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H. D. DORFMAN

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CIRCUIT BREAKER

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Fig. 1.

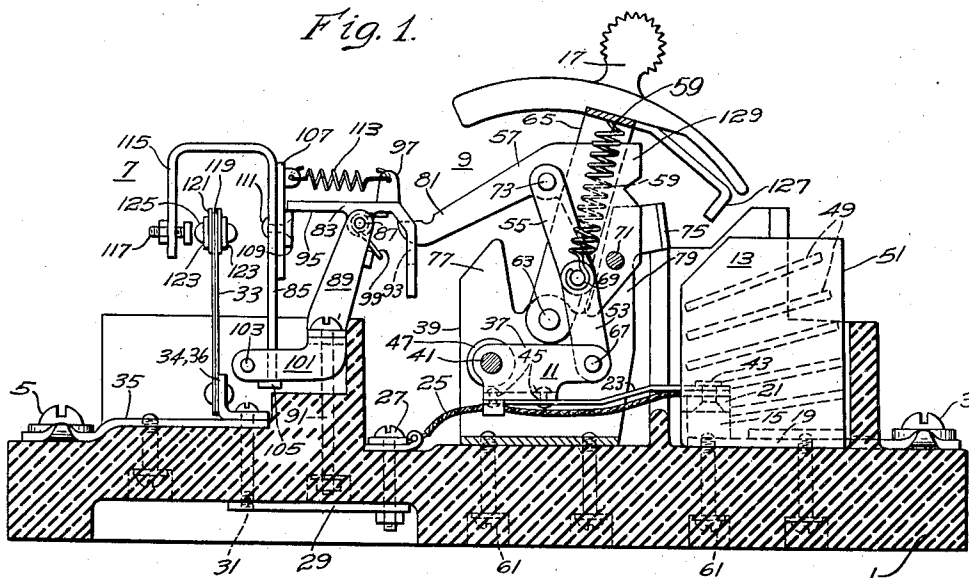


Fig. 2.

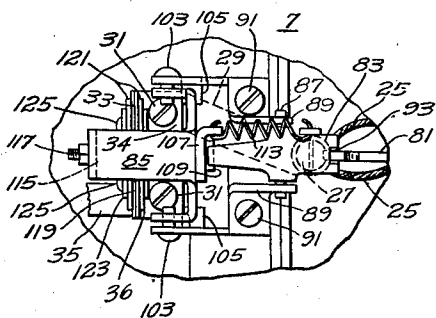


Fig. 3.

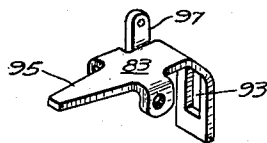
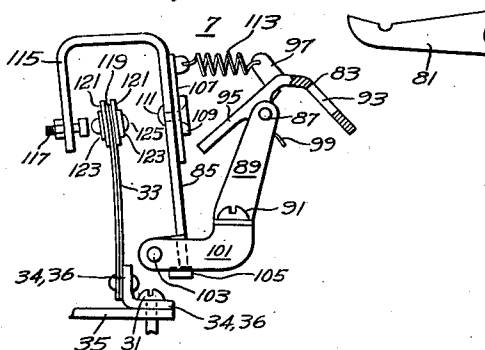


Fig. 4.

WITNESSES:

C. J. Miller
Paul D. Claister

INVENTOR

Hiller D. Dorfman.

BY

F. W. Lyle
ATTORNEY

UNITED STATES PATENT OFFICE

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CIRCUIT BREAKER

Hiller D. Dorfman, Mansfield, Ohio, assignor to
Westinghouse Electric & Manufacturing Com-
pany, East Pittsburgh, Pa., a corporation of
Pennsylvania

Application July 12, 1933, Serial No. 680,048

17 Claims. (Cl. 200—116)

My invention relates to circuit breakers and particularly to circuit breaker trip devices which utilize a thermally responsive, bimetallic trip member.

One form of circuit breaker trip device includes a latch for engaging the circuit breaker operating mechanism, a bimetallic member for actuating the latch, and a spring means for biasing the latch to the latched position. During the tripping operation, the bimetallic member moves the latch, against the force of the biasing spring, to the tripped position whereupon the circuit breaker operating mechanism moves the contacts to the open position. The circuit is not immediately interrupted, however, due to the time which must elapse before the arc is extinguished, and the movement of the bimetallic member continues for an appreciable time after the release of the latch. This movement must be effected against the force of the latch biasing means, and frequently results in causing the bimetallic member to take a permanent set, thus destroying the calibration of the trip device. This damaging of the bimetallic member is especially prevalent during the interruption of heavy current overloads and may result in serious future damage to the apparatus protected by the breaker.

