Jan. 16, 1945. F. G. VON HOORN 2,367,631

AUTOMATIC CIRCUIT BREAKER

Filed Nov. 1, 1943 2 Sheets-Sheet 1

Fig. 1.

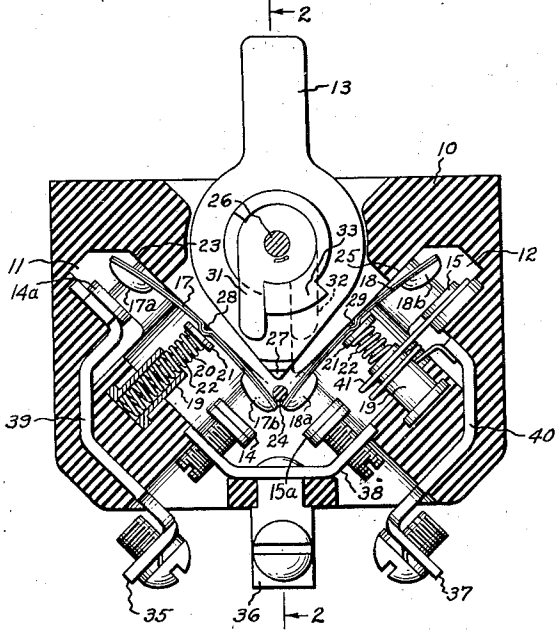

Fig. 2.

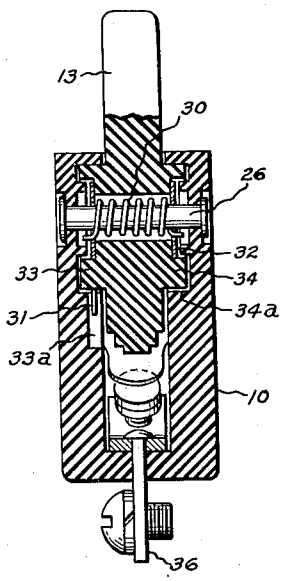

Fig. 3.

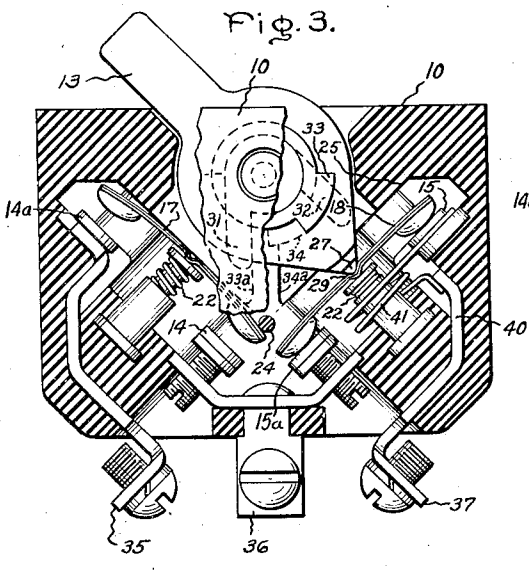

Fig. 4.

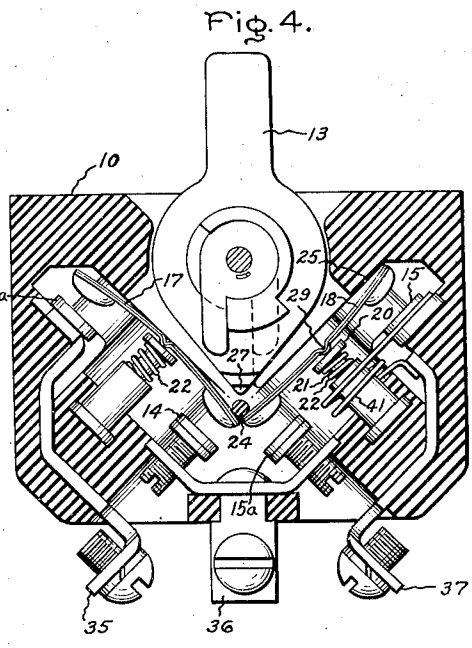

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Fig. 5.

