March 22, 1949. C. H. HODGKINS 2,465,230

ELECTRIC CIRCUIT INTERRUPTER

Filed Jan. 8, 1943

Fig. 1.

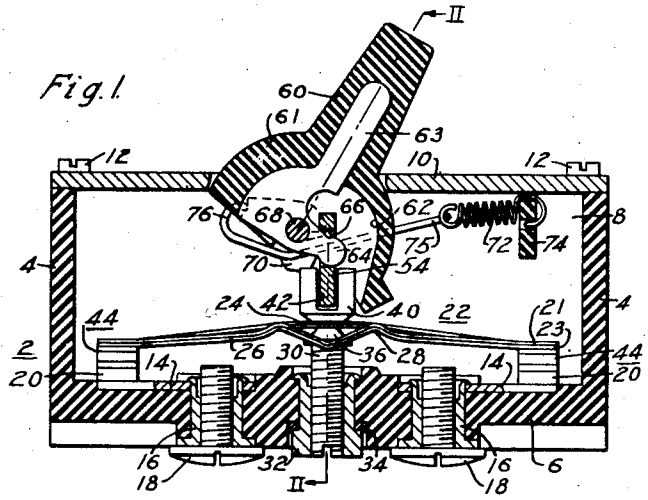


Fig. 2.

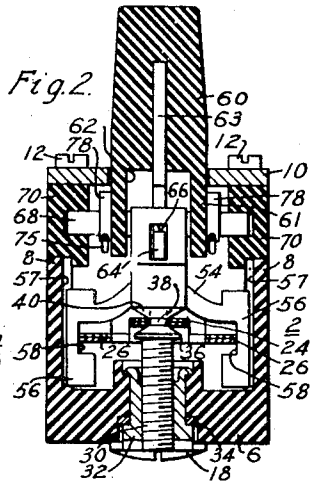


Fig. 3.

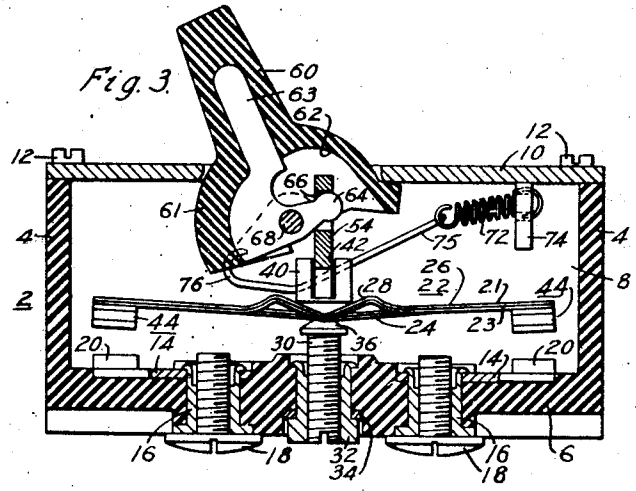


Fig. 5.

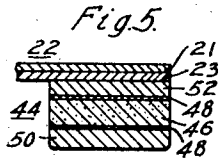


Fig. 6.

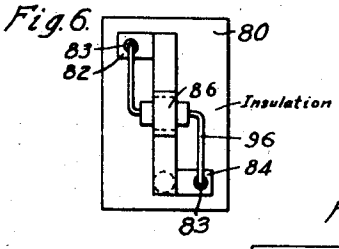


Fig. 7.

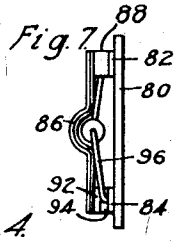


Fig. 8.

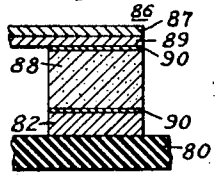
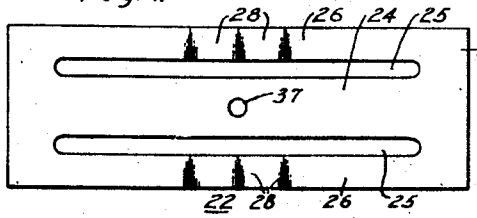


Fig. 4.



WITNESSES:

N. T. Susan

A. T. Stratton

INVENTOR

Charles H. Hodgkins.

BY

Ralph L. Swingle

ATTORNEY

Patented Mar. 22, 1949

2,465,230

UNITED STATES PATENT OFFICE

2,465,230

ELECTRIC CIRCUIT INTERRUPTER

Charles H. Hodgkins, Fairfield, Conn., assignor to The Bryant Electric Company, Bridgeport, Conn., a corporation of Connecticut

Application January 8, 1943, Serial No. 471,688

35 Claims. (Cl. 200—122)

1

This invention relates in general to electric circuit interrupters, and more specifically to circuit breakers of the type employing a snap-acting bimetal element as part of the contact actuating means, and to heating means for bimetal elements.

