March 28, 1944. H. D. DORFMAN ET AL 2,345,105

CIRCUIT BREAKER

Filed May 9, 1941 2 Sheets-Sheet 1

Fig. 1.

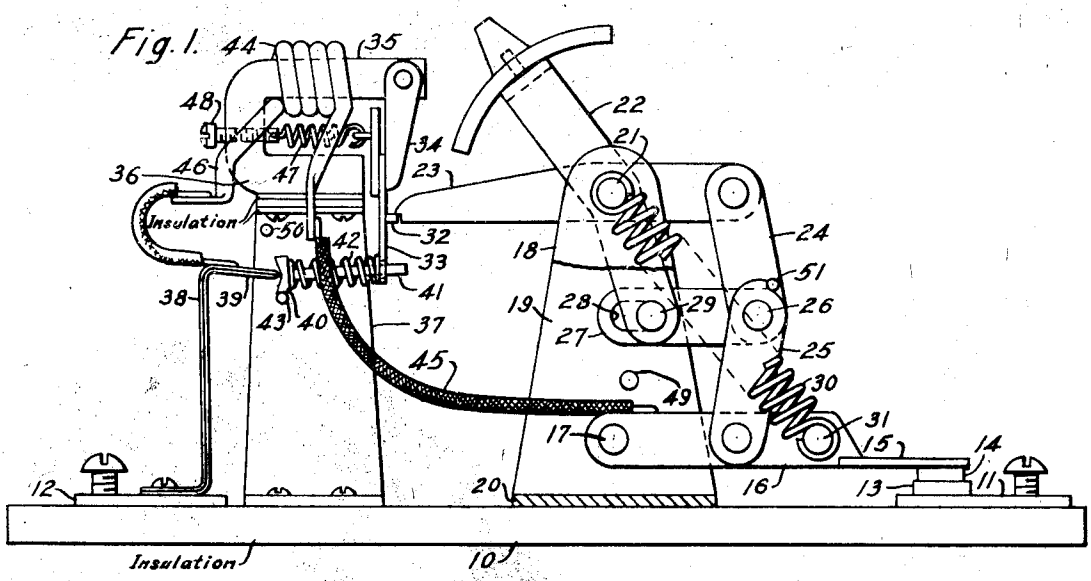
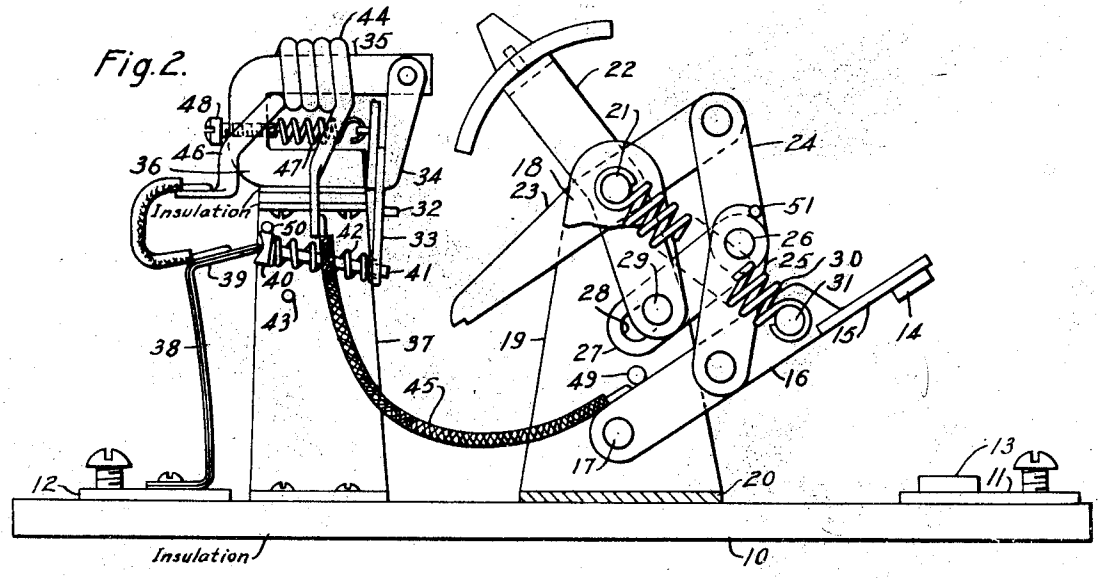


Fig. 2.



