Feb. 20, 1962 R. G. AREY 3,022,402

ELECTRICAL SWITCHES

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Fig. 1.

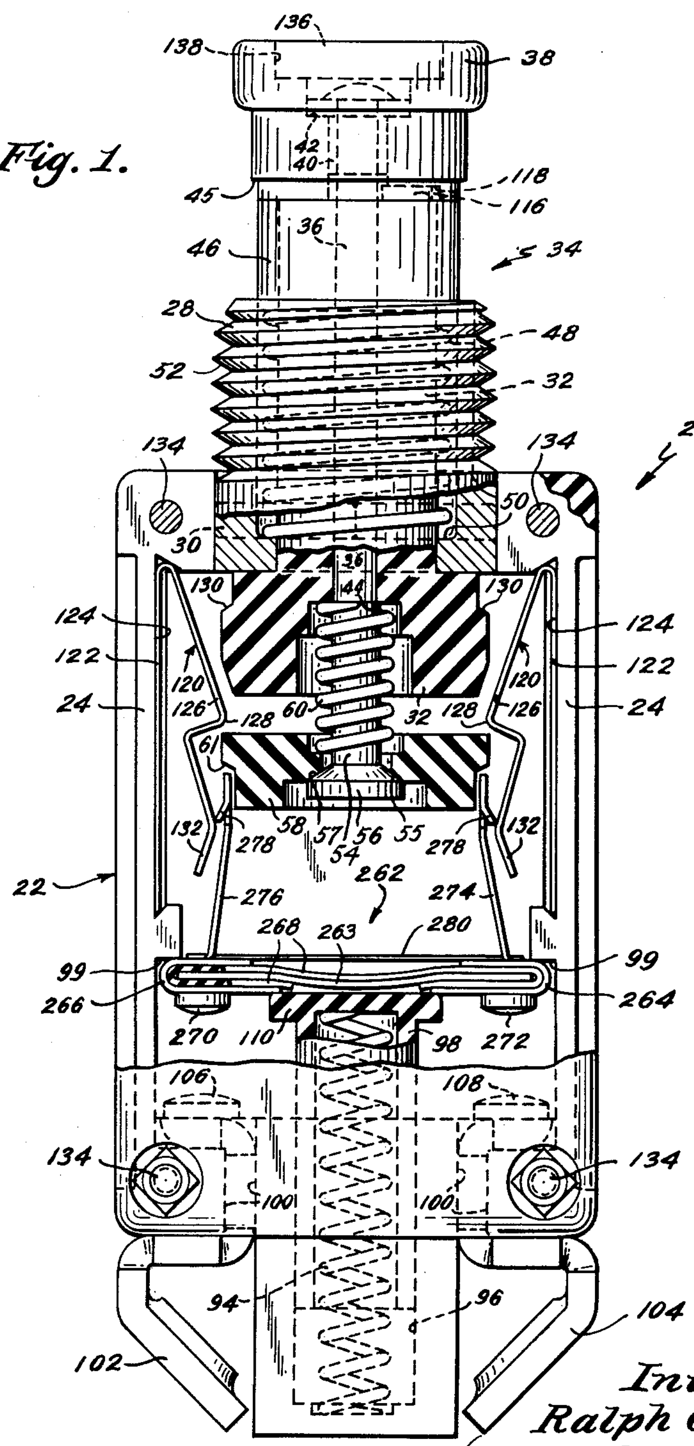

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Fig. 2.