It is an object of my invention, therefore, to provide a circuit breaker trip mechanism having a thermally responsive element of bimetallic material that is freed from external stresses immediately following the release of the associated latch means.

Another object of my invention is to provide an improved circuit breaker trip device that shall include a bimetallic thermally responsive element, a latch, and a member intermediate the latch and the breaker operating mechanism upon which the reaction forces of the operating mechanism act; my improved trip device to include means for preventing any external agency from stressing the bimetallic element at such times when that element might be in condition to take a permanent set.

The principal field for immediate application of my invention is in connection with trip devices for snap-acting circuit breakers such as are used for controlling lighting and distribution feeder circuits, and I shall hereinafter describe an embodiment of my invention as applied to such circuit breakers, without, however, in any way intending to restrict the scope of my invention except as indicated in the appended claims.

In the preferred embodiment of my invention,

I provide a manually operable mechanism for moving a switch member to the open or closed position, a stationary contact member for cooperating with the movable switch member, an insulating base for mounting the various elements of the circuit breaker, an arc extinguishing device affixed to the base adjacent the path of movement of the movable switch member, a means for biasing the switch member to the open position, a releasable restraining means for holding the switch member in the closed position, and a trip device for engaging and releasably restraining the means holding the switch member in the closed position.

The features of my invention which I believe to be new are particularly pointed out in the appended claims, and for a full understanding of the principles of the invention, reference may be had to the accompanying drawing, in which

Figure 1 is a view, partially in side elevation and partially in section, of a circuit breaker embodying the principal elements of my invention.

Fig. 2 is a fragmentary plan view showing the trip device of the circuit breaker illustrated in Fig. 1.

Fig. 3 is a fragmentary elevational view similar to Fig. 2, and shows the trip device in the tripped position, and

Fig. 4 is a perspective view of the latch utilized in this embodiment of my invention.

Referring to the drawing, the base 1 of the circuit breaker is of molded insulating material and has mounted thereon the terminal contacts 3 and 5, the trip device 7, the circuit breaker operating mechanism 9, which has associated therewith the switch member 11, the arc extinguisher 13, and the main stationary contact 15. A cover (not shown) of molded insulating material is ordinarily provided for enclosing and protecting the mechanism of the circuit breaker. An operating handle 17, also of molded insulating material, is provided for actuating the operating mechanism 9. The various parts of the trip device 7, the operating mechanism 9, and the arc extinguisher 13 are affixed to the base by means of screws which extend through suitable openings therein.

The electrical circuit through the breaker is very direct; beginning with the terminal contact 3, the current flows successively through the conducting strip 19, the stationary contact 15, the moving contact 21, which is supported on the resilient switch arm 23, the flexible conducting shunts 25, the bolt 27 which connects the end of the shunts 25 with the conducting strip 29, thence through the conducting strip 29 and the

bolt 31 to the terminal 34 of the U-shaped bimetallic trip element 33, and finally through that element, the other terminal 36, and the terminal conducting strip 35 to the other terminal contact 5.

5 The structural details of the circuit breaker operating mechanism 9 and the arc extinguisher 13 are not important parts of this invention, and any suitable mechanism which is adapted to engage a trip latch may be used. I prefer, however, to utilize a mechanism similar to that disclosed in my copending application, Serial No. 600,660, filed on March 23, 1932 and assigned to the same assignee as this invention.

10 The switch member 11 has a channel shaped frame 37 which is pivoted to the U-shaped frame 39 of the circuit breaker operating mechanism 9 through the agency of a pivot pin 41. The resilient switch arm 23 is preferably constructed of spring steel, and, as previously pointed out, the moving contact 21 is rigidly affixed to the free end thereof by means of a rivet 43. The switch arm itself is affixed to the channel shaped frame by means of two other rivets 45. The conducting shunts 25 are electrically connected to the moving contact 21 at one end, and are provided with terminals at the other end adapted to be engaged by the screw 27. Round spacing washers 47 are provided to position the switch member frame 37 between the up-standing sides of the frame 39 of the operating mechanism.

30 I prefer to use arc resisting material for both the moving and the stationary contacts, the former being composed of finely divided silver and graphite compressed into a conglomerate mass, and the latter being composed of a silver molybdenum alloy.