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Fig. 3.

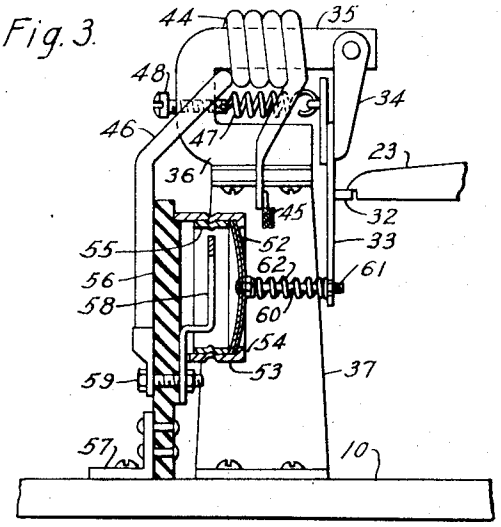


Fig. 4.

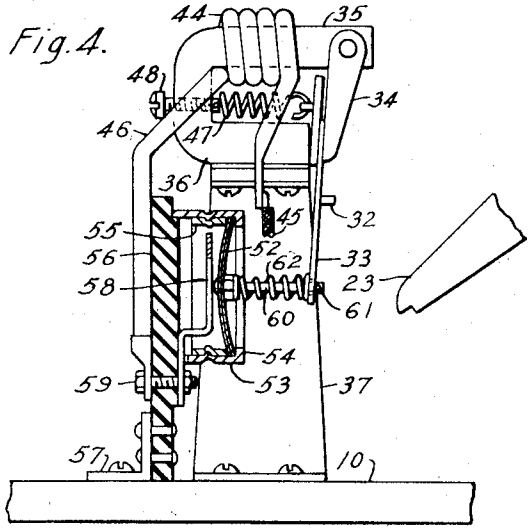
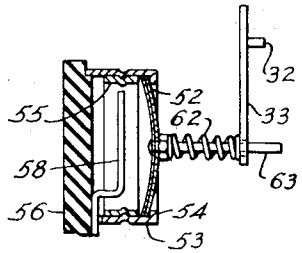


Fig. 5.



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UNITED STATES PATENT OFFICE

2,345,105

CIRCUIT BREAKER

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Application May 9, 1941, Serial No. 392,664

24 Claims. (Cl. 200—88)

This invention relates to circuit breakers, and more particularly relates to circuit breakers of the type which are automatically operated instantaneously on heavy overload currents above a predetermined magnitude, and after a time delay on sustained overloads of lesser magnitude.

It is an object of the instant invention to provide a circuit breaker having an improved snap-acting trip device.

Another object of the invention is the provision of a circuit breaker having a simplified thermally and magnetically responsive trip device.

Another object of the invention is the provision in a circuit breaker of a novel snap-acting toggle which includes a thermally responsive element as an operative part of the toggle.

A further object of the invention is the provision of a circuit breaker having a releasing member biased by opposed forces and a novel snap-acting toggle, including as an operative part thereof a thermally responsive element for reducing one of the forces to permit the other force to operate the releasing member.

Still another object of the instant invention is the provision of a circuit breaker having a trip member biased by opposed springs wherein the force exerted by one of the springs is controlled by a thermally responsive bimetal disk.

In carrying the invention into effect, the latch member, which restrains the breaker operating mechanism in closed circuit position, is biased in opposite directions by springs which normally exert substantially equal forces on the latch, the springs thus normally balancing each other. One of the springs is controlled by a thermally responsive element which, when heated by the current of the circuit controlled by the breaker, acts to reduce the force exerted by one of the springs and thereby cause tripping of the breaker. A series overload electromagnet also exerts a force on the latch tending to release the latch.