One object of this invention is to provide a circuit breaker of the type having a snap-acting bimetal element for actuating the breaker contacts, with novel means for supporting and actuating the bimetal.

Another object of this invention is to provide a novel circuit breaker construction capable of introducing a double-break in the circuit.

Another object of this invention is to provide novel supporting and actuating means for a snap-acting bimetal element of the type having three legs connected at opposite ends.

Another object of this invention is to provide a circuit breaker of the type employing a snap-acting bimetal element to actuate the breaker contacts, with novel actuating means for the element which is trip-free.

Another object of this invention is to provide novel heating means for a bimetal element.

A further object of this invention is to provide a novel circuit breaker construction using a snap-acting bimetal element, which is relatively simple in form yet efficient in operation.

These and other objects of this invention will become more apparent upon consideration of the following detailed description of preferred embodiments thereof, when taken in connection with the attached drawing, in which:

Figure 1 is a longitudinal section view of a circuit breaker embodying this invention with the bimetal element and contacts shown in elevation;

Fig. 2 is a transverse section of the breaker shown in Fig. 1 taken substantially on the line II—II thereof;

Fig. 3 is a view like Fig. 1 with the breaker shown in the open circuit position;

Fig. 4 is a plan view of the bimetal element used in the breaker shown in Figs. 1 to 3;

Fig. 5 is an enlarged section of one contact and a portion of the bimetal;

Fig. 6 is a plan view of a thermal relay using a heater similar to that shown in Figs. 1 to 4;

2

Fig. 7 is a side elevation view of the relay shown in Fig. 6; and

Fig. 8 is an enlarged cross-section of the support and heater for the bimetal element shown in Figs. 6 and 7.

The invention is shown as being embodied in a circuit breaker adapted to be mounted within a casing 2, preferably of a molded insulating material. Casing 2 includes opposite end walls 4 and opposed side walls 8, all integrally joined with a bottom wall 6. A cover 10 may be provided for the open side of the casing, and the cover may be removably secured in position, for example, as by screws 12. Terminal strips 14 are secured in recesses provided in bottom wall 6 of the casing adjacent opposite ends thereof by eyelets 16. Eyelets 16 are preferably internally threaded for receiving terminal screws 18 for securing electrical conductors thereto to connect the breaker in an electric circuit. Each terminal plate 14 also has secured thereon a contact element 20 which may be of any good electrical conducting and arc-resistant material.

A bimetal element 22 is employed, and this is constructed in the well-known manner of a pair of laminations of materials having different coefficients of thermal expansion, respectively. Thus, bimetal element 22 has the lamination 21 thereof of a material which has a lower coefficient of thermal expansion than the lamination 23. These laminations are secured together in any desired manner, such, for example, as by welding or the like. The bimetal element is provided with a pair of spaced longitudinally extending slots 25 (Fig. 4) terminating short of the ends of the element to form a middle leg 24 and a pair of outside legs 26. The side legs 26 are deformed, as shown at 28, to shorten the outside legs and thereby place the middle leg under compression and cause it to assume a bowed form, as shown in Figs. 1 and 3.

A bimetal element formed like the element 22 is capable of movement with a snap action upon reversal of curvature of middle leg 24. This reversal of curvature of middle leg 24 may be accomplished mechanically to cause reversal of curvature to take place in opposite directions, or it may take place in the upward direction, as viewed in Fig. 1, by the application of heat to the bimetal element causing more rapid expansion of lamina-

tion 23 than of lamination 21. Thus bimetal element 22 is capable of automatically moving with a snap action from the position shown in Fig. 1 to that shown in Fig. 3, when it is heated a predetermined amount.

Bimetal element 22 is supported on a supporting screw 30 which is threaded into a thimble 32 rotatably mounted in bottom wall 6 of the breaker casing. As shown, a wear-resistant washer 34 may be provided between the enlarged outer head of thimble 32 and bottom wall 6. The outer enlarged head of thimble 32 is slotted as shown, so that it may be rotated to vary the amount supporting screw 30 is extended into the casing. The inner end of supporting screw 30 is provided with an enlarged head 36 flared upwardly towards a reduced extension 38. The extension 38 is adapted to pass through an aperture 37 provided substantially centrally of middle leg 24 of the bimetal element, and a head member 40 is secured to extension 38 and it, in turn, is flared towards the bimetal element. Head member 40 is provided with a slot 42 in the upper portion thereof for a purpose to be described.

