

Jan. 2, 1968

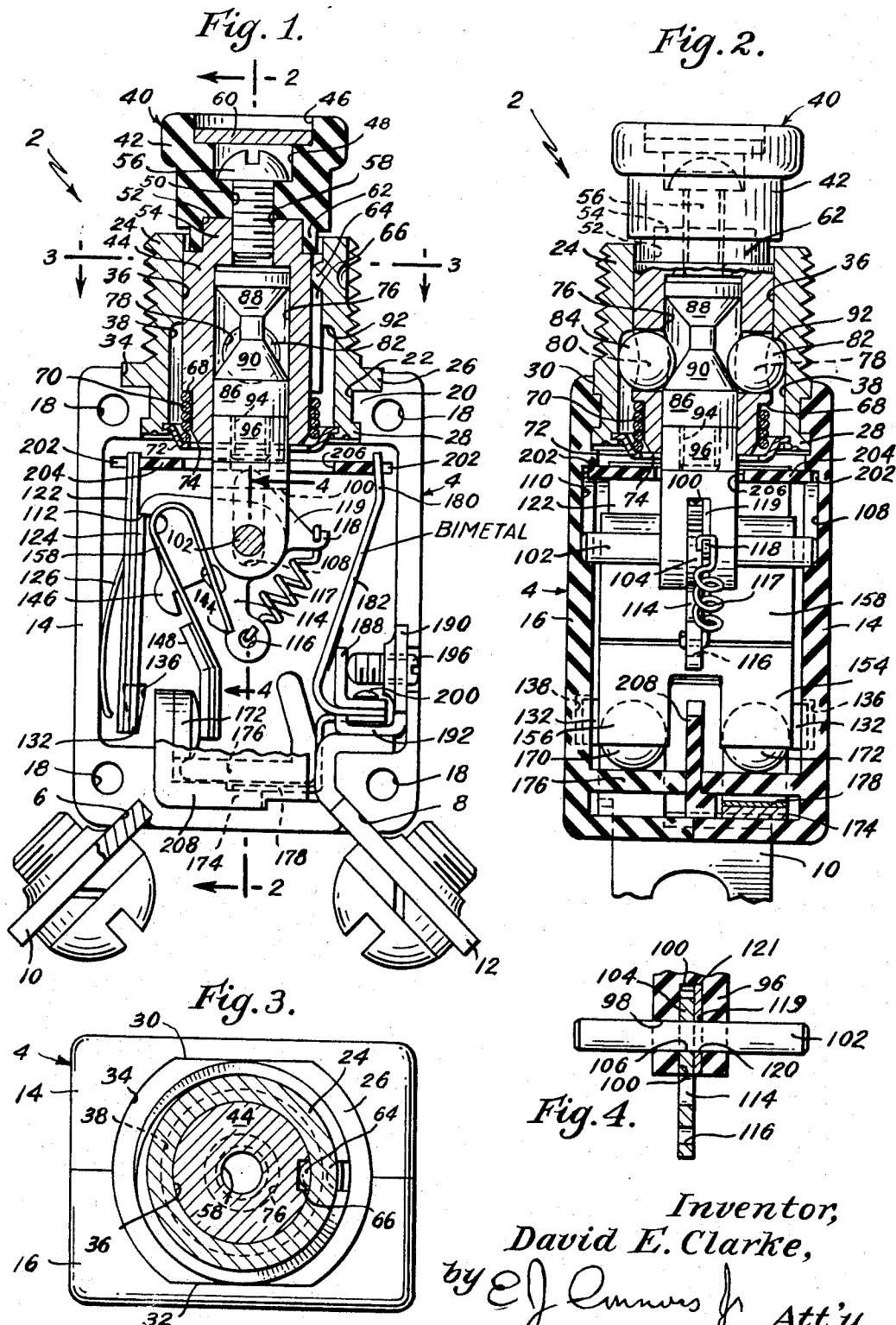
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3,361,882

CIRCUIT BREAKER HAVING A COMPENSATING ELEMENT WHICH COMPENSATES
FOR AMBIENT TEMPERATURE WITHOUT DISPLACING
THE CATCH ATTACHED THERETO

Filed Oct. 24, 1965

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Fig. 5.

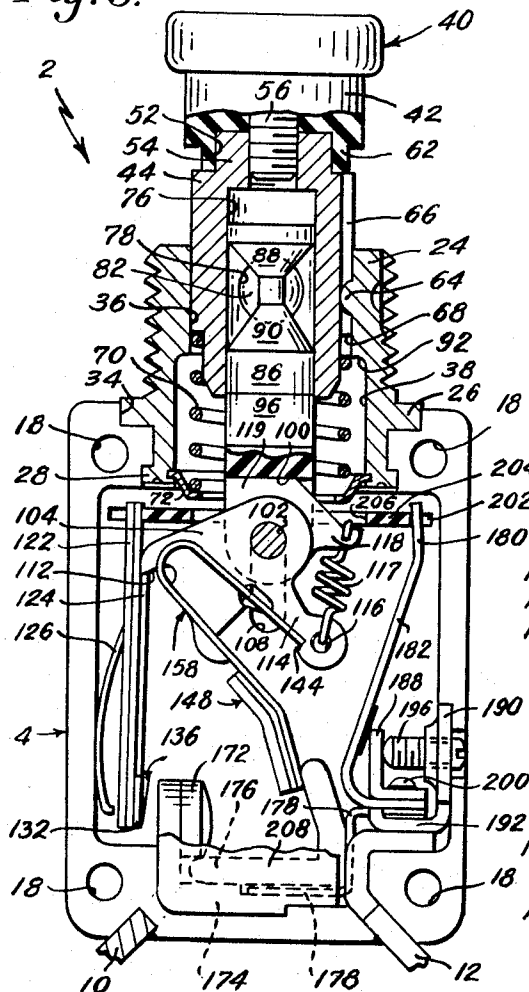


Fig. 6.

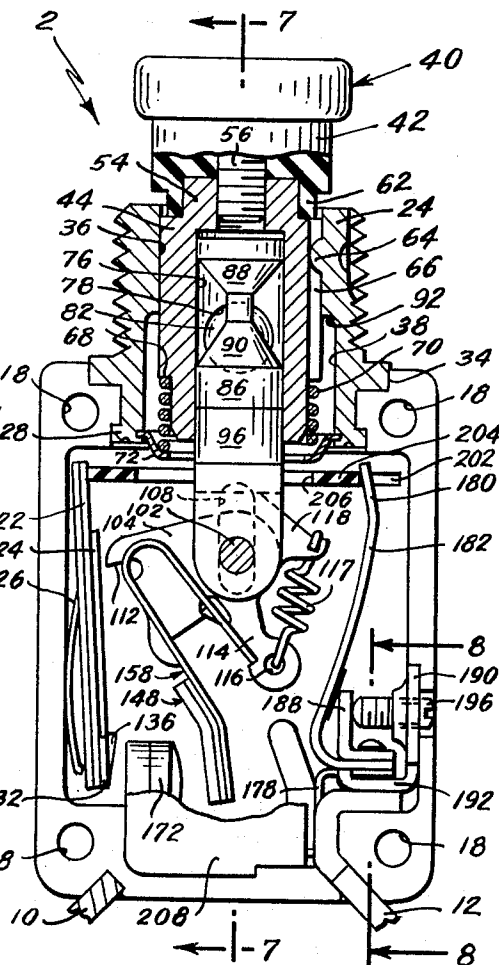


Fig. 7.