The novel features that are considered characteristic of the invention are set forth in particular in the appended claims. The invention itself, however, both as to structure and operation, together with additional objects and advantages thereof, will be best understood from the following detailed description of several embodiments thereof when read in conjunction with the accompanying drawings, in which:

Figure 1 is a view in side elevation of the circuit breaker with the casing removed and in the closed contact position;

Fig. 2 illustrates the same mechanism shown in Fig. 1, but in the tripped open position;

Fig. 3 is a fragmentary view, partly in section, showing a modified form of tripping mechanism in latched position;

Fig. 4 is a view similar to Fig. 3 showing the mechanism in tripped position; and

Fig. 5 is a detail view of another modification of the thermally responsive tripping element.

The several elements comprising the circuit breaker are mounted on an insulating base 10. A pair of terminals 11 and 12 secured on opposite ends of the base serve to electrically connect the breaker in the circuit to be controlled thereby. The terminal 11 carries a stationary contact 13, which cooperates with a movable contact 14 carried on a spring arm 15 secured to the free end of the contact arm 16. The contact arm 16 is mounted on a pivot 17 extending between arms 18 and 19 of a U-shaped bracket 20 secured to the base 10. Between the upper ends of arms 18—19 is mounted a pivot 21, upon which are pivoted a manually operable handle 22 and a releasable lever 23. Toggle links 24 and 25 pivotally connected, respectively, to the end of the releasable lever 23 and the contact arm 16, are connected by a knee pivot 26. A link 27 has one end connected to the links 24 and 25 at their knee pivot 26, and the opposite end of the link 27 is provided with a slot 28 embracing a stud 29 projecting from the lower arm of the operating handle 22. A pair of operating springs 30 (only one being shown) are disposed on opposite sides of the linkage and tensioned between the fixed pivot 21 and a projection 31 on the contact arm 16. The springs 30 bias the contact arm 16 to open circuit position.

The releasable lever 23 is normally retained in the position shown in Fig. 1 to normally provide a fixed support for the outer end of the toggle 24—25, by a latch 32 carried by an extension 33 of a magnet armature 34 forming part of a trip device. The armature 34 is pivotally mounted on one leg of a U-shaped magnet core 35 which has its other leg 36 secured to, but insulated from, a bracket 37 secured to the base 10. A thermally responsive bimetal element 38 mounted on and electrically connected to the terminal 12 has its outer end bent to form an angular portion 39, the point of which engages the notched head 40 of a rod 41 slidable in an opening in the lower end of the armature extension 33. A spring 42 compressed between the armature extension 33 and the head 40 maintains the head in close contact with the end of

the bent portion 39 of the bimetal element 38. The portion 39 is bent downwardly to form an angle of less than 90° with the vertical portion of the bimetal element. With the bimetal in its normally cold state and during normal current conditions, the toggle, formed by the bimetal portion 39 and the rod 41, is over center below a line drawn from the bend of the bimetal through the center of the opening in the armature extension 33 through which the rod 41 passes. A stop stud 43 on the bracket 37 limits the overcenter movement of the toggle.

The bimetal element 38—39 is connected in series with a coil 44 wound on one leg of the magnet core 35, and both are traversed by the current of the circuit controlled by the breaker, the circuit extending from terminal 11, contacts 13—14, spring arm 15, contact arm 16, a flexible shunt conductor 45, coil 44, conductor 46, bimetal 39—38 to the terminal 12.

The armature 34 is biased in tripping direction by a spring 47 having one of its ends connected to the armature 34 and the other end connected to an adjusting screw 48 in the magnet core 35. The force of the spring 47 is substantially balanced by the force of the spring 42 when the bimetal is cold and during normal current conditions. The screw 48 provides a convenient means whereby the tension of the spring 47 may be changed to vary the tripping point of the breaker.

The trip device is unresponsive to normal current conditions in the circuit controlled by the breaker, but is operable in response to overload currents of predetermined magnitude to effect automatic opening of the contacts 13—14 by releasing the lever 23.