The bimetal element 22 is provided with a contact structure 44 at each end therof for cooperation with the fixed contacts 20. Each contact structure 44 includes a block 46 of resistance material, preferably a non-metallic resistance material such as carborundum, carbon, or the like. Resistor block 46, when entirely or part of non-metallic resistance material, is preferably provided with thin layers of metal 48, such, for example, as copper or the like, sprayed or otherwise deposited upon opposite surfaces of the block to facilitate assembly thereof. A contact element 50 is secured to one surface of the resistor block having a metallic layer 48—for example, as by soldering, brazing or the like. A metal conducting plate 52 is secured to the opposite surface of the resistor block in the same manner, and this, in turn, is secured to bimetal element 22 by soldering, brazing, riveting or the like. With a contact construction of this type, it will be noted that the resistor element is sandwiched between contact element 50 and bimetal element 22, and mechanically as well as electrically joins these elements. This forms a relatively simple yet efficient manner for associating a resistor element of this type with a bimetal element, and it will also be noted that the resistor elements are placed at the points of concentration of current flow in good heat conducting relation with respect to the bimetal element. This is of special importance for breakers having low current ratings where it is necessary to supply auxiliary means for heating the bimetal element other than that generated by current flow through the element itself.

In order to actuate bimental element 22, an actuating yoke 54 has the mid-portion thereof received in slot 42 of supporting screw head member 40, and the legs 56 thereof slidably supported in grooves 57 cut in opposite side walls 8 of the casing. The opposed inner edges of the yoke legs 56 have notches 58 cut therein for receiving the outer legs 26 of bimetal element 22. An actuating handle 60, preferably constructed of a molded insulating material, is provided with an enlarged base portion positioned at least in part in an aperture provided in casing cover plate 10. The enlarged base 61 of the handle is hollowed out, as shown at 62, for receiving a metal actuator 63, a portion of which is embedded within handle 60 and extends into hollowed portion 62 at one side thereof, and is provided with an integral actuating projection 64 extending across the opening of hollowed portion 62 of the handle. Actuating projection 64 is adapted to extend through an aperture 66 provided in an integral extension of actuating yoke 54. Handle 60 is adapted to be pivotally mounted in the breaker casing by a pivot pin 68 passing through the handle and through actuator 63 to have the opposite ends thereof rotatably mounted in bearings 70. These bearings 70 are preferably mounted in slots cut in opposite side walls 8 of the casing, and are held in place by cover 10.

It will now be apparent that movement of handle 60 about its pivot 68 will cause sliding of actuating yoke 54 toward and away from bimetal element 22. It will be noted that slots 58 in the legs of actuating yoke 54 are of considerably greater extent than the thickness of bimetal element 22, so that there is considerable lost motion between the actuating yoke and the outer legs 26 of the bimetal element. There is also lost motion between handle 60 and yoke 54 because of the loose fit of projection 64 in aperture 66. It will be noted that the lost motion is positive in character in both instances because flexing of the bimetal element by handle 60 is ultimately caused by positive mechanical engagement of the parts. The purpose of providing this lost motion is so that in actuating the bimetal element, snap action thereof may take place independently of the handle—for example, assuming it is desired to move the breaker from closed-circuit position shown in Fig. 1 to the open-circuit position shown in Fig. 3—handle 60 should be moved in a counterclockwise direction. During the first part of this motion, the bimetal element is not moved, and is not even engaged until the bottom of yoke slots 58 engage the undersides of the outer legs 26 of the bimetal element. As soon as this occurs, the outer legs 26 of the bimetal element are raised relative to the point of support for middle leg 24. Middle leg 24 being bowed and under compression acts similar to a toggle, so that when the outer legs are raised the middle leg will, at an overcenter position, suddenly reverse its curvature with a snap action, and cause the bimetal element to assume the position shown in Fig. 3, wherein the ends thereof are moved upwardly to separate contact structures 44 from fixed contacts 20. The lost motion between handle 60 and the bimetal element is arranged so that this snap movement of the bimetal element may take place irrespective of the rate of movement of handle 60 merely by taking up the lost motion between the handle and outer legs 26 of the bimetal element. When it is desired to close the circuit, handle 60 is merely rotated in a clockwise direction from the position shown in Fig. 3 towards the position shown in Fig. 1. This will cause downward movement of yoke 54 until the upper ends of slots 58 engage outer legs 26 of the bimetal element, whereupon these outer legs will be moved downwardly until the point is reached where middle leg 24 of the bimetal element will suddenly reverse its curvature and cause closing of the breaker contacts with a snap action. This also occurs independently of the rate of movement of handle 60 by taking up the lost motion between the handle and the outer legs of the bimetal element.

In order to maintain the handle 60 at "off" and "on" positions, an overcenter spring arrangement is provided comprising a coil tension spring 72 anchored at one end in an anchor plate 74.

Anchor plate 74 is preferably provided with an aperture for receiving a hooked end of spring 72, and the plate itself is received in grooves cut in opposite side walls 8 of the casing, and is maintained in position by cover plate 10. The other end of spring 72 is hooked over a spring yoke 75, the arms of which extend on opposite sides of the enlarged portion 61 of the handle, and are hooked, as at 76, to engage in depressions formed on enlargements 78 provided at each side of handle 60.