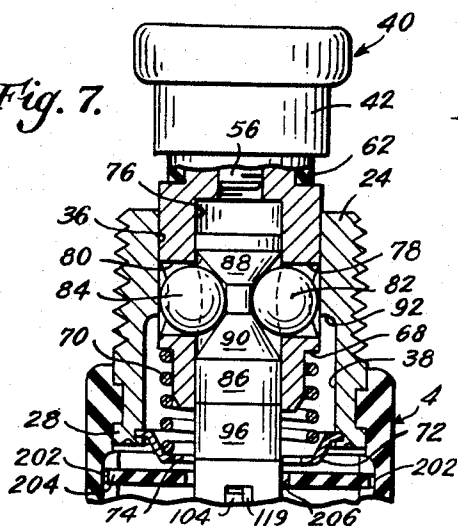
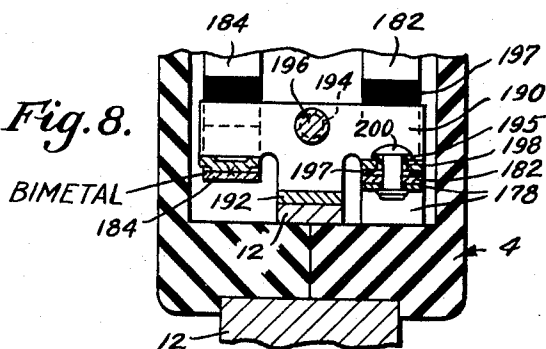


Fig. 8.



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Fig. 10.

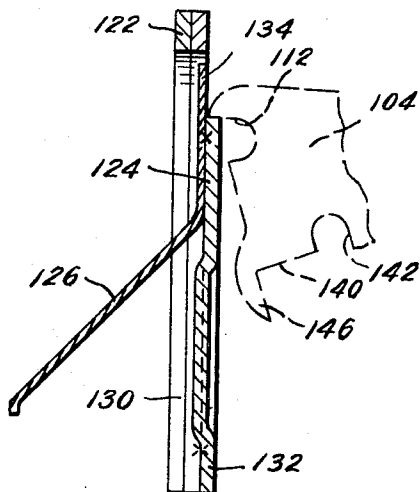


Fig. 9.

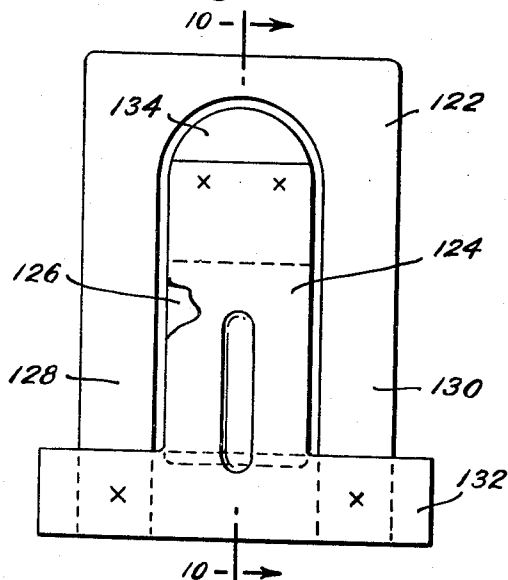


Fig. 13.

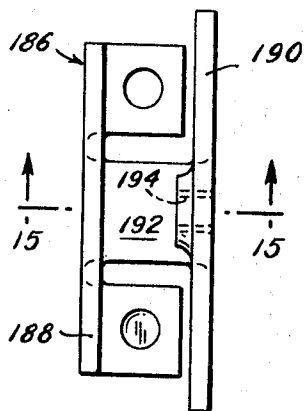


Fig. 11.

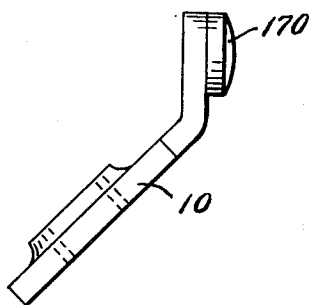


Fig. 12.

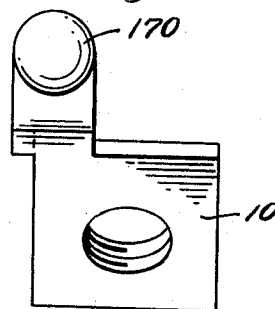


Fig. 14.

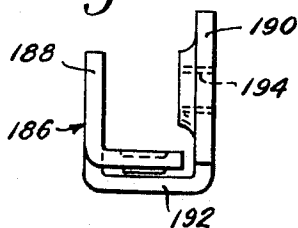
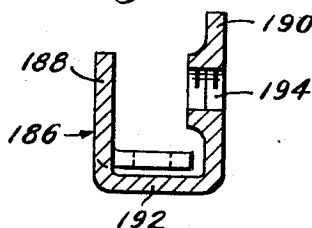


Fig. 15.