35 The arc extinguisher 13 is preferably of the spaced-plate type in which a plurality of slotted plates of magnetic material, each insulated from the adjacent plates and having a slot therein are provided. The slots in the plates are of substantially the same outline as the moving contact and the extinguisher is positioned closely adjacent the arc path. The magnetic plates so alter the field adjacent the arc that it is moved into the spaces between the plates where it is quickly cooled and extinguished.

40 In the structure shown in Fig. 1, the magnetic plates 49 having slots therein are assembled between two end plates 51 of insulating material, projecting lugs (not shown) being provided in the magnetic plates 49 for engaging the end plates 51.

45 The operating mechanism 9 comprises, in general, a U-shaped base 39, a pair of toggle links 53 and 55 for engaging and actuating the frame 37 of the switch member 11, a releasable carrier or trigger 57 for restraining the toggle links in an operative position, an operating member 17, and a pair of over-center springs 59 for connecting the operating member 17 to the knee of the toggle links. The U-shaped base 39 as previously pointed out, is fastened to the insulating base of the circuit breaker proper by means of two screws 61 that engage suitable threaded openings in the base. The pivot pin 41 which provides a pivot point for the switch member 11 extends through aligned openings in the opposing sides of the U. Other openings are provided for the reception of the pivot pins 63—one on either side of the U—which provide pivot points for the bifurcated portion 65 of the operating member 17.

70 The lower end (with respect to the base 1) of the toggle link 53 is pivoted to the frame 37 of the switch member 11 by means of a pivot pin 67. The upper end of the toggle link 53 is pivoted to

one end of the second toggle link 55 by means of the knee pivot pin 69. One of the operating springs 59 engages each end of the knee pivot pin 69 and thus serves to operatively connect the knee of the toggle with the operating member 17. The carrier 57, which is pivoted about the pin 71 provides a releasable restraining means for holding the toggle links in an operative position—the upper end of the toggle link 55 being pivotally fastened to the carrier 57 through the agency of a pin 73. The movement of the carrier about its pivot pin in a clockwise direction is limited by the projection 75 which extends inwardly from one side of the U-shaped base 39. The limits of motion of the bifurcated portion 65 of the operating member are defined by the off-set projections 77 and 79 forming a part of the sides of the U-shaped base. The carrier 57 is provided with a projecting portion 81 adapted to engage the trip device 7.

20 The trip device 7 includes a current carrying bimetallic member 33, a latch 83 for engaging the operating mechanism 9, and a member 85 intermediate the latch and the electro-responsive element. As shown particularly in Figs. 1 and 2, the latch is supported on a pivot pin 87 which extends through opposed holes in the upstanding sides of a pair of bracket members 89, the bracket members being affixed to the base by two screw bolts 91.

30 The latch 83 is shown particularly in Fig. 4, and includes a rectangular slot 93 for engaging the end 81 of the carrier lever 57, a rearwardly extending portion 95 for engaging the intermediate member 85, and an up-standing projection 97, the function of which will be described in some detail later. The latch 83 is biased to the unlatched position by means of the spring 99.

35 The intermediate member 85 is pivotally supported adjacent the point of support of the bimetallic element 33 by means of two support arms 101, affixed to the base by the screw bolts 91, and the two pivot pins 103. Each of the support arms 101 has an inwardly extending projection 105 which serves as a stop for limiting the motion of the intermediate member in a clockwise direction about its pivot point.

40 A pair of plate members 107 and 109 are rigidly secured to the body portion of the intermediate member 85 by means of a rivet 111. The plate 107 member 107 is utilized as an anchor means for the spring 113 which connects the latch 83 and the intermediate member 85. The other plate 109 is utilized as a stop for the latch. The intermediate member 85 has an overhanging portion 115 for engaging the freely movable end of the bimetallic member 33, an adjustable screw stop 117 being provided for securing such adjustment as may be necessary.

45 The bimetallic member 33 is substantially U-shaped, and is provided with a pair of L-shaped terminals 34 and 36, one of which is riveted to each of the leg portions of the U. The closed end 119 of the U is freely movable, and is provided with a stiffening means which also serves as a means for engaging the intermediate member 85. The stiffening means, as shown particularly in Figs. 1, 2, and 3, includes a pair of plates 121 of insulating material held together by a pair of metallic plates 123 and a pair of rivets 125 which extend through enlarged openings in the end 119 of the bimetallic member.