As shown in Fig. 1, handle 60 is maintained in the position shown, because the line of action of spring 72 is above handle pivot 68, and the handle cannot move any further in a clockwise direction because of the engagement of the ends of yoke legs 56 with the ends of grooves 57. Assuming that the handle is moved in a counterclockwise direction from the position shown in Fig. 1, the bimetal element will be caused to open the circuit with a snap action as described above, and as soon as the hooked ends 76 of spring yoke 75 pass below handle pivot 68, the handle will be biased in a counterclockwise direction so that when the operating force is removed it will be moved to the position shown in Fig. 3 and maintained in this position. As stated before, in moving the switch handle to open the circuit, bimetal element 22 is moved by the handle only an amount sufficient to cause reversal of curvature of middle leg 24, whereupon the contacts separate independently of movement of the handle. Consequently, the handle may move in a counterclockwise direction beyond the snapping point of bimetal element 22 by virtue of the lost motion between the handle and the outer legs 26 of the bimetal element. The snapping point of bimetal element 22 is correlated with the overcenter point of spring 72, so that if the handle is released at the time when bimetal element 22 snaps to open circuit position, spring 72 will then have moved overcenter to cause handle 60 to be moved to the position shown in Fig. 3. Substantially the same action takes place in manually closing the breaker. During the first part of clockwise movement of handle 60 from the position shown in Fig. 3, lost motion between the handle and legs 26 of the bimetal element is taken up while spring 72 is stressed, and finally legs 26 of the bimetal element are lowered by yoke 54 to cause snap-acting closure of the breaker contacts. At the same time spring 72 passes overcenter to restore handle 60 to the position shown in Fig. 1. The parts are arranged so that upon an automatic opening of the circuit, due to an overload sufficient to cause heating of bimetal element 22, either by itself or by heat conducted from resistor blocks 46, an amount sufficient to cause the bimetal to automatically reverse its curvature, handle 60 will be moved to its normal "off" position shown in Fig. 3. Because of the lost motion between actuating yoke 54 and the outer legs of the bimetal element, automatic opening of the circuit may occur even though actuating handle 60 is held in its normal closed circuit position, shown in Fig. 1. However, such an automatic operation of the bimetal element will cause engagement of the upper ends of slots 58 in actuating yoke 54 by the outer legs 26 of the bimetal element, and these will exert some upward pressure on the yoke. Enough pressure in an upward direction will be exerted by legs 26 of the bimetal element when in the position shown in Fig. 3 to move handle 60, when it is not held in the Fig. 1 position, an amount sufficient to move spring 72 overcenter and thereby throw the handle to the position shown in Fig. 3. Thus it can be seen that the handle will be moved to its normal "off" position in response to an automatic opening of the breaker contacts.

In Figs. 6, 7 and 8, there is illustrated a different manner of assembling heating means and a bimetal element. The bimetal element in this case is shown as embodied in a thermal relay mounted on an insulating plate 80. A pair of terminal strips 82 and 84 are secured to the base 80 at spaced points in any desired manner, such, for example, as by eyelets 83. A bimetal strip 86 is adapted to be supported on the terminal strip 82 and comprises a pair of laminations 87, 89 intimately joined together as, for example, by welding or the like. In this instance, the lamination 89 should be of a material having a higher coefficient of thermal expansion than the lamination 87. A non-metallic resistor block 88 similar to block 46 is provided with a relatively thin metallic coating 90 on opposite faces thereof, like the coating 48 on block 46 previously described. These coated faces of resistor block 88 may then be soldered or brazed to bimetal element 86 and terminal strip 82, respectively, to rigidly mechanically mount the bimetal strip at one end of the terminal strip 82. The other end of bimetal strip 86 is provided with a contact element 92 thereon for engagement with a cooperating contact 94 provided on terminal strip 84.

Since current in flowing between terminal strips 82 and 84 must pass through resistor block 88, it is obvious that currents above a predetermined value will cause heating of resistor block 88 and this will be conducted to the bimetal element and raise the temperature thereof. As the temperature of the bimetal strip rises, it will distort to move contact 92 out of engagement with contact 94 and thereby open the circuit therebetween.

The particular relay disclosed is also provided with a shunt resistor wire 96 connecting terminal strips 82 and 84, so that when contacts 92 and 94 are separated, resistor 96 will supply heat to bimetal strip 86 and maintain the contacts separated so long as currents above a predetermined value flow in the circuit.

In the foregoing applicant has disclosed a circuit breaker construction utilizing a snap-acting bimetal element which may be manually actuated to open and close the breaker contacts with a snap action, and yet which is capable of movement with a snap action both when manually actuated and automatically actuated in response to predetermined heating thereof, independently of the rate of movement of the operating handle. The breaker contacts will also be opened with a snap action in response to predetermined heating of the bimetal element, even if the actuating handle is held at its closed position. There has also been disclosed a novel arrangement for supporting and actuating a snap-acting bimetal element, as well as novel means for associating an auxiliary heater with bimetal elements in general. The circuit breaker construction disclosed, wherein a snap-acting bimetal element is movable independently of an actuating handle at least during snap movement thereof, is provided with separate biasing means to move the handle to its normal "off" and "on" positions to thereby give a clear indication of the position of the breaker contacts.