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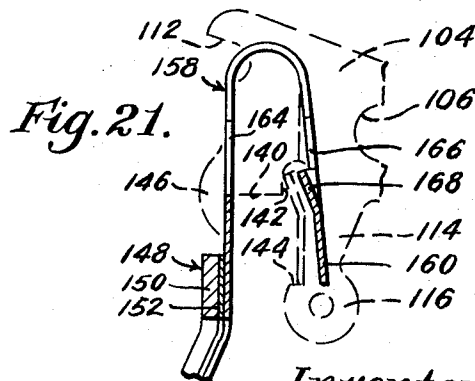
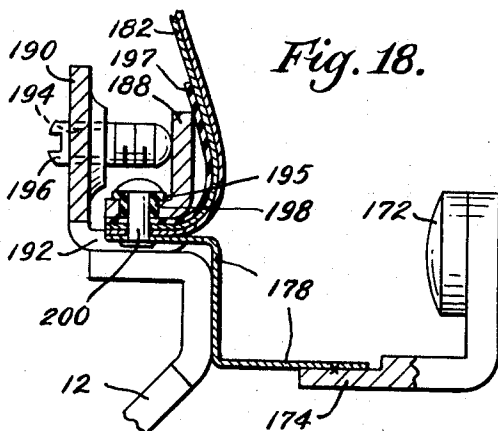
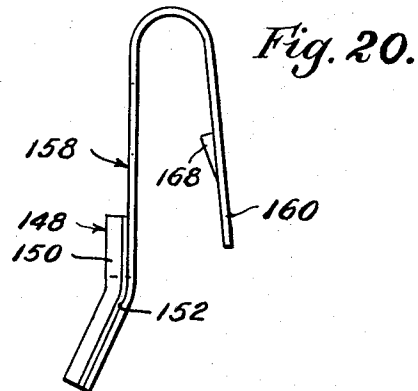
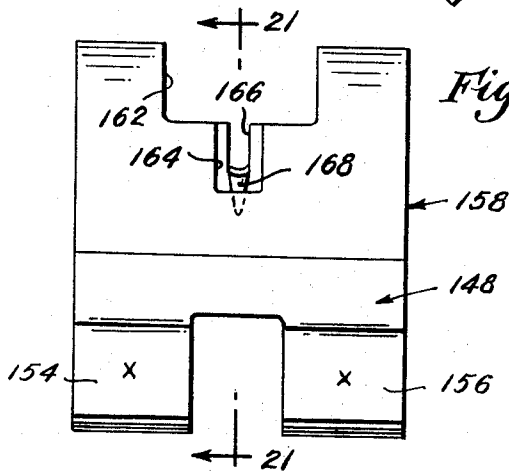
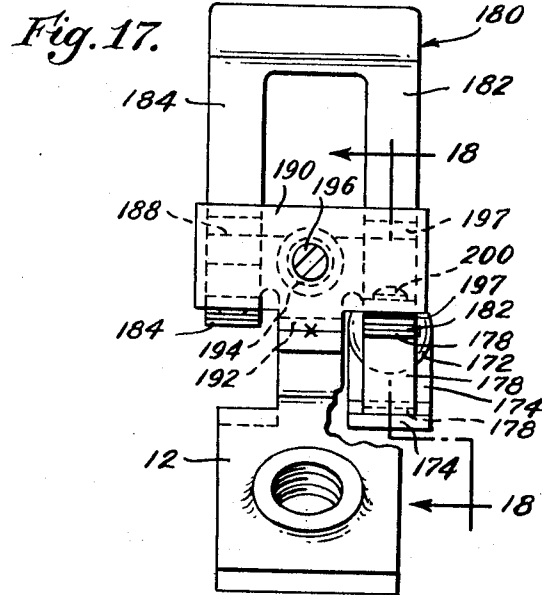
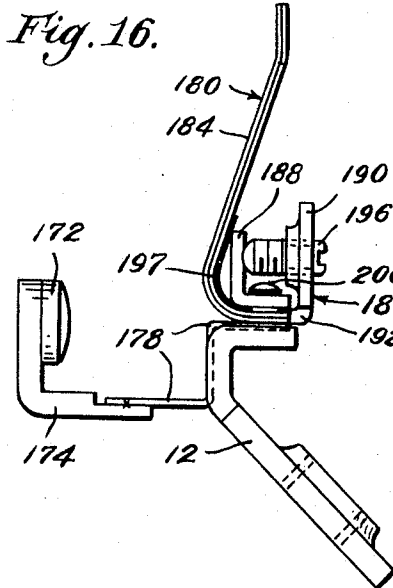
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Fig. 22.

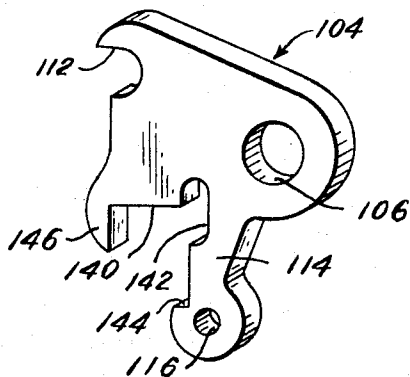


Fig. 23.

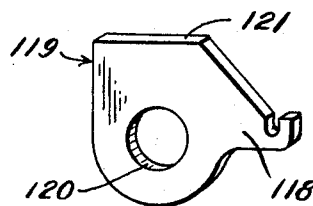


Fig. 24.

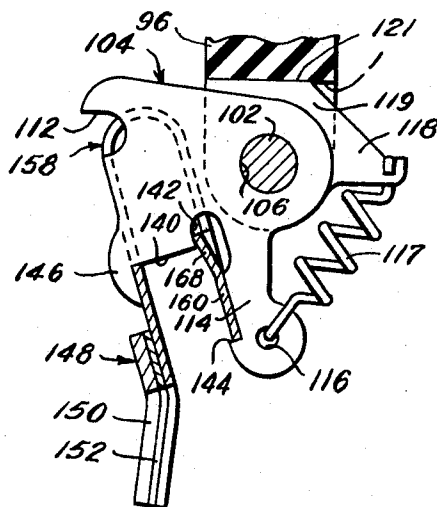
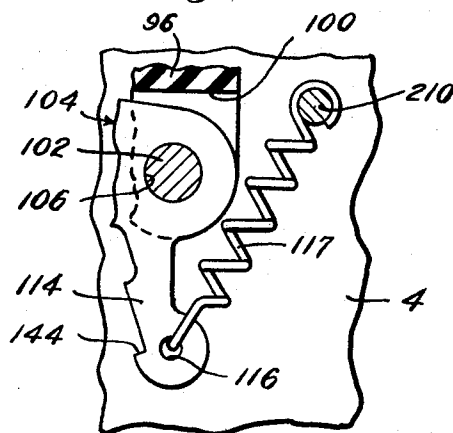


Fig. 25.



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CIRCUIT BREAKER HAVING A COMPENSATING ELEMENT WHICH COMPENSATES FOR AMBIENT TEMPERATURE WITHOUT DISPLACING THE CATCH ATTACHED THERETO

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10 Claims. (Cl. 200—116)

ABSTRACT OF THE DISCLOSURE

A miniature, trip-free, ambient-compensated, circuit breaker is shown to comprise a base or housing having first contact means fixedly mounted therein. A manual actuating means is mounted on the base for movement between first and second switch position and carries a first bell-crank latch rotatably mounted thereon, the latch carrying second contact means to be engaged and disengaged with the first contact means for making and breaking an electrical circuit therethrough. A first thermostatic element blade is pivotably mounted within the base or housing so that the opposite end of the blade is free for movement and an elongated catch member is attached at one end to said thermostatic blade adjacent the pivoting end thereof, the catch member having its opposite end disposed to normally engage the first latch during movement of the actuating means into the second switch position for rotating the first latch to engage the second contact means with the first contact means to close a circuit. A second latch holds the actuating means in said second position when the first latch is engaged with the catch, the second latch being releasable by manual movement of the actuating means for permitting the actuating means to move to the first switch position to disengage the first and second contact and to open the switch circuit. Current-responsive means interposed within the switch circuit are mounted for movement on the base in response to selected current in the switch circuit and motion transfer means extend between the current responsive means and said thermostatic blade to move the catch out of engagement with the first latch in response to selected current in the switch circuit for permitting the actuating means to move to the first switch position to open the switch circuit.