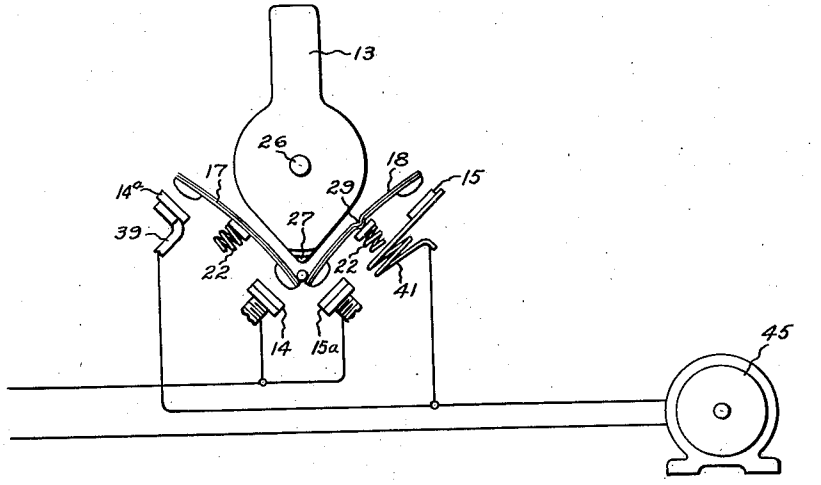
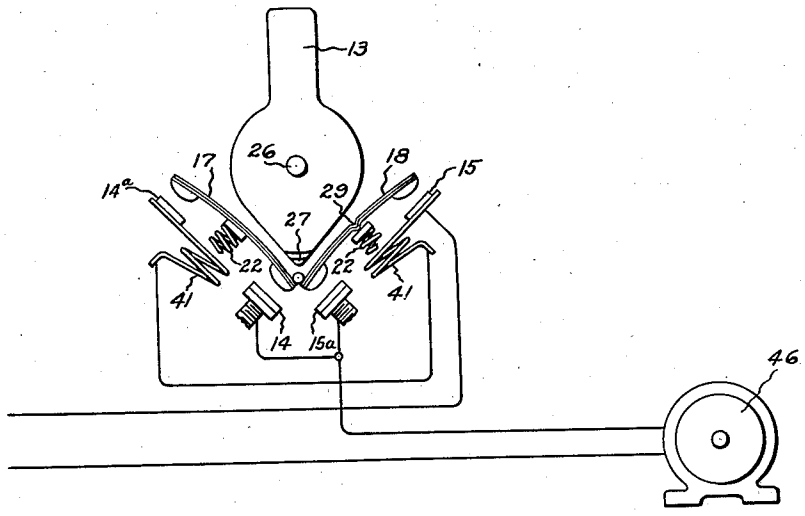


Fig. 6.



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UNITED STATES PATENT OFFICE

2,367,631

AUTOMATIC CIRCUIT BREAKER

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Application November 1, 1943, Serial No. 508,523

10 Claims. (Cl. 200—122)

My invention relates to automatic electric circuit breakers, and more particularly to double throw manually operable current responsively tripped circuit interrupters. The invention is especially suitable for use on aircraft, ships and certain land vehicles, where space and weight limitations are of major importance.

Heretofore, so-called double throw automatic circuit interrupters have been devised which comprise only a plurality of adjacently mounted single interrupters having their operating handles mechanically connected together or interlocked. Such devices are cumbersome and, while offering certain advantages in facility of multiple circuit control, effect no saving in space or weight over two separate circuit breakers. Small breakers of this type are used for control of lighting, heating and small motor circuits and the like, and, at least for aircraft applications, there has existed a long felt demand for an improved double throw automatic circuit breaker of reduced size and weight. It is also desirable in such breakers to provide for control of a multiplicity of circuits by a minimum number of manually operable members, thereby to simplify control panels and minimize confusion on the part of an operator.

It is a general object of my invention to provide a new and improved manually operable double throw circuit breaker having a single handle for selectively controlling a plurality of circuit interrupting devices, at least one of which is arranged for automatic tripping operation.

More specifically, my invention has for its object the provision of a double throw manually operable current responsively tripped circuit breaker which shall move the operating handle automatically to a neutral position upon overload tripping operation of a selected breaker and shall thereafter automatically reset the breaker in preparation for manual reclosure.

It is a further object of my invention to provide a double throw automatic circuit interrupter which is at once simple, compact and inexpensive in construction, reliable in operation, and easily adaptable to a diversity of plural circuit control applications.