50 The carrier member 57 is at all times biased in a clockwise direction by the reaction force of the over-center springs 59. This force must be

balanced by the latch 83, and in order to secure accurate operation of the trip device it is necessary that the location of the pivot points and the point of application of the balancing force be such that practically none of the reaction force must be overcome by the bimetallic element when moving the intermediate member 85 to tripped position.

This desired result is accomplished in the above described embodiment of my invention by causing the entire static balancing force to be supplied by the inwardly projecting stops 105 which limit the clockwise movement of the intermediate member 85, and by so proportioning the intermediate member that it can be moved to the tripped position without moving the latch 83 against the biasing force transmitted through the carrier 57; the total force which must be supplied by the bimetallic element when moving to the tripped position being merely that necessary to overcome the biasing action of the spring 113 and the sliding friction opposing the disengaging of the end 95 of the latch 83 by the latch plate 109 affixed to the intermediate member 85.

The circuit breaker is shown in the closed position in Fig. 1, and it will be noted that the toggle has been moved to the over-center latched position. To open the contacts manually the operating handle 17 is moved in a counter-clockwise direction about its pivot point, the pins 63; shortly before the operating handle 17 has reached its limit of travel in the counter clockwise direction the line of action of the over-center springs 59 is brought to the left of the center line of the toggle. This results in the producing of a component of force which moves the toggle to the collapsed position. Since movement of the knee of the toggle from the position shown in Fig. 1 toward the collapsed position results in a progressive increasing of the force causing the movement, the opening operation, once started, takes place automatically and results in the separation of the contacts with a snap action.

The closing operation is substantially the reverse of the opening operation. The handle is moved in a clockwise direction, the resulting tension of the over-center springs causes the knee of the toggle to move toward the closed circuit position, and since the same progressive increase in the component acting upon the knee of the toggle is present, the closing operation is likewise carried on with a snap action.

Upon the occurrence of a predetermined overload condition the increased I^2R loss in the current carrying bimetallic element 33 results in the production of sufficient heating to cause that element to deflect away from the operating mechanism 9. If the overload persists for a sufficient interval of time, this deflection becomes great enough to move the intermediate member 85 from the position shown in Fig. 1 to the position shown in Fig. 3, the plate 109 being moved out of engagement with the end 95 of the latch 83. This releases the latch 83 and allows the carrier 57 to move freely in a clockwise direction about its pivot pin 71 under the influence of the reaction forces of the over-center springs 59. Almost immediately, the end of the toggle link 55 which is pivoted on the carrier 57 is moved a sufficient distance to the right of the center line of the toggle to cause the toggle to collapse as a result of the tension force applied to the knee pivot pin 69 by the over-center springs 59. The switch

member frame 37 rotates about its pivot pin 41 and moves the contact 21 to the open circuit position in exactly the same manner as described for manual operation. Due to the change in the position of the knee pivot pin 69, the operating handle is biased in a counter-clockwise direction but moves only to the middle position due to the engagement of the downwardly projecting member 127 with the end 129 of cradle 57. This movement of the handle to the mid-position following the tripping of the breaker serves as a ready indicating means for showing that the circuit has been opened in response to an abnormal electrical condition.

During the tripping operation, the intermediate member 85 is moved against the biasing action of the spring 113 connecting that member and the latch 83. Immediately following the disengaging of the end 95 of the latch 83 by the plate 109 affixed to the intermediate member 85, the latch becomes free to rotate under the combined forces of its own biasing spring 99 and the reaction force transmitted through the cradle 57. The mechanism immediately moves to the position shown in Fig. 3 and it becomes readily apparent that all external forces biasing the intermediate member 85 against movement by the bimetallic element 33 are at once released due to the movement of the projecting portion 97 of the latch 83. Thus, following the tripping of the breaker, the bimetallic element 33 is free to move without having to overcome any external force tending to prevent such movement. This is particularly desirable when interrupting overloads of large magnitudes, because, due to the steepness of the wave front and the resulting rapidity with which such overloads reach a dangerously large value, it is impossible to secure a bimetallic element that does not have an appreciable time lag with respect to the progress of the overload. The movement of the bimetallic member, therefore, does not occur simultaneously with the occurrence of the overload, nor does it occur simultaneously with its own heating due to the mechanical inability of the metal to expand instantaneously. Further, the heating continues after the trip device has been actuated due to the time required to extinguish the arc, and if any external force acts upon the bimetallic element during the time of arc extinction, that element due to the lowering of its elastic limit as a result of the high temperature to which the element is heated, may take on a permanent set. If this happens, the calibration of the device is entirely destroyed and serious damage may result to the equipment which is protected thereby upon the occurrence of successive overload conditions. The trip devices heretofore known in the art have not been provided with means for removing all external stress from the bimetallic elements immediately upon the actuation of the trip device, and it is to this feature that my invention is particularly directed.