Upon the occurrence of overloads above a predetermined magnitude, for example, in excess of approximately 10 times rated current, and overloads such as are occasioned by short circuits, the magnet becomes immediately effective to attract the armature 34 and release the lever 23. In this case the spring 42 compresses slightly without appreciably moving the bimetal element 38—39. Overloads below a predetermined magnitude if continued, may cause serious damage to the circuit and/or devices operated thereby. The bimetal element 38—39 is thermally responsive to such continuous overloads, and when heated thereby possesses the characteristic of flexing to substantially the shape disclosed in Fig. 2. During this flexing, the portion 38 of the bimetal bends to the left, allowing the rod 41 and the armature 34 to follow, and, at the same time, the portion 39 bends upwardly carrying the headed rod 40—41 therewith away from stop 43. This decreases the force of the spring 42 opposing unlatching movement of the armature extension 33. When the tip of the portion 39 and the notched head 40 pass dead center, that is, when rod 41 passes a line perpendicular to the extension 33 of the armature, the resultant force of the movement of the bimetal element 38—39 and the tension of the spring 42 causes it to snap upwardly against a stop 50. As a result of this action, the force exerted by the spring 42 on the extension 33 is suddenly reduced and the spring 47 assisted by the pull of the electromagnet overcomes the spring 42, moving the armature 34 and its extension 33 to unlatch the lever 23.

When the lever 23 is thus released, the operating springs 30 act to move the contact arm 16, toggle 24—25, and lever 23 to their tripped open circuit positions in which they appear in Fig. 2.

As the bimetal element 38—39 cools and assumes its normal shape, the toggle 39—41 passes center and resumes its normal position (Fig. 1) with a snap action.

The bimetal element 38—39 provides a time delay during which a temporary overload condition below the predetermined magnitude may return to normal without tripping the breaker. If, however, the overload continues, the elements operate in the manner above set forth to interrupt the circuit.

Before the contacts 13—14 can be closed following an automatic tripping operation, it is necessary first to restore the lever 23 to latched position. This is effected manually by clockwise movement of the handle 22 to its open position, that is, the extreme clockwise position of the handle. The link 27 transmits this movement of the handle to the toggle links 24—25 which, since counter-clockwise movement of the contact arm 16 is limited by a stop 49, breaks the toggle and rocks the lever 23 clockwise to latching position where it is restrained by the latch 32. Counterclockwise movement of the handle 22 now straightens the toggle 24—25 and closes contacts 13—14. The toggle 24—25 is limited in its overcenter travel by a stud 51 projecting from link 24 which engages a projection on the end of the link 25.

The circuit may be interrupted manually by operation of the handle 22. With the parts in the positions in which they appear in Fig. 1, the handle 22 is rotated clockwise. At this movement the stud 29 strikes the end of the slot 28 in the link 27. This moves the link 27 toward the left (Fig. 1) and breaks the toggle 24—25. The releasable member 23, in this case, provides a fixed pivot for the toggle link 24. Breaking of the toggle 24—25 operates the arm 16 to open the contacts 13—14. Counterclockwise movement of the handle 22 straightens the toggle 24—25 and recloses the contacts 13—14.

The modification of the invention illustrated in Figs. 3 and 4 makes use of a snap acting bimetal disk 52 to cause operation of the tripping device on overloads of less than the predetermined magnitude. The disk 52 is mounted in a cylindrical shell 53 against the inturned flange 54 of the shell. A retainer sleeve 55 suitably secured in the shell 53 holds the disk 52 in place against the flange 54. The shell 53 is rigidly mounted on a vertically disposed insulating bar 56 secured to the base 10 by an angle member 57. Also secured to the bar 56 is a U-shaped heater element 58 projecting into the shell 55 and disposed substantially parallel to the disk 52. Terminals 59 (only one of which is shown) serve to electrically connect the heater element 58 in the circuit in series with the coil 44 of the magnet and in series with the circuit controlled by the breaker, so as to be traversed by the current of the circuit.

A rod 60 secured to the disk 52 by a lock nut projects loosely through the armature extension 33, and has a pin 61 secured transversely therein on the opposite side of the extension. A spring 62 compressed between the lock nut and the extension 33 balances the spring 47 which tends to bias the armature 34 to tripping position.