My invention may be more fully understood and its objects and advantages further appreciated by referring now to the following detailed specification taken in conjunction with the accompanying drawings, in which Figs. 1, 3, and 4 are cross sectional views showing various conditions of operation of a circuit interrupter embodying my invention; Fig. 2 is a cross sectional view taken along the line 2—2 of Fig. 1; and Figs. 5 and 6 are diagrammatic views showing other embodiments of my invention and their application to certain representative motor control circuits.

Referring now to the drawings, and particularly to Figs. 1 and 2, the circuit interrupter which I have shown by way of illustration comprises a base or casing 10, preferably formed of a molded plastic insulating material and having an irregular configuration adapted to accommodate the various parts of the switch mechanism. In general, the casing 10 is recessed to provide two switch chambers 11 and 12 and suitable space therebetween for an operating lever 13.

Within the switch chambers 11 and 12 are mounted, respectively, pairs of stationary contacts 14, 14*a* and 15, 15*a*. A movable switch member 17 within the chamber 11 is arranged to bridge the pair of fixed contacts 14, 14*a* and a movable switch member 18 within the chamber 12 is arranged to bridge the the fixed contacts 15, 15*a*. The switch members 17 and 18 are formed of a suitable thermal responsive material, such as thermal deformable bimetal, and have normal concavo-convex flexed positions as shown at Fig. 1. It is well known that such a spherical section of bimetal has the property of snapping suddenly from its normal flexed position to an opposite flexed position upon the application of a predetermined amount of heat thereto. The switch members carry at their ends moving contacts 17*a*, 17*b* and 18*a*, 18*b* for cooperation with the fixed contacts 14*a*, 14, 15*a* and 15, respectively.

Intermediate each pair of fixed contacts 14, 14*a* and 15, 15*a*, the casing 10 is formed to receive and support a hollow cylindrical post 19. Within each of the hollow posts 19 is slidably mounted a pin 20 having a head 21. A pair of compression springs 22, positioned between the heads 21 of the pins 20 and the bases of the hollow posts 19, are arranged to bias the pins 20 outwardly from the base and against the under sides of the associated thermal responsive elements 17 and 18. The springs 22 thus serve to bias the bimetallic switch members 17 and 18 away from the fixed contacts 14, 14*a*, 15, and 15*a* and into engagement with suitable fixed stops 23, 24 and 25 formed integrally with the casing 10. The bimetallic switch elements 17 and 18 are loosely mounted within the switch chambers 11 and 12 and their contacts are held in proper alignment for engagement with the associated fixed contacts by the walls of the switch chambers. Therefore, while if desired the bimetallic snap-acting switch members 17 and 18 may be connected to the head portions 21 of the pins

20, such connection is not necessary if alignment is otherwise maintained.

The snap-acting bimetallic switch members 17 and 18 are so positioned within the casing 10 that tangential planes at their centers intersect at approximately a right angle. The operating handle 13 is pivotally mounted upon a fixed pivot 26 which is positioned within the casing at approximately the point of intersection of two lines drawn perpendicular to the concavo-convex switch members 17 and 18 at their centers. The lower end 27 of the handle 13 is tapered and constitutes a camming surface which is selectively engageable with either of the bimetallic switch members 17, 18 to press them inwardly against their bias to positions of contact engagement. Suitable detent means, such as central indentations 28 and 29 in the switch members 17 and 18, respectively, are provided for receiving the tapered end 27 of the operating handle 13 releasably to hold the handle in a selective position of contact engagement.

The operating handle 13 is biased to a neutral position of disengagement with both the bimetallic switch members 17 and 18, as shown at Fig. 1, by means of a torsion spring 30 encircling the pin 26 and attached at its end to extending arms 31 and 32. As shown at Fig. 2, the arms 31 and 32 are positioned at opposite ends of the pin 26 and are biased by the spring 30 into engagement with a pair of movable stops or lugs 33 and 34, respectively, mounted upon the handle 13. A fixed stop 33a of the casing 10 prevents counterclockwise movement of the arm 31, and a fixed stop 34a prevents clockwise movement of the arm 32. The arms 31 and 32 are thus free to move in opposite directions against the bias of the spring 30 as the handle 13 is moved away from the neutral position to either switch closing position. Normally, however, the arms 31 and 32 center the handle 13 between the stops 33a and 34a.