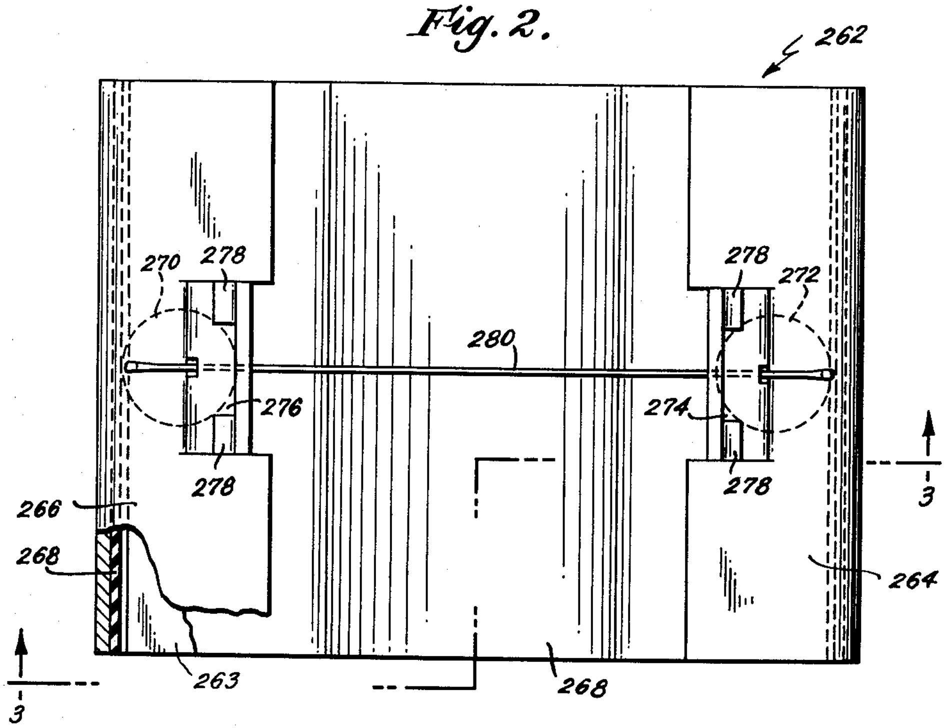

Fig. 3.

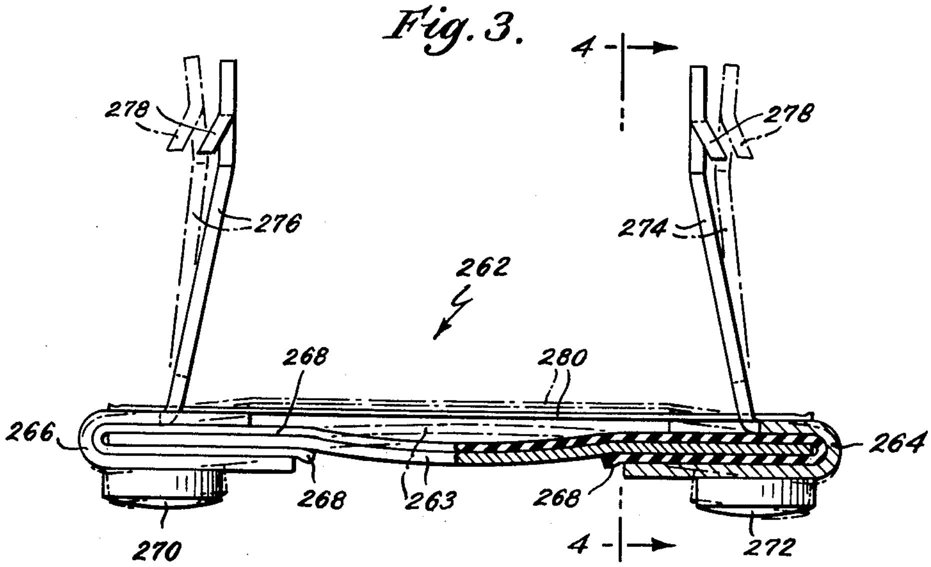

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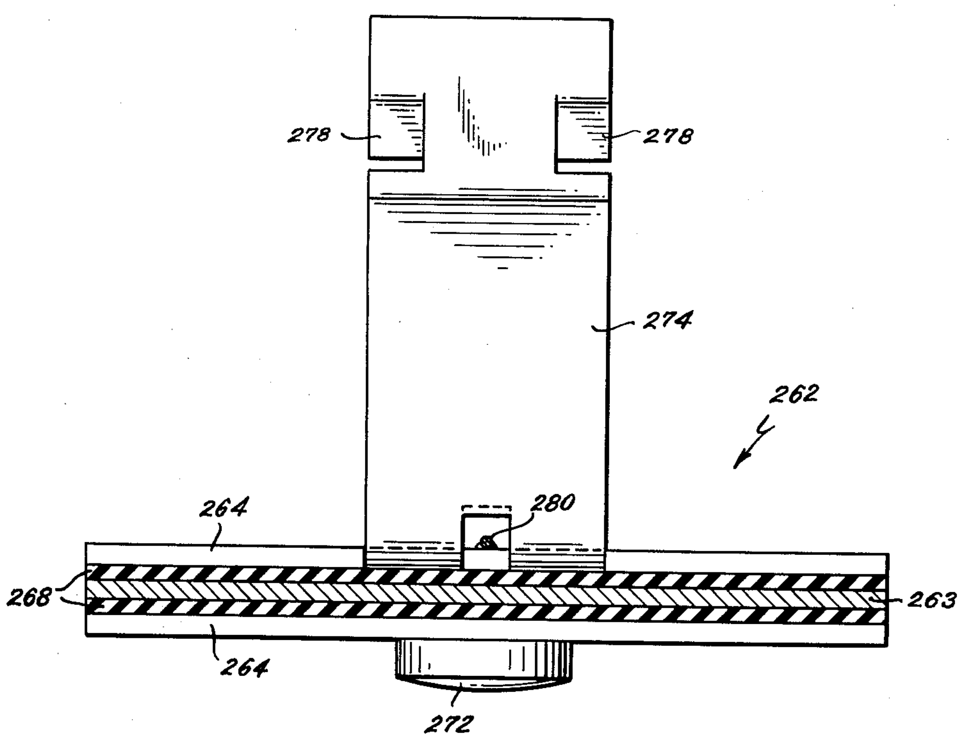
Fig. 4.