Having described preferred embodiments of the invention in accordance with the patent

statutes, it is desired that the invention be not limited to these particular structures, because it will be obvious particularly to persons skilled in the art that many modifications and changes may be made therein without departing from the broad spirit and scope of this invention. Accordingly, it is desired that the invention be interpreted as broadly as possible, and that it be limited only as required by the prior art.

I claim as my invention:

1. In a circuit breaker, separable contacts, a flexible snap-acting bimetal element for automatically separating said contacts in response to predetermined conditions, manually operable means movable in opposite directions to open and close said contacts, said manually operable means flexing said element upon movement in said opposite directions to move said element at least to its snapping point, and a positive lost motion connection between said manually operable means and element permitting the snap action of said element to take place independently of the movement of said manually operable means.

2. In a circuit breaker, separable contacts, a flexible snap-acting bimetal element for automatically separating said contacts in response to predetermined conditions, manually operable means movable in opposite directions to open and close said contacts, said manually operable means flexing said element upon movement in said opposite directions to move said element at least to its snapping point, a positive lost motion connection between said manually operable means and element permitting the snap action of said element to take place independently of the movement of said manually operable means, and means for moving said manually operable means to extreme positions upon movement thereof in said opposite directions, respectively, to at least partly take up said lost motion.

3. In a circuit breaker, separable contacts, a flexible snap-acting bimetal element for automatically separating said contacts in response to predetermined conditions, manually operable means movable in opposite directions to open and close said contacts, said manually operable means flexing said element upon movement in said opposite directions to move said element at least to its snapping point, a positive lost motion connection between said manually operable means and element permitting the snap action of said element to take place independently of the movement of said manually operable means, and an overcenter spring for biasing said manually operable means to spaced positions upon movement thereof in said opposite directions, respectively, to at least partly take up said lost motion.

4. In a circuit breaker, separable contacts, a flexible snap-acting bimetal element for automatically separating said contacts in response to predetermined conditions, manually operable means movable in one direction to close said contacts, said manually operable means flexing said element upon movement in said one direction to move said element at least to its snapping point, and a positive lost motion connection between said manually operable means and element permitting snap movement of said element to close the contacts independently of movement of said manually operable means.

5. In a circuit breaker, separable contacts, a flexible snap-acting bimetal element for automatically separating said contacts in response to predetermined conditions, manually operable means movable in one direction to close said contacts, said means flexing said element upon movement in said one direction to move said element at least to its snapping point, a positive lost motion connection between said manually operable means and element permitting snap movement of said element to close the contacts independently of movement of said manually operable means, and means responsive to movement of said manually operable means in said one direction an amount sufficient to cause snap action closing movement of said element, for biasing said manually operable means for movement a further amount to take up at least a part of said lost motion.

6. In a circuit breaker, separable contacts, a flexible snap-acting bimetal element for automatically separating said contacts in response to predetermined conditions, manually operable means movable in one direction to close said contacts, said means flexing said element upon movement in said one direction to move said element at least to its snapping point, a positive lost motion connection between said manually operable means and element permitting snap movement of said element to close the contacts independently of movement of said manually operable means, an overcenter spring responsive to movement of said manually operable means in said one direction an amount sufficient to cause snap action closing movement of said element, for biasing said manually operable means for movement a further amount to take up at least a part of said lost motion, and said element operative upon automatic operation thereof to move said manually operable means an amount at least sufficient to move said spring overcenter so that said manually operable means will be moved in an opposite direction to a position indicating such an automatic operation and wherein it is operable to reclose the breaker.

7. In a circuit breaker, separable contacts, a flexible snap-acting bimetal element for opening and closing said contacts with a snap action, said element being responsive to predetermined heating thereof to automatically open said contacts, a movable actuating handle, means actuated by said handle having spaced operating parts positioned to engage said element when said handle is moved in opposite directions, respectively, to flex said element to cause snap action opening and closing of said contacts, respectively, whereby snap action of said element occurs in the space between said parts independently of the rate of movement of said handle.

8. In a circuit breaker, separable contacts, a flexible snap-acting bimetal element for opening and closing said contacts with a snap action, said element being responsive to predetermined heating thereof to automatically open said contacts, an actuating handle adapted when moved in opposite directions to flex said element to cause snap action opening and closing of said contacts, respectively, means whereby snap action of said element occurs independently of the rate of movement of said handle, and means responsive to automatic operation of said element to move said handle to one extreme position independently of said element.

9. In a circuit breaker, separable contacts, a flexible snap-acting bimetal element for opening and closing said contacts with a snap action, said element being responsive to predetermined heating thereof to automatically open said con-

tacts, an actuating handle adapted when moved in opposite directions to flex said element to cause snap action opening and closing of said contacts, respectively, said handle having positive lost motion with said element whereby snap action of said element occurs independently of said handle, and means effective to bias said handle to an extreme position in each direction in response to movement of said handle in each direction an amount sufficient to cause snap action of said element.