The entire mechanism is entirely resettable by movement of the operating handle 17. As mentioned above, the projection 127 which extends downwardly from the operating handle 17 engages the end 129 of cradle 57 when the breaker is in the tripped position. To reset the mechanism and the trip device, the handle is moved to the full "off" position. This movement causes a rotation of the cradle 57 in a counter-clockwise direction about its pivot pin 71, the end 81 of cradle 57 engages the bottom of the rectangular slot 93 in the latch 83, the latch is rotated in

a clockwise direction about its pivot pin 87, the spring 112 connecting the latch 83 and the intermediate member 85 is tensioned, thereby moving the intermediate member 85 to the position shown in Fig. 1, whereupon the projecting end 95 of the latch reengages the latch plate 109. The breaker may then be closed manually as described in the previous paragraph.

The operating mechanism 9 is trip free of the operating handle 17 because the movement of cradle 57 following its release by the trip latch is independent of the position of the handle, and because the parts are so proportioned that the toggle cannot be held from collapsing following the release of the cradle.

It will thus be seen that I have disclosed an improved circuit breaker trip device utilizing a bimetallic electro-responsive element which is normally free from external stress, and which is stressed only during that portion of its movement which is necessary to cause the release of the latch holding the trip device in the untripped position. In addition, I have disclosed how this principle may be utilized in combination with a trip device having means inherent therein for equalizing the reaction forces resulting from the operating mechanism.

While in accordance with the patent statutes, I have given the foregoing details of a practical embodiment of my invention, it is to be understood that many of these details are merely illustrative and the variation in their precise form will be desirable in some applications. I desire, therefore, that the language of the accompanying claims shall be accorded the broadest reasonable construction and that my invention be limited only by what is explicitly stated in the claims and by the prior art.

I claim as my invention:

1. In a trip device for a circuit interrupter a thermally responsive element of bimetallic material, and a tripping mechanism adapted to be actuated thereby, said tripping mechanism including a member movable in response to movement of said element to cause said mechanism to move to the tripped position, means biasing said member against movement, and means for rendering said biasing means ineffective when said member has been moved to the tripped position.

2. In a trip device for a circuit interrupter, an electro-responsive element, a latch, a latch retaining means adapted to be moved by said element to release said latch, means biasing said retaining means to the latch-retaining position, and means for rendering said biasing means ineffective immediately following the release of said latch by said retaining means.

3. In a trip device for a circuit interrupter, a thermally responsive element of bimetallic material, a tripping means adapted to be actuated thereby, means biasing said tripping means to the untripped position, and means for reducing the force exerted by said biasing means as soon as said tripping means has been moved to the tripped position by said thermally responsive element.

4. In a trip device for a circuit interrupter, a thermally responsive element of bimetallic material supported adjacent one end and having a freely movable portion at the other end, a latch, a pivotally supported latch retaining means adapted to be moved by said element to release said latch, means biasing said retaining means against movement by said element, and means for relieving said element from the force exerted

by said biasing means immediately following the release of said latch by said retaining means.

5. In a trip device for a circuit interrupter, a thermally responsive element of bimetallic material, supported at one end and having a freely movable portion at the other end, a latch, a latch actuating means pivotally supported adjacent the supported end of said bimetallic element and having a portion extending along the freely movable portion of said bimetallic element, said latch actuating means being adapted to be moved by said bimetallic element to release said latch, spring means biasing said actuating means to the untripped position, and means for rendering said biasing means ineffective immediately following the movement of said actuating means to the tripped position.

6. In a circuit interrupter, a switch member, for opening and closing the circuit, means for biasing said switch member to one position, a latch for releasably restraining said switch member against said biasing means, an electro-responsive device for releasing said latch, a member, intermediate said electro-responsive device and said latch upon which the force of said switch member biasing means acts, said intermediate member being engaged by said electro-responsive device to release said latch, means biasing said intermediate member to the latch engaged position, and means for causing said biasing means for said intermediate member to become ineffective when said intermediate member has been moved a predetermined distance by said electro-responsive device.