Upon the occurrence of an overload greater than a predetermined magnitude, for example, greater than approximately 8 to 10 times rated current, the coil 44 energizes the magnet suf-

ficiently to cause it to attract its armature and thus release the lever 23 immediately irrespective of the position of the disc 52. The pull of the magnet on overloads of less than predetermined magnitude is normally insufficient to move the armature to attracted position against the tension of the spring 62 when the disc 52 is in the position shown in Fig. 3. Such overload currents flowing through the heater element 58 heat the disk 52 until, due to the different coefficients of expansion of the two metals comprising the disk 52, the disk suddenly snaps from the position shown in Fig. 3 to the position shown in Fig. 4. This snap action of the disk carries the rod 60 and, through the pin 61, the extension 33 to the left, causing release of the lever 23 to automatically interrupt the circuit. The pull of the magnet increases as the magnitude of the current increases and acts to assist in snapping the bimetal disk, thus causing it to snap sooner than it would in the absence of the magnet in the case of moderate and heavy overloads.

After the circuit is interrupted, the disk 52 cools to a predetermined point whereupon it snaps back to its original position shown in Fig. 3, restoring the latch element to latching position. The breaker may now be reset in the same manner described in connection with the previously described embodiment. The other elements of the breaker are the same as in Fig. 1 and corresponding parts have been indicated by like reference numerals.

The modification disclosed in Fig. 5 omits the pin 61. In this embodiment of the invention, a longer rod 63 is provided, which rod projects a greater distance through the latch element 33 to insure that the rod does not become disengaged from the latch 33 during operation. The spring 62 of Fig. 5, as in the modification in Fig. 3, is of substantially the same strength as the spring 47, and consequently these springs balance each other. In this case the snap action of the disk 52 when heated by the element 58 suddenly reduces the biasing effect of spring 62, whereupon spring 47 now having the greater strength and being aided by the pull of the magnet overcomes the spring 62 and operates the latch to release the operating mechanism. Reverse snapping of the bimetal disk as it cools, increases the tension of the spring 62 which restores the latch 33 to latching position and reestablishes the balance between springs 47 and 62. On overloads above a predetermined magnitude, the armature 34 is attracted by the magnet to release the operating mechanism, the element 33 compressing the spring 62, without displacing the disk 52. The spring 62 when thus compressed is stronger than the spring 47 and acts to restore the armature 34 to latching position upon interruption of the circuit.

In each of the embodiments of the invention disclosed herein the tension of the spring 47 may be adjusted by turning the screw 48 to vary the tripping point of the breaker. It is also pointed out that in each of the embodiments, the magnet aids the deflection of the bimetal element so that tripping will occur sooner than it would if the bimetal were acting alone.

Having described several embodiments of the invention in accordance with the patent statutes, it is to be understood that various changes and modifications may be made in the particular embodiments disclosed without departing from some of the essential features of the invention. It is desired, therefore, that the language of the appended claims be given as reasonably broad interpretation as the prior art permits.

We claim as our invention:

1. In a circuit breaker, the combination of relatively movable contacts, releasable operating mechanism to open the contacts automatically, a latch operable to release the operating mechanism, a trip device having one member of a toggle operatively associated therewith, and a thermally responsive element acting conjointly with the toggle member to form a somplete toggle, the thermally responsive element acting in response to predetermined circuit conditions to operate the toggle and effect release of the operating mechanism.

2. In a circuit breaker, the combination of relatively movable contacts, releasable operating mechanism to open the contacts, a latch operable to release the operating mechanism and a trip device comprising a snap-acting toggle, one member of said toggle being thermally responsive to predetermined circuit conditions for effecting release of the operating mechanism.

3. In a circuit breaker, the combination of relatively movable contacts, releasable operating means to open the contacts automatically, a latch movable to release the operating mechanism, and a toggle including a bimetal element as one element of the toggle thermally responsive to predetermined abnormal circuit conditions to effect operation of the latch to release the operating mechanism.

4. In a circuit breaker, the combination of relatively movable contacts, releasable operating means to automatically open the contacts, a latch movable to release the operating means, means acting to release the latch, means normally biasing the latch to latching position, and a toggle including a bimetal element as an element thereof, said bimetal element being responsive to predetermined circuit conditions to operate said toggle and render the biasing means ineffective.

