetallic strip in a direction to unlatch said contacts for sequentially establishing said positions prior to the unlatching of said contacts.

13. In a circuit breaker, relatively movable contacts, means for actuating said contacts to the closed and open position, resilient means urging said contacts to the open position, means including a bimetallic strip for normally latching said contacts in the closed position, means responsive to a movement of said bimetallic strip for unlatching said contacts, an indicating member cooperating with said bimetallic strip, said indicating member being movable to at least one indicating position, means responsive to a predetermined movement of said bimetallic strip in a direction to unlatch said contacts for establishing said indicating position prior to the unlatching of said contacts, and means for delaying the movement of said bimetallic strip, said last-named means comprising a body of metal in physical contact with said bimetallic strip for a substantial portion of the length thereof.

14. In a circuit breaker, relatively reciprocable contacts for opening and closing a circuit, resilient means urging said contacts to the open position, a reciprocable operating member for urging said contacts to the closed position, a bodily movable thermal strip in series circuit relation with said contacts, said thermal strip being arranged for longitudinaly reciprocable movement along said operating member, a latch mechanically connecting said operating member with said thermal strip for maintaining said contacts in the closed position, said latch including a latch member rotatively mounted on a pivot so as to tension said thermal strip and compress said operating member, said pivot being so positioned with respect to the bearing points of said latch member on said strip and said operating member that the tensile stress in said thermal strip is substantially less than the compressive stress on said operating member, means operable on overload in the circuit to release the mechanical connection and subsequently to release said operating member, an indicating member cooperating with said bimetallic strip, said indicating member being movable to an indicating position, and means dependent upon a predetermined movement of said bimetallic strip in a direction to unlatch said operating member for establishing said position while maintaining said contacts in the closed position.

15. A circuit breaker comprising a hollow tubular insulator, upper and lower terminal members secured adjacent the respective ends of said insulator, an upper contact conductively mounted on the upper terminal member within said insulator, a reciprocably movable lower contact arranged to engage and disengage said upper contact, a longitudinally movable bimetallic strip connecting said lower contact to the lower terminal, a reciprocable operating rod for urging said contacts to engagement, a latch member normally mechanically connecting said rod to said bimetallic strip, retaining means normally maintaining the mechanical connection and also maintaining the contacts in engagement, means operable on overload in the circuit to release the mechanical connection and subsequently to release said retaining means, an indicating member cooperating with said bimetallic strip, said indicating member being movable to an indicating position, and means dependent upon a predetermined movement of said bimetallic strip in a direction to unlatch said operating member for establishing said indicating position prior to the release of said retaining means.

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