This invention relates to a new and improved circuit breaker, and more particularly to a new and improved circuit breaker of the thermostatic type for applications in which it is desired to interrupt an electrical circuit under predetermined conditions.

In circuit breakers, desired features are: the contacts are to open with a snap action the circuit breaker, if thermostatically trippable, is ambient compensated; the device will indicate visually that it has tripped; calibration of the device is readily made; the circuit breaker can be manually actuated as a switch; and the device is trip-free. (By the expression "trip-free" is meant a device which will open its contacts upon response to overload current passing through it, even though the manually actuable resetting means is held in the contact-closed position.) In addition to the above, it is also desirable to have a circuit breaker which is small in size and weight, is relatively economical to manufacture, and as to which it is possible to construct most of the operating features of the device outside the casing which holds the same, this assembly then to be inserted in the casing as a final step prior to calibration of the device.

It is readily understandable that to provide all of the above features of a circuit breaker in a small device is

relatively difficult, and it is therefore the basic purpose of this invention to do so.

Among the several objects of the invention, therefore, may be noted the provision of a new and improved snapping circuit breaker for the protection of electrical circuits and components against transients, sustained overloads and short circuits; the provision of a circuit breaker of the class described which is trip-free; the provision of a thermostatic circuit breaker which is ambient compensated; the provision of a circuit breaker which may be assembled as to many of its construction features outside the casing prior to final assembly and calibration, thus leading to economy and ease of assembly; the provision of a circuit breaker of the classes described which indicates that the circuit breaker has automatically tripped; the provision of a circuit breaker which can be used as a manually operated switch without deleterious effects on its function of responding properly to overloads; the provision of a circuit breaker which is small and light-weight; and finally the provision of a circuit breaker which is economical to manufacture and readily adapted to mass production means.

Other objects will be in part apparent and in part pointed out hereinafter.

The invention accordingly comprises the elements and combinations of elements, features of construction and arrangements of parts which will be exemplified in the structures hereinafter described and the scope of the application of which will be indicated in the appended claims.

In the accompanying drawings in which several of the various possible embodiments of the invention are illustrated:

FIG. 1 is an elevation, in section, of one embodiment of the invention;

FIG. 2 is a side elevation, in section, of the FIG. 1 embodiment;

FIG. 3 is a sectional view of FIG. 1, taken in the direction of sight lines 3—3 thereon;

FIG. 4 is a fragmentary section of a portion of the FIG. 1 embodiment;

FIG. 5 is a view corresponding to FIG. 1 but showing the device with its contacts open;

FIG. 6 is a view similar to FIG. 1, but showing an intermediate position of the operative parts;

FIG. 7 is a fragmentary sectional view of FIG. 6 taken in the direction of sight lines 7—7 thereon;

FIG. 8 is a sectional fragmentary view of a portion of the FIG. 1 embodiment, taken in the direction of sight lines 8—8 on FIG. 6;

FIG. 9 is a plan view of one element of the FIG. 1 embodiment;

FIG. 10 is a sectional elevation of the FIG. 9 element, taken in the direction of sight lines 10—10 thereon;

FIG. 11 is a side view of a terminal and contact structure of the FIG. 1 embodiment;

FIG. 12 is a plan view of the FIG. 11 terminal and contact structure;

FIG. 13 is an elevation of a combined mounting and adjusting bracket element of the FIG. 1 embodiment;

FIG. 14 is an end view of the FIG. 13 element;

FIG. 15 is a cross section of the FIG. 13 element, taken in the direction of sight lines 15—15 on FIG. 13;

FIG. 16 is an end view of an assembly of the FIG. 13 element, a stationary terminal, a thermostatic element, and a stationary contact, all as used in the FIG. 1 embodiment;

FIG. 17 is an elevation of the FIG. 16 assembly;

FIG. 18 is a cross section of the FIGS. 16—17 assembly, taken in the direction of sight lines 18—18 on FIG. 17;

FIG. 19 is an elevation of an assembly of a movable

contact and supporting contact arm of the FIG. 1 embodiment;

FIG. 20 is a side elevation of the FIG. 19 embodiment;

FIG. 21 is a sectional view of the FIG. 19 assembly, taken in the direction of sight lines 21—21 thereon;

FIG. 22 is a perspective view of a bell-crank element of the FIG. 1 embodiment;

FIG. 23 is a perspective view of another element of the FIG. 1 embodiment;

FIG. 24 is a fragmentary section of an assembly (incorporating the elements of FIGS. 21—23) used in the FIG. 1 embodiment; and

FIG. 25 is a fragmentary section of a device similar to FIG. 1 in many respects, but showing the details of another embodiment of the invention.

The dimensions of certain of the parts as shown in the drawings may have been modified and/or exaggerated for the purpose of clarity of illustration.

Referring now to the drawings, and more particularly to FIGS. 1 and 2, one embodiment of this invention takes the form of thermostatic circuit breaker generally indicated by reference numeral 2, and includes a housing or casing 4 which may be made of any suitable molded resin which is insulating and durable. Also, the resin should be arc-resistant, and an example thereof may be a phenolic resinous material. At one end of the casing suitable slots 6 and 8 are provided for receiving the fixedly mounted terminal structures 10 and 12. As shown, terminals 10 and 12 are of the screw-type, but if desired they may be of clinch-type, or solder-type.

For ease of assembly of the circuit breaker into a complete device, the casing 4 is made of two "clamshells" 14 and 16. In this construction, one-half of slots 6 and 8 each is molded in the respective clam shell, these slots matching when the clamshells are put together. When the clam shells are put together in final assembly they are held together by screws or rivets passing through the properly provided holes 18 which have previously been molded in the respective clam-shells and which match when the clam shells are assembled.

At the end of the clam-shells remote from the end of the slots 6 and 8, there is provided an inwardly projecting molded shoulder 20. Shoulder 20 is received by recess 22 extending around the outer periphery of the neck structure 24 to hold neck 24 securely to the casing, the peripheral recess 22 providing the engaging oppositely-disposed shoulders 26 and 28 for this purpose.

It will be noted that in order to keep the neck 24 from turning in the casing, as mounted, the oppositely-disposed flat portions 30 and 32 are provided on shoulder 26, and a suitably molded recess 34 is provided in the ends of the clam-shells which provides a matching depression to receive the thus-shaped shoulder 26. Neck 24 is made of suitable metal such as steel.

Neck 24 comprises the mounting for a plunger assembly and mechanical latch which will now be described, and which is one of the features of the invention.