5. A circuit breaker comprising relatively movable contacts, releasable operating mechanism to cause automatic opening of the contacts, a latch movable to release the operating mechanism, a member operatively associated with the latch, said member forming a part of a toggle, biasing means intermediate the member and the latch biasing the latch to latching position, means for releasing the latch, and a bimetal element cooperating with the toggle member to complete the toggle, said bimetal element being thermally responsive to predetermined abnormal circuit conditions for causing the toggle to move and render the biasing means ineffective.

6. A circuit breaker comprising relatively movable contacts, releasable operating mechanism to cause automatic operation of the contacts, a latch operable to release the operating mechanism, means biasing the latch to latching position, and a bimetal element coacting with said biasing means to form a toggle, the bimetal element being thermally responsive to predetermined abnormal circuit conditions for operating the toggle to effect automatic tripping of the breaker.

7. A circuit breaker comprising relatively movable contacts, releasable operating mechanism to cause automatic opening of the contacts, a latch operable to release the operating mechanism, and a thermally responsive toggle to per-

mit the latch to release the operating mechanism in response to predetermined abnormal circuit conditions.

8. A circuit breaker comprising relatively movable contacts, releasable operating mechanism to cause automatic opening of the contacts, restraining means operable to release the operating means, means at all times applying a force tending to move the restraining means in releasing direction and a thermally responsive snap acting toggle to control the operation of the restraining means.

9. A circuit breaker comprising contacts biased to open position, a latch movable to released position to effect automatic opening of the contacts, means for moving said latch to released position, a member slidably associated with the latch, a spring on said slidable member disposed to restrain the latch in latching position, and a bimetal element operatively associated with the slidable member and the spring, said bimetal element being thermally responsive to predetermined abnormal circuit conditions to render the restraining means ineffective to restrain the latch in latching position and cause said latch to be moved to released position.

10. A circuit breaker comprising relatively movable contacts, releasable operating mechanism to automatically open the contacts, means operable to release the operating mechanism, an electromagnet for operating the releasing means to effect automatic opening of the contacts on overloads above a predetermined magnitude, and a thermally responsive toggle operable to permit the electromagnet to release the operating mechanism on overloads below the predetermined magnitude.

11. A circuit breaker comprising relatively movable contacts, releasable operating mechanism to automatically open the contacts, a latch movable to release the operating mechanism, a member operatively associated with the latch, said member having a recessed head, resilient means intermediate the member and the latch normally biasing said latch to latching position, and a bimetal element having its free end formed to cooperate with the recessed head, the bimetal element together with the member forming a toggle responsive to predetermined circuit conditions to effect unlatching operation of the latch.

12. A circuit breaker comprising relatively movable contacts, releasable operating mechanism to automatically open the contacts, a pivoted latch movable to release the operating mechanism, means comprising an electromagnet acting to release the latch, a bimetal element having its free end formed over at substantially right angles to the main portion of said element, a rod having one end provided with a notched head cooperating with the free end of the bimetal element to form a toggle and having its opposite end slidably associated with the latch, and a spring intermediate the toggle and the latch to normally bias the latch to latching position, the bimetal element being thermally responsive to predetermined abnormal circuit conditions to operate the toggle and reduce the biasing influence of the spring to effect operation of the latch.

13. A circuit breaker comprising relatively movable contacts, releasable operating mechanism for automatically opening the contacts, means movable to release the operating mechanism, snap-acting means comprising a thermal element and a spring normally opposing releasing movement of said releasing means, the thermal element being responsive when heated a predetermined amount to reduce the force exerted on said releasing means, and means including an electromagnet acting to release the operating mechanism.

14. A circuit breaker comprising relatively movable contacts, operating mechanism releasable to automatically open said contacts, a latch operable to release the operating mechanism, a bimetal element disposed to be heated by the current traversing the circuit controlled by the breaker, a member having one end cooperating with the bimetal, the other end of said member being operatively associated with the latch, and a spring intermediate the bimetal and the latch for biasing the latch to latching position, a portion of said spring being operatively associated with and movable with said bimetal element, said bimetal being responsive when heated a predetermined amount to flex with a snap action to cause unlatching operation of the latch.