In the embodiment of the invention shown at Figs. 1, 3 and 4, I have shown the double circuit breaker provided with three terminal connectors 35, 36, and 37. The two adjacent lower stationary contacts 14 and 15a are connected together and to the terminal 36 by means of a rigid electrically conducting bar 38. The terminal connector 35 is formed upon one end of conducting bar 39 inlaid in a suitably shaped recess in the casing 10 and connected at its other end to the stationary contact 14a. Similarly, the terminal connector 37 is formed upon one end of a conducting bar 40 positioned in a like recess in the opposite side of the casing 10. In the embodiment of Fig. 1, however, the conducting bar 40 is not connected directly to the stationary contact 15, but rather is connected thereto through a helical electric heating resistor 41 which encircles the hollow post 19 immediately under the bimetallic switch member 18.

In view of the foregoing detailed description of the construction and arrangement of the various elements of my circuit breaker, its mode of operation will now be understood by referring conjointly to Figs. 1, 3 and 4. Fig. 1 shows the normal open position of the device with the operating handle 13 in its neutral position and both snap-acting bimetallic elements 17 and 18 in their contact disengaging positions under the influence of the compression springs 22. Both bimetallic elements are in their normal flexed positions. If now the operating handle 13 is rotated 45° in a counterclockwise direction as viewed at Fig. 3, the tapered lower end of the operating handle acts as a cam to depress the snap-acting bimetallic element 18 into its contact engaging position in opposition to the spring 22. The resilient bimetallic strip 18 itself is sufficient to permit the slight deformation after contact engagement necessary to enable the tapered end 27 of the operating handle to be brought into the indentation 29 in the center of the bimetal element 18. To escape from the detent 29 with the bimetallic element 18 in its normal flexed position, it is necessary both to deform the element 18 and to overcome the spring 22. The neutral biasing force upon the handle 13 is insufficient to overcome these combined forces so that the handle 13 will now remain in the position shown at Fig. 3. With the contacts 15 and 15a thus bridged, current may now flow from the terminal connector 36 through the stationary contact 15a, the bimetallic element 18, the stationary contact 15, the electric heating resistor 41, and the conducting bar 40 to the terminal connector 37.

If it is desired to open the switch manually, it is only necessary to forcibly move the operating handle 13 from the position of Fig. 3 to that of Fig. 1. The switch member 18 will then be moved to its circuit opening position by the associated spring 22.

Assuming, however, that the bimetallic switch member 18 is left in its contact engaging position of Fig. 3, the bimetal experiences a heating effect from two sources, namely, from the current passing directly through the element 18 itself, and also from the current passing through the heating resistor 41. It will be understood that the device is suitably calibrated so that when the current thus flowing reaches a predetermined undesirably large value, the heat generated thereby is sufficient to cause the bimetallic element 18 to snap from its normal flexed position shown at Fig. 3 to an opposite flexed position, such as that shown at Fig. 4. When the bimetallic element 18 is in the position shown at Fig. 4, its flexure is such that the moving contacts attached to the element are separated from the fixed contacts 15 and 15a, despite the fact that the operating handle 13 momentarily remains in the position shown at Fig. 3. As soon as this condition of opposite flexure of the strip 18 occurs, the pressure applied against the tapered end 27 of the operating handle 13 is reduced to that pressure applied by the spring 22 alone. The force of the spring 22 alone on the detent 29 is insufficient to hold the operating handle 13 against its neutral bias so that the operating handle frees itself from the detent and assumes its neutral position as shown at Fig. 4. It may be observed that with the element 18 in its reverse flexed position, the associated switch contacts cannot be engaged even though the operating handle 13 were held in its circuit closing position, i. e., the breaker is trip-free in automatic tripping operation.

As soon as the operating handle 13 moves to its neutral position, the spring 22 moves the bimetallic element 18 outwardly and into engagement with the fixed stops 24 and 25. In the position shown at Fig. 4, it is assumed that the bimetal element 18 is still sufficiently heated so that it is unable to assume its normal flexed position. It will be understood that when the bimetal element 18 has been cooled to a predetermined extent, it becomes possible to reset the element to its normal flexed position by applying a suitable snapping force thereto. Such a snapping force is automatically supplied according to my invention by the compression spring 22, which continuously holds the head 21 of the pin 20 against the lower

surface of the snap-acting bimetallic element 18. Thus, as soon as the element 18 has cooled sufficiently to permit the spring 22 to force it to its critical unstable position, it will automatically be reset by snapping to its normal flexed position as shown at Fig. 1.