Neck 24 is provided with a bore 36 at the outer end thereof, and bore 36 communicates with bore 38 of larger diameter at the inner end thereof. Bores 36 and 38 are co-axial, and received in these bores is the composite plunger indicated generally by numeral 40 and comprising a push-button or head 42 and a cylindrical sleeve 44. Head 42 may be made of electrically insulating molded resin and is provided with the co-axial bores 46, 48, 50, and 52. Sleeve 44 has one end 54 reduced in diameter, as shown, which end fits into bore 52. A screw 56 passes through bore 50 and into threaded engagement with a bore 58 provided in end 54 to fasten head 42 to sleeve 44. A cover cap 60 may thereafter be press-fitted into bore 46 in order to prevent tampering with the screw 56.

In order to be sure of proper clearance for the push button 42 in the bore 36, the end 62 of button 42 is slightly reduced in diameter as shown.

As indicated above, sleeve 44 is preferably made of steel, and in order to prevent its turning in the neck 24,

a keyway 66 is milled in its outer surface, which keyway is adapted to receive the key 64 which is provided as shown in the neck 24. In this instance, the key 64 has been provided by milling a slot at the outer end of the neck 24 in order to reduce the wall thickness of a portion of the neck, and then the key 64 is formed by an upsetting operation so as to project inwardly into the keyway 66.

The inner end of sleeve 44 is provided with a peripheral shoulder 68 as shown to act as a bearing for a compression spring 70. Spring 70 is the button-return spring, and its other end has for its bearing a cup-shaped washer 72 which is mounted by a suitable upsetting or staking operation at the end of sleeve 44. Washer 72 has a hole 74 through it, as shown, of suitable diameter to receive freely a latch-plunger 86 and certain associated parts which will now be described.

Sleeve 44 is provided for a portion of its length with the bore 76. Located diametrically opposite each other are the two holes 78 and 80 in the wall of sleeve 44 each hole being adapted to receive slidable the respective ball bearings 82 and 84.

Slidably received in bore 76 is the latch plunger 86 which is likewise made of steel and preferably hardened. The middle portion of latch plunger 86 is fashioned as shown in the form of a pair of coaxial cones whose apices are joined. The size of plunger 86, the inward depth of the cones, the size of the holes 78 and 80 and the aforementioned ball bearings 82 and 84 are all so related that when the restraining force upward on the latch plunger is relieved, as will be described later, the ball bearings 82 and 84 are permitted to move toward each other a sufficient distance for the ball bearings to clear the shoulder 92 formed at the juncture of bores 36 and 38.

At the inner end of plunger 86, there is provided the threaded stub 94 which is suitably threaded into a connecting link 96 which is made of a molded, tough resin such as a phenolic resin or, for example, nylon. A hole 98 (see FIG. 4) is provided through the end of connecting link 96, and a suitably dimensioned slot 100 is also provided at this same end to form a clevis or yoke. If desired, the stub 94 may be in the form of a headed extension, and the connecting link 96 may thereafter be molded about the thus-formed stub for secure engagement to latch plunger 86.

It will be thus seen that with the above construction of the neck 24, sleeve 44, latch plunger 86, and the ball bearings 82 and 84, one of the features of the invention is provided; namely, that a complete mechanical latch is now positioned in the neck 24, and by thus utilizing hitherto unused space, miniaturization of the whole circuit breaker is furthered. With the assembly thus described in the position shown in FIG. 1, then if the push button 42 and the end of the connecting link 96 are squeezed together, the plunger assembly 40 is held relatively immovable in the neck 24 because of the latching engagement of the balls 82 and 84 with the shoulder 92. However, if this pressure is released, and the plunger 86 is moved downwardly (as drawn), the balls 82 and 84 are permitted to move toward each other in the recess provided by the inverted cones 88 and 90 to clear the shoulder 92. This in turn permits the whole plunger 40 assembly to move upwardly (as drawn) in the neck 24 to perform certain contact-opening operations.

Rotatably mounted in slot 100 by means of a transversely extending pin 102 is the bell crank or latch 104, the bell crank being provided with a suitable hole 106 for this purpose. Pin 102 passes through the hole 98, and for guiding purposes, the ends of pin 102 slide in slots 108 and 110 suitably molded in the walls of the clam shells 14 and 16.

Bell crank or latch 104 is provided with a laterally extending latch part 112 and, in angular relationship to latch part 112, an extending leg 114 which is provided with a suitable hole 116 for engaging one end of the tension spring 117, the other end of spring 117 being

attached to an extending finger 118 of anchor plate 119. Plate 119 is held in slot 100 by means of the aforesaid pin 102 which passes through a hole 120 in plate 119. The latter has provided thereon a flat side 121 which is so positioned with respect to hole 120, that when the plate is held in the slot 100 by the pin, side 121 abuts the end of the slot so that plate 119 cannot rotate about pin 102. Thus in effect, plate 119 is a means for attaching the stationary end of spring 118 to the connecting link 96 for biasing the bell crank 104 counterclockwise about pin 102.

Referring now to FIGS. 9 and 10, there is shown a composite catch the purpose of which is to releasably engage the latch part 112 on bell-crank 104, and act as an ambient compensation means for the thermostatically operating portion of the circuit breaker.

The aforesaid combined catch and ambient compensation structure comprises three parts; namely, the compensation element 122, the catch proper 124, and the leaf spring 126. Element 122 is made of thermostat metal, is U-shaped, and has the legs 128 and 130. The catch 124 is T-shaped, as shown, having at one end the cross-bar 132. The ends of the legs 128 and 130 are welded or otherwise tightly fastened to the cross-bar 132 as shown. Leaf spring 126 is welded or otherwise securely fastened to the top of the catch 124, and projects somewhat above the end of the catch, as shown at numeral 134. Portion 134 acts as a back-stop for the latch part 112 of the bell crank to keep part 112 from over-riding the catch.

In view of the fact that the bimetal compensating element 122 is fastened to the catch 124 only at the ends of the legs 128 and 130, it will be seen that if the element 122 is heated, it can bend or curve by itself without affecting the position of the catch 124. That is, catch 124 will not move when element 122 bends under the influence of a temperature change. As shown, the high expansion layer of the element 122 is to the right as drawn, and the low expansion layer is to the left. Thus, when the element 122 is heated by the surrounding ambient it will flex or bend to the left, as drawn.

The bimetal compensating element 122, together with its associated catch 124 and biasing spring 126, is pivotally mounted by its end in a pair of slots or recesses 136 and 138 molded in the walls of the clam-shells 14 and 16. Into these are pivotally fitted the respective ends of the cross-bar 132. As so mounted, the spring 126 bears against the side wall of the casing, and therefore biases the compensating element 122 clockwise, as drawn, about its pivot point in the recesses 136 and 138.

Turning now to FIGS. 19-24, there is shown in detail the bell crank 104 and its assembly with a movable contact structure. The bell crank is provided with the contact leaf-spring receiving and holding recesses and shoulders 140, 142, and 144. A retaining hook portion 146 is provided at the outer periphery of the bell crank.