15. A circuit breaker comprising relatively movable contacts, releasable operating mechanism for automatically opening the contacts, a pivoted latch movable to release the operating mechanism, a snap-acting bimetal disc disposed to be heated by the current traversing the circuit controlled by the breaker, said disc being responsive when heated a predetermined amount to operate the latch with a snap action, a spring intermediate the disc and the latch biasing the latch to latching position, a portion of said spring being operatively associated with and movable with said bimetal disc, and electromagnetic means responsive to overloads above a predetermined magnitude to operate the latch.

16. A circuit breaker comprising relatively movable contacts, releasable operating mechanism for automatically opening said contacts, an armature operable to release the operating mechanism, an electromagnet responsive to overloads of a predetermined magnitude to operate the armature, a snap-acting bimetal disc disposed to be heated by overload currents, a spring intermediate the disc and the armature biasing the armature to restrain the operating mechanism, said bimetal disc when heated a predetermined amount moving with a snap action in a direction to reduce the force exerted by the spring, and a second spring opposing the first-mentioned spring for operating the armature to release the operating mechanism when the force exerted by the first-mentioned spring has been reduced.

17. A circuit breaker comprising relatively movable contacts, releasable operating mechanism for automatically opening said contacts, restraining means operable to release the operating mechanism, means comprising an electromagnet energized by the current of the circuit, said electromagnet when energized acting to move the restraining means to releasing position, a snap acting device comprising a thermally responsive element disposed to be heated by abnormal currents traversing the circuit controlled by the breaker, and a spring acting to normally maintain the restraining means in restraining position, the thermally responsive element when heated a predetermined amount operating to reduce the force exerted on the restraining means through said spring to permit the electromagnet to operate the restraining means to released position.

18. A circuit breaker comprising relatively movable contacts, releasable operating mechanism for automatically opening the contacts, a

latch operable to release the operating mechanism, a spring biasing the latch to unlatching position, a second spring biasing the latch to latching position against the biasing force of the first-mentioned spring, and a bimetal element coacting with the first-mentioned spring to form a toggle thermally responsive to predetermined circuit conditions to control the effectiveness of the second-mentioned spring.

19. A circuit breaker comprising releasable operating mechanism for causing automatic operation of the breaker, a latch operable to release the operating mechanism, means acting to release the latch, a spring biasing the latch to latching position, a bimetal element coacting with the spring to form a toggle, said bimetal being thermally responsive to predetermined circuit conditions to reduce the force exerted by the spring and effect release of the operating mechanism.

20. A circuit breaker including releasable operating mechanism for causing automatic operation of the breaker, a latch operable to release the operating mechanism, a toggle including a bimetal element and a spring intermediate the bimetal element and the latch, said bimetal element being operable when heated a predetermined amount to cause operation of the toggle and thereby effect release of the latch.

21. A trip device for a circuit breaker comprising latching means operable to trip the breaker, means comprising a spring acting to release the latching means, a second spring acting to maintain the latching means in latching position, and snap-acting time delay means responsive to overload currents in the circuit controlled by the breaker to reduce the force applied to the latching means through said second named spring and permit the first named spring to trip the breaker.

22. A trip device for a circuit breaker comprising a pivoted latch operable to trip the breaker, means acting to move the latch to tripping position, a snap acting bimetal disc heated in response to the current of the circuit controlled by the breaker and normally opposing movement of the latch to tripping position, said bimetal disc being operable when heated a predetermined amount in response to overload currents to cause the latch to trip the breaker.

23. A circuit breaker comprising releasable operating mechanism to cause automatic operation of the breaker, restraining means operable to release the operating mechanism, a snap acting device including a thermally responsive element disposed to be heated by abnormal currents traversing the circuit controlled by the breaker, a spring between the thermal element and the restraining means biasing the restraining means to restraining position, the thermally responsive element being responsive when heated a predetermined amount to reduce the force applied to said restraining means through the spring, and an electromagnet to operate the restraining means.

24. A circuit breaker comprising releasable operating mechanism to cause automatic operation of the breaker, a latch operable to release the operating mechanism, means acting to release the latch, a bimetal element disposed to be heated by the current traversing the circuit controlled by the breaker, and a spring intermediate the bimetal and the latch biasing the latch to latching position, a portion of said spring being operatively associated with and movable with said bimetal element, said bimetal being responsive when heated a predetermined amount to flex with a snap action to cause operation of the latch.

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