It will be evident that manual opening and closing operation and automatic tripping of the snap-acting bimetal element 17 may be effected in a manner entirely similar to that described above by operating the handle 13 in a clockwise direction, as viewed at Fig. 1, rather than in a counterclockwise direction as previously described.

By way of example only, I have shown at Figs. 1, 3 and 4 a double snap-acting switch in which only one of the snap-acting elements is provided with an electric heating resistor 41 and in which the current path through that element traverses the electric heating resistor and the associated bimetal snap-acting element in series circuit relation. Thus, in this embodiment, overload heating is applied to the snap-acting bimetal element 17 only by the current traversing that element itself. It will of course be understood that my invention is not limited to the particular circuit arrangement shown, but that either, or both, of the snap-acting elements may be supplied with electric heating resistors and that the electric heating resistor associated with a snap-acting element may be connected in series circuit relation with the snap-acting element itself, or to any other desired source of current supply. Furthermore, it is not necessary that both contact carrying elements be supplied with detent means for releasably retaining the operating handle 13 in contact engaging position. If desired, the detent may be omitted from any or all of the elements, so that the circuit controlled by such an element may be maintained closed only by holding the operating handle in the appropriate circuit closing position. It will be understood that, even without such detent means for automatically retaining a circuit closed, overload protection is still provided when the handle is held manually in the circuit closing position because snapping of the affected bimetal element to its opposite concavo-convex position will separate the contacts in the same manner as if the handle were latched in position.

I have illustrated at Figs. 5 and 6 certain representative circuit applications of a device embodying my invention and in which only one of the snap-acting bimetal elements is provided with a detent for automatically holding the associated contacts closed. The switch device of Fig. 5 is entirely similar to that of Fig. 1 in all respects except that the detent 28 in the center of the snap-acting bimetallic element 17 has been omitted. Like parts of the device have been assigned the same reference numerals. In this figure I have shown how such a device may be applied to control the starting and running circuits of a single-phase, alternating-current motor 45. For this purpose the pairs of stationary contacts 14, 14a and 15, 15a are connected in parallel circuit relation. The bimetallic element 17 is so calibrated that it opens the circuit at a much higher current value than does the bimetallic element 18. To start the motor, the operating handle 13 is first rotated in the clockwise direction to close the motor circuit through the bimetallic element 17. The element 17, due to its high overload setting, is able to withstand the normally high starting current without automatically opening its contacts, but still provides protection against excessive currents such as short-circuit currents. After the motor has started and the current has decreased to approximately its normal running value, the circuit is closed through the latched-in element 18 by rotating the operating handle 13 in a counterclockwise direction to bridge the contacts 15, 15a. In this position the operating handle will be releasably maintained in circuit closing position by the detent 29, and overload protection for the running current will be provided by the element 18.

At Fig. 6, I have shown a slightly different embodiment of my invention applied also to the control of a single-phase alternating-current motor, identified in this instance by the reference numeral 46. In the embodiment of Fig. 6, however, both snap-acting elements 17 and 18 of the switch have associated therewith electric heating resistors 41 connected in series circuit relation between the contacts 14a and 15. As at Fig. 5, the snap-acting element 17 is formed without a detent and may be held closed only manually. To start the motor, the operating handle 13 is rotated in a clockwise direction to close the motor circuit through the bimetallic element 17. In this starting condition the motor current traverses the two heating resistors 41 and the bimetallic element 17 in series circuit relation, thereby to provide a predetermined high starting overload protection by reason of the direct and indirect electric heating applied to the bimetallic element 17 of high setting, and serving also to preheat the bimetallic element 18 with heat supplied by the associated electric heating resistor. When the motor current has fallen substantially to its running value, the operating handle 13 is moved in a counterclockwise direction to open the circuit through the bimetallic element 17 and to reclose the circuit through the bimetallic element 18. The element 18, being provided with a central detent, releasably retains the operating handle 13 in position, and thus automatically maintains the running circuit closed. With the switch closed in its running position, the motor current traverses only the bimetallic element 18, and does not pass through either of the electric heating resistors 41. Thus, overload heating is supplied to the element 18 only by reason of the load current passing through the element itself. However, by reason of the preheat applied to the snap-acting element 18 through the associated electric heating resistor 41 when the operating handle 13 was in the starting position, the element 18 is in condition immediately upon its closure to render its normal overload protection. The preheating avoids an otherwise necessary period of heating up of the element 18 to its normal running temperature.