The movable contact 148 is bifurcated and in this instance, is made of bilayer material, the front surface 150 being of electrical contact material such as silver, and the backing layer 152 being of a material such as steel or nickel which is adapted to be readily welded to the leaf spring 158. As indicated, contact 148 is bifurcated to provide the legs 154 and 156 for the purpose of making contact 148 a bridging type contact. Spring 158 in this instance is shown as a leaf spring having a return-bent portion 160. One end of spring 158 is bifurcated to provide legs which match the legs 154 and 156 of the movable contact 148. The bight portion of spring 158 is also bifurcated as shown at numeral 162 to provide greater flexibility of the spring, and to provide clearance for inserting the spring in the ball crank 104.

Two notches 164 and 166 are also provided in the spring, notch 164 being in the forepart of the spring and notch 166 being in the return-bent portion. At the lower end of notch 166, the material of return-bent portion 160 is formed inwardly to provide a projection 168 to assist in holding the spring in the bell crank 104.

In order to assemble the combination of the spring 158 and bell crank 104, the ends of the spring are held together sufficient to slide the bell crank into the bifurcation at 162 and into the notches 164 and 166. In this position, these notches straddle the body portion of the bell crank 104 to prevent too much lateral play. The insertion is done far enough so that when the ends of the spring are released, the free end of the return bent portion 160 is engaged in the shoulder 144, and the protrusion 168 comes to bear against one surface of the recess 142, all as shown. In this position, the hook portion 146 of the bell crank acts as a stop to prevent forward movement of the spring 158, and the combination of hook 146, the protrusion 168, and the shoulder 144 serve to lock the spring and its movable contacts securely in place in the bell crank 104.

Turning now to FIG. 1, there is shown stationary contacts 170 and 172 mounted in the base of the circuit breaker in fixed position. Contact 170 is mounted on an extension of the terminal 10 by a suitable fastening means such as welding, or soldering, the complete structure being held in the casing by means of slots 6. Contact 172 is likewise mounted on a support 174, being fastened thereto by welding or soldering or other conventional means. Support means 174 is made of metal and is held in the casing by means of a slot provided by the end wall of the base and an interiorly positioned molded partition 176, the partition and the end of the casing also providing an interior channel adapted to receive an electrically connecting lead or strap 178. Connecting strap 178 is electrically attached at one end to the support 174 and at its other end is electrically attached to the end of leg 182 of the thermostatic bimetal actuator 180. Contacts 170 and 172 are thus separate, and are adapted to be bridged by the bridging movable contact 148 when contact 148 is in engagement therewith.

Referring now to FIGS. 13-17, a U-shaped thermostatic metal actuator 180 is provided having the legs 182 and 184. The free ends of legs 182 and 184 are connected, in a manner now to be described, to a channel-shaped supporting member 186. In order to lessen the rigidity of the channel member for purposes of calibration of the thermostatic bimetal actuator 180, a bottom of the channel member is slotted as shown in order to have one wall 188 of the channel supported from the other wall 190 thereof by only the center connecting strap or web 192. A tapped hole 194 is provided in wall 190, and an adjusting screw 196 is suitably provided therein and extends to abut wall 188 for the purpose of spreading the walls of the channel for calibration purposes.

Affixed to one end of the channel is a bent over portion of the end of leg 182 of thermostat actuator 180. The end of leg 182 is electrically insulated from the channel 186 by means of conventional insulation and insulating washers 195, 197, and 198. Insulating material 197 extends far enough up the leg 182 to lie between the leg and wall 188, thus preventing electrical contact between leg 182 and the channel at this point. Instead of continuing material 197 up the leg, a separate piece of insulating material may be used, if desired.

Also fastened to this end of the channel is one end of the connecting strap 178, and it will be noted that this end of strap 178 makes electrical connection with the bent over end of leg 182. These several parts are fastened together by conventional means such as the rivet 200.

A bent over portion of the free end of leg 184 is fastened directly to the other end of channel 188 by means of welding (as shown) or, if desired, by riveting. This end of the thermostat actuator 180 is therefore in electrical connection with channel 186. As drawn, the high expansion side of actuator 180 lies on the right and the low expansion side on the left.

By the above construction, it will be seen that by turning the adjusting screw 196 inwardly or outwardly, the walls 188 and 190 of the channel are spread apart or permitted to approach each other, and this motion of the wall

188 has the effect of causing the thermostat actuator 180 to move toward or away from the bimetal compensating element 122.

Channel 186 is mounted by the web 192 to one end of the stationary terminal 12 which in turn is securely mounted in a slot 8 in the ends of the clam shells 14 and 16 provided for that purpose. Terminal 12 may be attached to the center web 192 by welding or riveting, and is in electrical connection therewith.

Provided in each of the opposing face walls of the clam shells 14 and 16 are a pair of slots 202. Slots 202 receive in slidable relation the edges of slide member 204. Slide 204 is a generally rectangularly shaped piece of molded electrically insulating material, such as a phenolic resin, and its purpose is to transmit motion from the thermostat actuator 180 to the compensating element 122, and thus to the catch 124. Slide 204 is provided with a suitably shaped and dimensioned hole 206 through which is adapted to pass freely the connecting link 96 and its associated bell crank and movable contact.

It will be noted that with the above construction, electrical current passes through the circuit breaker via the path of terminal 12, channel 186, leg 184, connecting strap 178, support 174, electrical contact 172, bridging contact 148, electrical contact 170, and terminal 10. It will be noted also that the ambient compensating element 122 does not receive electrical current, and therefore derives its temperature change (if any) because of the temperature of the ambient air surrounding it or by radiation from the casing itself, or conduction from heated portions of the casing.

In assembling the various parts of the device, the feature of having the bell crank spring 117 fastened to the latch plunger 86 will now become apparent. By doing this, many of the various elements of the device may be assembled outside the casing as a unitized structure. That is, the push button 42, sleeve 44, latch plunger 86, balls 82 and 84, neck 24, spring 70, connecting link 96, bell crank 104 with its associated spring 158 and movable contact 148, and tension spring 118 may be so assembled. Slide 204 is also put in place on this assembly. In one-half of the casing (for example, clam shell 16) can then be placed stationary terminal 10 and its contact 170. In the other clam shell 14, can be put the other stationary contact 172 and its supporting structure 174, the stationary terminal 12, the channel member 186, and the thermostat actuator 180. The above associated unitized structure (on which has now been put slide 204) can then be put in place in such a position that the latch 112 engages the catch 124, and then the other clam shell 16 (for example) is fitted into proper enlignment. The two clam shells are thereafter fastened together to hold the assembly in place.

The operation of the device will now be described.

The position of the parts shown in FIG. 1 was arrived at by pushing the plunger 40 inwardly into the casing. When this is done, the latch 112 is caught by the catch 124 and bell crank 104 will rotate clockwise under the influence of the pin 102 and against the pull of the tension spring 118 to bring the movable contact 148 into engagement in bridging fashion with stationary contacts 170 and 172.