7. In a circuit interrupter, a switch member for opening and closing the circuit, means for biasing said switch member to the open position, a pivoted latch for releasably restraining said switch member in the closed position against the force of said biasing means, an electro-responsive device including a bimetallic member for releasing said latch, a pivotally mounted member, intermediate said electro-responsive device and said latch upon which the force of said switch member biasing means acts, said bimetallic member being adapted to engage said intermediate member to release said latch, spring means biasing said intermediate member against movement by said bimetallic member, and means for rendering said spring biasing means for said intermediate member ineffective when said member has been moved sufficiently to release said latch.

8. In a circuit interrupter, a switch member for opening and closing the circuit, means for biasing said switch member to one position, a releasable latch means for restraining said switch member against said biasing means, means biasing said latch means to the restrained position, electro-responsive means, movable in a substantially fixed path, for causing said latch means to move against said latch biasing means to the released position when said electro-responsive means has moved a predetermined distance along said fixed path, and means for causing said latch biasing means to become ineffective when said latch means has been moved to release said switch member.

9. In electrical apparatus, a movable electro-responsive element, a latch means adapted to be actuated by said electro-responsive element, a spring for biasing said latch means against movement to the unlatched position by said electro-responsive element, and support means for said spring, said support means causing said spring to move toward said electro-responsive element

and thereby unstress said spring when said latch is released.

10. In a trip device for a circuit interrupter, an electro-responsive element of bimetallic material, a latch means actuated thereby, and a spring intermediate said electro-responsive element and said latch means, said spring being affixed to support means forming a part of said latch means and being adapted to be tensioned when said electro-responsive element moves to the tripped position to actuate said latch, said support means moving toward said electro-responsive element to reduce the stress of said spring as soon as said latch is caused to move to the tripped position by said electro-responsive element.

11. In a trip device for use with electrical apparatus, an electro-responsive element, a latch, a latch retaining means intermediate said latch and said electro-responsive element, said latch retaining means being adapted to be moved by said electro-responsive element to cause the release of said latch, means biasing said retaining means against movement by said electro-responsive element, and means operable to cause said electro-responsive element to be relieved of the force exerted by said biasing means opposing movement of said retaining means by said element immediately following a release of said latch by said retaining means.

12. In a trip device for use with electrical apparatus, a thermally responsive element of bimetallic material having a freely movable portion, a latch, a pivotally supported latch retaining means adapted to be moved by said bimetallic element to effect the release of said latch, means biasing said retaining means against movement by said element, and means for relieving said element from the force exerted by said biasing means opposing movement of said latch retaining means by said element immediately following the release of said latch by said retaining means.

13. In a trip device for a circuit interrupter, a thermally responsive element of bimetallic material supported adjacent one end and having a freely movable portion at the other end, a latch, a pivotally supported latch retaining member intermediate said latch and said thermally responsive element which is adapted to be moved by said element to effect the release of said latch, a resilient means biasing said retaining member against movement by said thermally responsive element, and means for relieving said element from the force exerted by said biasing means opposing movement of said latch retaining means by

said element immediately following the release of said latch by said retaining means.

14. In a trip device for a circuit interrupter, a thermally responsive element of bimetallic material having a freely movable portion, means movable in response to movement of said element to cause actuation of said trip device, a spring biasing said actuating means against movement by said element, means normally preventing said spring means from causing said movable means to engage said electro-responsive element except during the tripping operation, and means for reducing the effect of said biasing means when said actuating means has been moved a predetermined distance by said electro-responsive element.

15. In a trip device for a circuit interrupter, a thermally responsive element of bimetallic material supported adjacent one end and having a freely movable portion at the other end, a latch, a pivotally supported latch retaining means adapted to be moved by said element to release said latch, spring means biasing said retaining means against movement by said element, stop means for normally preventing said element from being subjected to the force of said spring biasing means except during the tripping operation, and means for relieving said element from the force exerted by said spring biasing means immediately following the release of said latch by said latch retaining means.

16. In a trip device for a circuit interrupter, an electro-responsive element, a latch, a latch retaining means engaging and holding said latch against movement and adapted to be moved by said element to release said latch, a spring connected between said latch and said latch retaining means for biasing said retaining means to the latch-retaining position, and said spring being connected to said latch at a point movable in such direction as to render said spring ineffective immediately following the release of said latch by said retaining means.

17. In a trip device for a circuit interrupter, a thermally responsive element of bimetallic material, a tripping means adapted to be actuated thereby, a spring biasing said tripping means to the untripped position, said spring being connected at one end to an element of the device which moves when the device is tripped in such direction as to reduce the force exerted by said spring as soon as said tripping means has been moved to the tripped position by said thermally responsive element.

HILLER D. DORFMAN.