In the light of the foregoing description, it may now be observed that, by positioning a plurality of disked bimetallic switch elements in juxtaposition for selective actuation by a single common operating handle, I have succeeded in building, into the confines of a single small and light unit, a plurality of manually operable, current responsively tripped circuit interrupters. Because of its small physical size and weight and because of its simplicity and reliability, the circuit breaker of my invention is particularly suitable for the control of various aircraft auxiliaries, such as lights, heaters, control surface driving motors, and the like.

While I have described only certain preferred embodiments of my invention by way of illustration, many modifications will occur to those skilled in the art. I therefore wish to have it understood that I intend in the appended claims to cover all such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. A multiple circuit interrupter comprising a plurality of pairs of separable switch contacts, a plurality of resilient switch members each movably mounted to control engagement and disengagement of one of said pairs of contacts, at least one of said switch members being thermally deformable and having a normal concavo-convex flexed position, means for biasing said switch members normally to separate said contacts, a single manually operable member biased to a neutral position and movable into alternative camming engagement with said switch members selectively to engage said pairs of contacts when said thermally deformable switch member is in said normal flexed position, and means responsive to the current passing through the contacts associated with said thermal responsive switch member for snapping said member from said normal flexed position to an opposite flexed position to separate said contacts.

2. A multiple circuit interrupter comprising a plurality of pairs of separable switch contacts, a plurality of resilient switch members each movably mounted to control engagement and disengagement of one of said pairs of contacts, at least one of said switch members being thermally deformable and having a normal concavo-convex flexed position, means for biasing said switch members normally to separate said contacts, a single manually operable member biased to a neutral position and movable into alternative engagement with said switch members selectively to engage said pairs of contacts when said thermally deformable switch member is in said normal flexed position, detent means operable by flexure of said thermal responsive switch member for releasably retaining said manually operable means in latching engagement therewith, and means responsive to the current passing through the contacts associated with said thermal responsive switch member for snapping said member from said normal flexed position to an opposite flexed position to separate said contacts and to release said manually operable member.

3. A multiple circuit interrupter comprising a plurality of pairs of separable switch contacts, a plurality of snap-acting thermal responsive elements each having a normal concavo-convex flexed position, each of said elements being movably mounted to control engagement and disengagement of one of said pairs of contacts, means for biasing said elements to hold said pairs of contacts normally in positions of disengagement, a single manually operable member biased to a neutral position and movable into alternative camming engagement with said thermal responsive elements selectively to engage said contacts when said elements are in said normal flexed positions, and means responsive to the current passing through said contacts for snapping said thermal responsive elements from said normal flexed positions to opposite flexed positions to separate the associated switch contacts.

4. A multiple circuit interrupter comprising a plurality of pairs of separable switch contacts, a plurality of snap-acting thermal responsive elements each having a normal concavo-convex flexed position, each of said elements being movably mounted to control engagement and disengagement of one of said pairs of contacts, means for biasing said elements to hold said pairs of contacts normally in positions of disengagement, a single manually operable member biased to a neutral position and movable into alternative camming engagement with said thermal responsive elements selectively to engage said pairs of contacts when said elements are in said normal flexed positions, detent means operable by flexure of at least one of said thermal responsive elements for releasably retaining said operating handle in latching engagement with said element, and means responsive to the current passing through said contacts for snapping said thermal responsive elements from said normal flexed positions to opposite flexed positions to separate said contacts.

5. A multiple circuit interrupter comprising two pairs of separable switch contacts, a pair of snap-acting thermal responsive elements each having a normal concavo-convex flexed position, each of said elements being movably mounted to control engagement and disengagement of one of said pairs of contacts, means for biasing said elements to hold said pairs of contacts normally in positions of disengagement, a single manually operable member biased to a neutral position and movable into alternative engagement with said thermal responsive elements selectively to engage said pairs of contacts when said elements are in said normal flexed positions, means operable by flexure of said thermal responsive elements for releasably retaining said manually operable member in a selected position of engagement with either of said elements, and means responsive to the current passing through said contacts for snapping the associated thermal responsive element from said normal flexed position to an opposite flexed position to separate said contacts and to release said manually operable member.