Upon inward motion of the plunger 40, the balls 82 and 84 are pushed outwardly by the lower cone 90 (as drawn) beyond the shoulder 92, and compression spring 70 is compressed. When the plunger is now released, the cone 90 acts against the balls to maintain them in latching engagement with shoulder 92. The latch plunger 86 is maintained in an outwardly biased position because of the force against the pin 102 of the leaf spring 158 and spring 117, this force fulcruming on the latch 112 and end of catch 124. If an overload current now flows through the circuit breaker, thermostatic actuator 180 will heat because of the current through it, and will bend to the left. As it bends to the left, it will thrust upon slide

204 and thus the motion of the thermostat actuator 180 will be transferred by slide 204 to the bimetal compensating lever 122. Motion of the thermostat element 180 will thus move lever 122 to the left carrying the catch 124 with it until the latch 112 escapes the catch. (See FIG. 6.) With the loss of the fulcrum for the aforesaid reactive force (caused by the escape of latch 112 from the catch 124) the reactive force on the latch plunger 86 ceases, thus relieving the radially outward force on balls 82 and 84. The sloping engagement of the shoulder 92 on the curved surfaces of the balls 82 and 84 will cause the balls to move inwardly until they clear the shoulder 92, and then the complete plunger assembly 40 will move upwardly of the casing under the bias of spring 70, carrying the pin 102 with it. The upward motion of pin 102 (as drawn) together with the pull of the tension spring 118 will rotate bell crank counter-clockwise about pin 102 to pull movable contact 148 away from stationary contacts 170 and 172, thus breaking the electrical circuit through the circuit breaker.

FIG. 6 shows the parts in the intermediate position just after unlatching because of current flow through the thermostat actuator 180. It will be noted that the latch 112 has become disengaged from its catch 124, and that the spring 118 has thus had an opportunity to disengage immediately the bridging contact 148 from the stationary contacts 170 and 172. The balls 82 and 84 have disengaged from the shoulder 92, and the latch plunger has commenced its upward motion, as has also the sleeve 44.

Referring to FIG. 5, the parts are shown in the complete contacts-open position. In this position, it will be noted that the parts have moved upwardly, and that because of this upward movement, the bell crank is so positioned that the catch 124 and its latch 112 are now in position for engagement if the push button is shoved inwardly to close the contacts again. Shoving the push button 42 inwardly will cause the parts to return to the FIG. 1 position with the contacts closed. Of course, the latch 112 will not engage the catch 124 unless the thermostat actuator 180 has cooled down sufficiently to permit the slide 204 to move to the right enough to permit the biasing spring 126 to move the thermostat bimetal compensator 122 and the catch 124 also to the right.

That the device is trip-free will be seen by the following explanation: if the plunger 40 is held inwardly of the casing by externally applied force, and the thermostat actuator 180 moves to the left (as drawn) to move the ambient compensating lever 122 to the left and thus free latch 112 from catch 124, then, even though pin 102 is held stationary, the tension spring 118 will act on the leg 114 of the bell crank in order to rotate the bell crank counter-clockwise to pull movable contact 148 from the stationary contacts 170 and 172.

In the event that the circuit breaker is exposed to a higher ambient temperature than that at which it originally was calibrated, ambient compensation takes place as follows: as has been described above, the ambient compensating element 122 is made of thermostat metal, and its high expansion side is to the right as drawn and its low expansion side is to the left. Upon heating due to the change in ambient temperature, the end of the bimetal compensating element will move to the left approximately the same distance that the end of the thermostat actuator 180 moves to the left under the influence of the same ambient temperature, and thus the relative spacing between these two respective ends will remain constant. This means that in order to trip at a given electrical current, the end of thermostatic actuator 180 must always move the same distance in order to move the bimetal compensating lever 122 a sufficient distance to trip the latch 112 from catch 124.

It is to be noted that the end of the compensating lever 122 can move under the influence of ambient temperature without substantially affecting the position of catch

124. Thus, the invention has the feature that the ambient compensating element is combined with the latch, but can move for compensation without affecting the position of the catch in respect to the latch.

If desired, an arc shield 208 may be suitably provided between electrical contacts 170 and 172 and suitable other partitions may be provided to form arc chambers for the contacts.

Referring now to FIG. 25, there is shown a fragmentary section of a device similar to the FIG. 1 embodiment in all respects except that the stationary end of the spring 118 is, in this embodiment, fastened to a stationary support 210. Support 210 may constitute a pin extending across the interior of the casing, the ends of the pin being held in recesses suitably inserted in the inside walls of the casing. With this construction, it will be noted that the assembly of the plunger, the ball latch, the bell crank latch, the terminals, slide, thermostat actuating element, and compensating element can be placed in one of the clam shells, and then the spring 118 can be hooked over the end 210. In order to help on this it would be advantageous to make one of the recesses in the side wall a snug fit for one end of the pin so that the pin would be held erectly in alignment with the mating recess of the other clam shell when the latter is applied to contain the parts. As indicated above, the FIG. 1 embodiment is the preferred embodiment because of its ease of assembly; however, the embodiment of FIG. 25 can be used when desired.

In view of the above, it will be seen that the several objects of the instant invention are achieved and other unique and advantageous results attained.

As many changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings, shall be interpreted as illustrative and not in a limiting sense, and it is also intended that the appended claims shall cover all such equivalent variations as come within the true spirit and scope of the invention.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. A switching device comprising a casing; a plunger mounted on said casing and movable into and out of said casing; at least one first contact mounted on said casing; a first thermostatic element mounted in said casing and having one end free for movement; a second thermostatic element mounted in said casing and having one end free for movement; slide means between the free ends of said first and second thermostatic elements, said slide means being adapted to transfer motion from the free end of said first thermostatic element to the free end of said second thermostatic element; a catch attached to said second thermostatic element and movable therewith upon movement thereof by said first thermostatic element; a first latch rotatably mounted at one end of said plunger and adapted to cooperate with said catch; a movable contact carried by said first latch and movable thereby to engage and disengage said first contact to make and break an electrical circuit therethrough upon movement of said first latch; a second latch engaging said plunger releasably to hold said plunger in position with said first and movable contacts closed, said second latch being releasable to permit motion of said plunger toward a contact-open position when said first latch is released from said catch; and a portion of said second thermostatic element being movable under the influence of a change in ambient temperature without disengaging said first latch and said catch.

2. The switching device of claim 1 in which said first latch is a bell-crank one extremity thereof being adapted to engage said catch, and another extremity of which is engaged by spring means resiliently and rotatively

biasing said crank about its pivot, and in which said movable contact is resiliently mounted on said bell-crank.

3. The switching device of claim 1 in which said second thermostatic element is a blade pivotally mounted at one end thereof in said casing with the other end thereof being engageable by said slide; and said catch is an elongated metal member attached at one end to said blade adjacent the pivoting end of the latter with the remaining length of said member being free of said blade and having its free end positioned between the ends of said blade, whereby said blade can bend under the influence of heat without moving the free end of said catch.