10. In a circuit breaker, separable contacts, a flexible snap-acting bimetal element for opening and closing said contacts with a snap action, said element being responsive to predetermined heating thereof to automatically open said contacts, an actuating handle adapted when moved in opposite directions to flex said element to cause snap action opening and closing of said contacts, respectively, said handle having positive lost motion with said element whereby snap action of said element occurs independently of said handle, means effective to bias said handle to an extreme position in each direction in response to movement of said handle in each direction an amount sufficient to cause snap action of said element, and said element effective, upon an automatic operation thereof, to move said handle toward the extreme position it normally occupies when said contacts are open an amount sufficient to render said biasing means effective to move said handle the remainder of the distance.

11. In a circuit breaker, a flexible snap-acting bimetal element having a plurality of substantially parallel legs connected at opposite ends, supporting means secured to an intermediate portion of one of said legs, manually operable actuating means engageable with another of said legs to move it laterally relative to said one leg, at least one end of said element being free to move laterally, relatively stationary contact means, contact means carried by at least said one end of said element for movement into and out of engagement with said relatively stationary contact means, and said element being initially deformed so that movement of said actuating means in opposite directions will cause snap-acting movement of said movable contact means into and out of engagement with said relatively stationary contact means.

12. In a circuit breaker, a flexible snap-acting bimetal element, supporting means secured to an intermediate portion of said element at a point spaced from the edges thereof, manually operable actuating means engageable with an intermediate portion of said element at a point spaced from said supported portion to move said second mentioned portion laterally relative to said supported portion, at least one end of said element being free to move laterally, relatively stationary contact means, contact means carried by at least said one end of said element for movement into and out of engagement with said relatively stationary contact means, and said element being initially deformed so that movement of said actuating means in opposite directions will cause snap-acting movement of said movable contact means into and out of engagement with said relatively stationary contact means.

13. In a circuit breaker, a flexible snap-acting bimetal element having three substantially parallel legs connected at their opposite ends, said element being stressed so that at least one leg assumes a bowed form, supporting means secured to an intermediate portion of said bowed leg, manually operable actuating means engageable with at least one other leg to move said other leg laterally in opposite directions to cause reversal of curvature of said bowed leg, at least one end of said element being free to move laterally, relatively stationary contact means, contact means carried by at least said one end of said element for movement into and out of engagement with said relatively stationary contact means whereby movement of said actuating means in opposite directions will cause snap action movement of said movable contact means into and out of engagement with said relatively stationary contact means.

14. In a circuit breaker, a flexible snap-acting bimetal element having three substantially parallel legs connected at their opposite ends, said element being stressed so that the middle leg assumes a bowed form, supporting means secured to an intermediate portion of said bowed leg, manually operable actuating means including a yoke having ends engageable with the other legs to move said other legs laterally in opposite directions to cause reversal of curvature of said bowed leg, at least one end of said element being free to move laterally, relatively stationary contact means, contact means carried by at least said one end of said element for movement into and out of engagement with said relatively stationary contact means, whereby movement of said actuating means in opposite directions will cause snap action movement of said movable contact means into and out of engagement with said relatively stationary contact means.

15. In a circuit breaker, a flexible snap-acting bimetal element having three substantially parallel legs connected at their opposite ends, said element being stressed so that the middle leg assumes a bowed form, supporting means secured to an intermediate portion of said bowed leg, manually operable actuating means including a yoke slidably mounted for movement laterally toward and away from said element, said yoke having ends engageable with the other legs to move said other legs laterally in opposite directions to cause reversal of curvature of said bowed leg, at least one end of said element being free to move laterally, relatively stationary contact means, contact means carried by at least said one end of said element for movement into and out of engagement with said relatively stationary contact means, whereby movement of said actuating means in opposite directions will cause snap action movement of said movable contact means into and out of engagement with said relatively stationary contact means.

16. In a circuit breaker, a flexible snap-acting bimetal element having a plurality of substantially parallel legs connected at opposite ends, supporting means secured to an intermediate portion of one of said legs, manually operable actuating means engageable with another of said legs to move it laterally relative to said one leg, at least one end of said element being free to move laterally, relatively stationary contact means, contact means carried by at least said one end of said element for movement into and out of engagement with said relatively stationary contact means, said element being initially deformed so that movement of said actuating means in opposite directions will cause snap-acting movement of said movable contact means into and out of engagement with said relatively stationary contact means, and at least one of said

contact means including a contact element secured on a block of resistance material by good electrical and heat conducting means.

17. In a circuit breaker, a flexible snap-acting bimetal element having a plurality of substantially parallel legs connected at opposite ends, supporting means secured to an intermediate portion of one of said legs, manually operable actuating means engageable with another of said legs to move it laterally relative to said one leg, opposite ends of said element being free to move laterally, spaced relatively stationary contact means, contact means carried by each end of said element for movement into and out of engagement with said relatively stationary contact means, and said element being initially deformed so that movement of said actuating means in opposite directions will cause snap-acting movement of said movable contact means into and out of engagement with said relatively stationary contact means.