6. A multiple circuit interrupter comprising two pairs of separable switch contacts, a pair of snap-acting thermal responsive elements each having a normal concavo-convex flexed position, each of said elements being movably mounted to control engagement and disengagement of one of said pairs of contacts, means for biasing said elements to hold said pairs of contacts normally in positions of disengagement, a single operating handle pivotally mounted intermediate said snap-acting elements, said operating handle being biased to a neutral position and arranged for movement into alternative engagement with said thermal responsive elements selectively to engage said pairs of contacts when said elements are in said normal flexed positions, detent means operable by flexure of at least one of said thermal responsive elements for releasably retaining said operating handle in latching engagement with said element, and means responsive to the current passing through said contacts for snapping the associated thermal responsive element from said normal flexed position to an opposite flexed position to separate said contacts even though said handle is manually held in a circuit closing position.

7. A multiple electric circuit interrupter comprising two pairs of separable switch contacts, a pair of movably mounted snap-acting thermal responsive elements each having a normal concavo-convex flexed position and arranged to control engagement and disengagement of one of said

pairs of contacts, fixed stop means for limiting contact disengaging movement of said elements, means for biasing said elements against said fixed stop means to separate said contacts, a single manually operable member biased to a neutral position and movable into alternative engagement with either of said thermal responsive elements to engage said contacts when said elements are in said normal flexed positions, detent means operable by flexure of said elements for releasably retaining said manually operable member in either selected engaging position, and means responsive to the current passing through said contacts for snapping the associated thermal responsive element from said normal flexed position to an opposite flexed position to separate said contacts and to release said manually operable member, said fixed stop means and said biasing means being operable upon cooling of said snapped thermal responsive element to reset said element to said normal flexed position.

8. A multiple circuit interrupter comprising two pairs of separable switch contacts, a pair of movably mounted snap-acting thermal responsive elements each carrying a contact of one of said pairs of contacts and having a normal concavo-convex flexed position, a spring engaging each of said thermal responsive elements for biasing said elements against fixed stops to normal positions of contact disengagement, a pivotally mounted operating handle biased to a neutral position of disengagement with both of said thermal responsive elements and having a camming portion arranged alternatively to engage and move said elements to positions of contact engagement when said elements are in said normal flexed positions, detent means operable by flexure of at least one of said elements for releasably retaining said handle in engagement with said element, and means responsive to the current passing through said contacts for heating the associated thermal responsive element to snap said element from said normal flexed position to an opposite flexed position to separate said contacts irrespective of the position of said operating handle, said detent means being operable upon snapping of the associated element to release said operating handle.

9. A multiple circuit interrupter comprising two pairs of separable switch contacts, a pair of movably mounted snap-acting bimetallic elements each carrying a contact of one of said pairs of contacts and having a normal concavo-convex flexed position, a spring engaging each of said elements for biasing said elements against fixed stops to normal positions of contact disengagement, a single pivotally mounted operating handle biased to a neutral position of disengagement with both of said elements and having a camming portion arranged alternatively to engage and move either of said elements to a position of contact engagement, detent means associated with said camming portion and operable by flexure of said elements releasably to retain said operating handle in locking engagement with a selected element, and electric heating means responsive to the current passing through an engaged pair of contacts for snapping the associated bimetallic element to an opposite flexed position to separate said contacts and to release said operating handle, said spring and said fixed stop being arranged upon predetermined cooling of said element automatically to reset said element to said normal flexed position.

10. A multiple circuit interrupter comprising two pairs of separable switch contacts, a pair of movably mounted snap-acting bimetallic elements each carrying a contact of one of said pairs of contacts and having a normal concavo-convex flexed position, separate spring means engaging each of said elements for biasing said elements against limiting stops to normal positions of contact disengagement, a single pivotally mounted operating handle biased to a neutral position of disengagement with both said bimetallic elements and having a camming portion arranged alternatively to engage and move either of said elements to a position of contact engagement, detent means formed upon at least one of said bimetallic elements and operable by flexure of said element releasably to retain said operating handle in engagement therewith, and electric heating means responsive to the current passing through an engaged pair of said contacts for snapping the associated bimetallic element from said normal flexed position to an opposite flexed position to separate said contacts, said detent means releasing said operating handle for movement to said neutral position upon snapping of the associated element, said spring means and said fixed stop being arranged upon predetermined cooling of an oppositely flexed element automatically to reset said element to said normal flexed position.

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