4. A switching device comprising a casing; manually actuable means mounted on said casing and movable with respect thereto; at least one first contact mounted on said casing; condition-responsive means mounted in said casing and having at least a portion thereof free for movement; a thermostatic element blade pivotally mounted at one end thereof in said casing with the other end thereof being free for movement; motion transfer means operatively coupling the movable portion of said first condition-responsive means and the movable end of said thermostatic blade; a catch operatively associated with said thermostatic blade and moveable thereby upon movement of said first condition-responsive means; said catch embodying an elongated metal member attached at one end thereof to said thermostatic blade adjacent the pivoting end of the latter but the remaining length of said member being free of said blade and having its free end positioned between the ends of said blade so that said blade can bend under the influence of heat without moving the free end of said catch; a first latch operatively connected to said manually actuable means and adapted to cooperate with said catch; at least one movable contact operable by said latch and adapted to engage and disengage said first contact to make and break an electrical circuit therethrough upon movement of said latch; a second latch engaging said manually actuable means releasably to hold the latter means in position with said first and movable contacts closed; said second latch being releasable to permit motion of said manually actuable means toward a contacts-open position when said first latch is released from said catch; said movable end of said thermostatic blade being movable in the same direction as the movable portion of said first condition-responsive means under the influence of a change in condition of both of said first condition-responsive means and said thermostatic blade without disengaging said first latch and said catch.

5. A switching device comprising a casing; manually actuable means mounted on said casing and movable with respect thereto; at least one first contact mounted in said casing; a first condition-responsive means mounted in said casing and having at least a portion thereof free for movement; a second condition-responsive means mounted in said casing and having at least a portion thereof free for movement; coupling means between the free portions of said first and second condition-responsive means for transferring motion from the free portion of one of said condition-responsive means to the free portion of the other of said condition-responsive means; a catch connected to said second condition-responsive means and movable therewith upon movement thereof by said first condition-responsive means; a bell-crank latch rotatably mounted on said manually actuable means and adapted to cooperate with said catch; at least one movable contact resiliently mounted on said bell-crank for movement thereby to engage and disengage said first contact to make and break an electrical circuit therethrough upon turning movement of said bell-crank latch; a ball-clutch latch engaging said manually actuable means releasably to hold said latter means in position with said stationary and movable contacts closed, said ball-clutch latch detaining said manually operable means from automatic release while force is exerted on said clutch but automatically releasing said

manually actuatable means when said force is relieved by disengagement of said catch from said latch; and a second portion of said second condition-responsive means being movable under the influence of a change in ambient temperature without disengaging said bell-crank latch in said catch.

6. A switching device comprising a base, first contact means mounted on said base, manual actuating means mounted on said base for movement between first and second switch positions, means biasing said actuating means to said first switch position, a first latch rotatably mounted on said actuating means for movement therewith between said first and second switch positions, second contact means carried by said first latch, a catch movably mounted on said base to normally engage said first latch during movement of said actuating means into said second switch position for rotating said first latch to engage said second contact means with said first contact means, a second latch holding said actuating means in said second position when said first latch is engaged with said catch, said second latch being releasable by manual movement of said actuating means for permitting said actuating means to move to said first switch position to disengage said first and second contact means, and current-responsive means mounted for movement on said base to move said catch out of engagement with said first latch for permitting said actuating means to move to said first switch position to disengage said first and second contact means.

7. A switching device comprising a base, first contact means mounted on said base, manual actuating means mounted on said base for movement between first and second switch positions, means biasing said actuating means to said first position, a first latch rotatably mounted on said actuating means for movement therewith between said first and second switch positions, second contact means carried by said first latch, a thermostatic element blade pivotably mounted at one end on said base and having its opposite end free for movement, an elongated catch member attached at one end to said thermostatic blade adjacent the pivoting end of said blade and having its opposite end positioned to normally engage said first latch during movement of said actuating means into said second switch position for rotating said first latch to engage said second contact means with said first contact means to close a circuit, means biasing said front latch to disengage said first and second contact means when said first latch is disengaged from said catch, a second latch holding said actuating means in said second switch position when said first latch is engaged with said catch, said second latch being releasable by manual movement of said actuating means for permitting said actuating means to move to said first switch position to disengage said first and second contacts to open said circuit, current-responsive means interposed in said circuit and mounted for movement on said base in response to selected current in said circuit, and motion transfer means between said current-responsive means and said free end of said thermostatic blade to move said catch out of engagement with said first latch in response to said selected current in said circuit for permitting said actuating means to move to said first switch position to disengage said first and second contact.

8. A trip-free, ambient-compensated, switching device adapted for miniaturization comprising a base housing forming a generally rectangular housing chamber, first contact means mounted in said housing chamber at one

end thereof, manual actuating means mounted at an opposite end of said housing chamber for movement between first and second switch positions, means biasing said actuating means to said first switch position, a first latch rotatably mounted on said actuating means within said chamber for movement with said actuating means between said first and said second switch positions, second contact means carried by said first latch, a thermostatic element blade having one end pivotably mounted within said housing adjacent said one end of said housing, said blade extending along one side of said housing chamber and having its opposite end free for movement, an elongated catch member attached at one end to said thermostatic blade adjacent the pivoting end of said blade and having its opposite end positioned to normally engage said first latch during movement of said actuating means into said second switch position for rotating said first latch to engage said second contact means with said first contact to close a circuit, means biasing said first latch for rotation to disengage said first and second contact means when said first latch and catch are disengaged, a second latch holding said actuating means in said second switch position when said first latch is engaged with said catch, said second latch being releasable by manual movement of said actuating means for permitting said actuating means to move to said first switch position to disengage said first and second contact to open said circuit, a second thermostatic element blade having one end mounted within said housing adjacent said one end of said housing, said blade extending along the opposite side of said housing and having its opposite end free for movement, said second blade being interposed within said circuit for movement in response to selected current in said circuit, and motion-transfer means extending across said opposite end of said housing chamber between said free ends of said thermostatic element blade for movement with said blades independent of said catch in response to change in ambient temperature, said motion transfer means moving said catch out of engagement with said first latch with movement of said second thermostatic element blade in response to said selected current in said circuit for permitting said actuating means to move to said first switch position to disengage said first and second contact means to open said circuit.

9. A switching device as set forth in claim 8 having a hollow, generally cylindrical neck attached to said housing at said opposite end thereof for mounting said housing, said second latch being enclosed within said mounting neck.

10. A switching device as set forth in claim 8 wherein said motion transfer means comprises a slide apertured to permit movement of said actuating means therethrough.

References Cited

UNITED STATES PATENTS

2,666,828	6/1954	Dyer et al.	200—116
2,318,279	5/1943	Aschwanden	200—116.1
2,908,786	10/1959	Schleicher	200—116.1
3,142,732	7/1964	Clarke et al.	200—116.1

FOREIGN PATENTS

242,726 11/1925 Great Britain.

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