18. In a circuit breaker, a flexible bimetal element, supporting means for said element, stationary contact means, contact means on said element movable therewith into and out of engagement with said stationary contact means, and at least one of said contact means including a contact element secured on a block of resistance material by good electrical and heat conducting means.

19. A bimetal element, heating means therefor comprising a block of resistance material, and means of a good electrical and heat conducting material interposed between said element and block and being rigidly bonded to both and in intimate contact therewith for securing said block to said element.

20. A bimetal element, heating means therefor comprising a block of non-metallic resistance material, and means of a good electrical and heat conducting material interposed between said element and block and being rigidly bonded to both and in intimate contact therewith for securing said block to said element.

21. A bimetal element, heating means therefor comprising a block of non-metallic resistance material, a metallic coating on one face of said block, and means of a good electrical and heating conducting material interposed between said element and block for securing said coated face of the block to said element.

22. A bimetal element, a terminal therefor, a block of resistance material interposed between said element and terminal, and separate means interposed between said block and element and between said block and terminal with each of said means being rigidly bonded to the members adjacent its opposite sides and in intimate engagement therewith for mechanically securing said block to said element and terminal with opposite faces of said block in good electrical and heating conducting relation with said element, and at least in good electrical conducting relation with said terminal, respectively.

23. A bimetal element, a contact element therefor, a block of resistance material interposed between said element and contact element, and means for mechanically securing said block between said element and contact element with opposite faces of said block in good electrical and heat conducting relation with said element, and at least in good electrical conducting relation with said contact element, respectively.

24. A bimetal element, a terminal therefor, a block of non-metallic resistance material interposed between said element and terminal, a metallic coating on opposite faces of said block, and means of a good electrical and heat conducting material interposed between said block and element and between said block and terminal for securing said opposite faces of the block to said element and terminal, respectively.

25. A bimetal element, a contact element therefor, a block of non-metallic resistance material interposed between said elements, a metallic coating on opposite faces of said block, and means of a good electrical and heat conducting material securing said opposite faces of the block to said element and contact element, respectively.

26. A bimetal element, an electrical conductor, a block of non-metallic resistance material interposed between said element and electrical conductor, a metallic coating on opposite faces of said block and means of a good electrical and heat conducting material interposed between said block and element and between said block and terminal for securing said opposite faces of the block to said element and electrical conductor, respectively.

27. In a circuit breaker, separable contacts, a flexible snap-acting bimetal element for opening and closing said contacts with a snap action, said element being responsive to predetermined heating thereof to automatically open said contacts, an actuating handle adapted when moved in opposite directions to flex said element to cause snap action opening and closing of said contacts, respectively, and trip-free operating means connecting said handle and said element so that said element is capable of opening said contacts in response to said predetermined heating thereof even when said handle is held in a position corresponding to the closed position of said contacts.

28. In a circuit breaker, separable contacts, a flexible snap-acting bimetal element for opening and closing said contacts with a snap action, said element being responsive to predetermined heating thereof to automatically open said contacts, an actuating handle adapted when moved in opposite directions to flex said element to cause snap action opening and closing of said contacts, respectively, said handle being trip-free of said element so that said element is capable of opening said contacts in response to said predetermined heating thereof even when said handle is held in a position corresponding to the closed position of said contacts, and means responsive to an automatic circuit opening operation by said element to move said handle to a position corresponding to the open position of said contacts when said handle is not held at its closed contact position.

29. In a circuit breaker, a flexible snap-acting bimetal element having at least a pair of substantially parallel legs connected at their opposite ends, said element being stressed so that at least one of said legs assumes a bowed form, supporting means secured to one of said legs and manually operable actuating means engageable with the other of said legs to move said other leg laterally in opposite directions to cause reversal of curvature of said bowed leg, the one of said means associated with said bowed leg being located intermediate the ends thereof, at least one end of said element being free to move laterally, relatively stationary contact means, contact means carried by at least said one end of said element for movement into and out of engagement with said relatively stationary contact means whereby move-

ment of said actuating means in opposite directions will cause snap action movement of said movable contact means into and out of engagement with said relatively stationary contact means.

30. In a circuit breaker, a flexible snap-acting bimetal element having at least a portion thereof curved in section so as to be operable in response to predetermined temperature change to automatically reverse the curvature of said portion with a snap-action, supporting means for said element, manually operable actuating means for said element, one of said means adapted to engage said element at a point intermediate the extent of said curvature, the other of said means adapted to engage said element at a spaced point so that operation of said actuating means in opposite directions will cause relative movement of said spaced points of said element to cause corresponding reversal of curvature of said element, relatively stationary contact means, and contact means on a movable portion of said element adapted to move into and out of engagement with said stationary contact means in response to reversal of curvature of said element.

31. In a circuit breaker, a flexible snap-acting bimetal element having at least a portion thereof curved in section so as to be operable in response to predetermined temperature change to automatically reverse the curvature of said portion with a snap-action, supporting means for said element, manually operable actuating means for said element, said supporting means being secured to said element at a point intermediate the extent of said curvature, said actuating means adapted to engage said element at a spaced point, so that operation of said actuating means in opposite directions will cause relative movement of said spaced points of said element to cause corresponding reversal of curvature of said element, relatively stationary contact means, and contact means on a movable portion of said element adapted to move into and out of engagement with said stationary contact means in response to reversal of curvature of said element.

32. In a circuit breaker, a flexible snap-acting bimetal element having at least a portion thereof curved in section so as to be operable in response to predetermined temperature change to automatically reverse the curvature of said portion with a snap-action, supporting means for said element, manually operable actuating means for said element, one of said means adapted to engage said element at a point intermediate the extent of said curvature, the other of said means adapted to engage said element at a spaced point so that operation of said actuating means in opposite directions will cause relative movement of said spaced points of said element to cause corresponding reversal of curvature of said element, relatively stationary contact means, said actuating means having lost motion relative to said element so that snap-action movement of said element may occur at a predetermined rapid rate independent of the rate of movement of said actuating means, and contact means on a movable portion of said element adapted to move into and out of engagement with said stationary contact means in response to reversal of curvature of said element.

33. In a circuit breaker, a flexible snap-acting bimetal element having at least a portion thereof curved in section so as to be operable in response to predetermined temperature change to automatically reverse the curvature of said portion with a snap-action, supporting means for said element, manually operable actuating means for said element, one of said means adapted to engage said element at a point intermediate the extent of said curvature, the other of said means adapted to engage said element at a spaced point so that operation of said actuating means in opposite directions will cause relative movement of said spaced points of said element to cause corresponding reversal of curvature of said element, relatively stationary contact means, said actuating means having lost motion relative to said element so that snap-action movement of said element may occur at a predetermined rapid rate independent of the rate of movement of said actuating means, means biasing said handle to take up at least a portion of said lost motion so that the position of said actuating means clearly indicates the operation last performed, and contact means on a movable portion of said element adapted to move into and out of engagement with said stationary contact means in response to reversal of curvature of said element.

34. In a circuit breaker, a flexible snap-acting bimetal element having at least a portion thereof curved in section so as to be operable in response to predetermined temperature change to automatically reverse the curvature of said portion with a snap-action, supporting means for said element, manually operable actuating means for said element, one of said means adapted to engage said element at a point intermediate the extent of said curvature, the other of said means adapted to engage said element at a spaced point so that operation of said actuating means in opposite directions will cause relative movement of said spaced points of said element to cause corresponding reversal of curvature of said element, relatively stationary contact means, said actuating means having lost motion relative to said element so that snap-action movement of said element may occur at a predetermined rapid rate independent of the rate of movement of said actuating means, means biasing said handle to take up at least a portion of said lost motion so that the position of said actuating means clearly indicates the operation last performed, stop means for preventing movement of said actuating means under the influence of said biasing means from taking up all of said lost motion so that said element may automatically reverse its curvature even though said actuating means is held at an extreme position, and contact means on a movable portion of said element adapted to move into and out of engagement with said stationary contact means in response to reversal of curvature of said element.

35. In a circuit breaker, a flexible snap-acting bimetal element having at least a portion thereof curved in section so as to be operable in response to predetermined temperature change to automatically reverse the curvature of said portion with a snap-action, supporting means for said element, manually operable actuating means for said element, one of said means adapted to engage said element at a point intermediate the extent of said curvature, the other of said means adapted to engage said element at a spaced point so that operation of said actuating means in opposite directions will cause relative movement of said spaced points of said element to cause corresponding reversal of curvature of said element, relatively stationary contact means, said actuating means having lost motion relative to said element so that snap-action movement of

said element may occur at a predetermined rapid rate independent of the rate of movement of said actuating means, means responsive to movement of said actuating means an amount sufficient to cause snap-action movement of said element for biasing said handle to take up at least a portion of said lost motion so that the position of said actuating means clearly indicates the operation last performed, said biasing means also being responsive to automatic operation of said element to bias said actuating means to a position indicating such an operation of the element, and contact means on a movable portion of said element adapted to move into and out of engagement with said stationary contact means in response to reversal of curvature of said element.

CHARLES H. HODGKINS.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
851,420	Hewitt et al.	Apr. 23, 1907
1,181,742	Coolidge	May 2, 1916
1,898,174	Dubilier	Feb. 21, 1933
2,255,330	Platz	Sept. 9, 1941
2,257,793	Frank	Oct. 7, 1941
2,262,397	Immel et al.	Nov. 11, 1941
2,268,229	Walle	Dec. 30, 1941
2,285,450	McCarthy	June 9, 1942
2,293,179	Swingle	Aug. 18, 1942
2,295,456	Eaton	Sept. 8, 1942
2,345,451	Bolesky	Mar. 28, 1944