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ELECTRICAL SWITCHES

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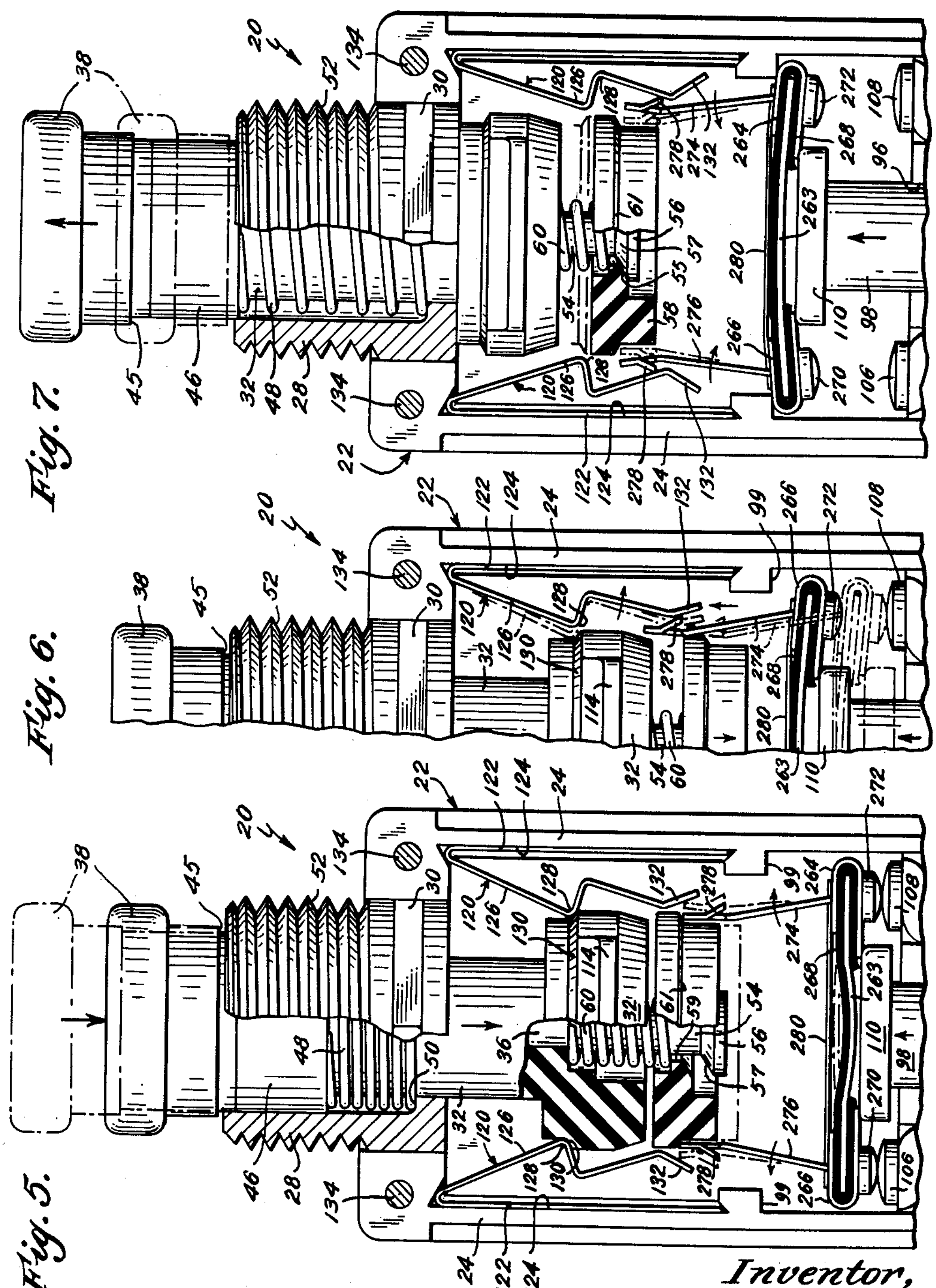

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United States Patent Office

3,022,402

Patented Feb. 20, 1962

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3,022,402

ELECTRICAL SWITCHES

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Filed Sept. 2, 1959, Ser. No. 837,754

17 Claims. (Cl. 200—116)

This invention relates to electrical switch structure, and more particularly, to thermally responsive switch structures.

An object of this invention is to provide an improved switch structure incorporating a new and improved combination of interrelated parts.

A further object is to provide such a switch structure which accommodates the use of compressive resilient biasing means for biasing operating parts thereof.

Another object is to provide such a switch structure utilizing new and improved thermally responsive means.

Another object is to provide such a switch structure utilizing a new and improved thermally responsive means which is ambient compensated.

A further object is to provide a thermally responsive switch which is also mechanically actuable repeated as an on-off switch without upsetting the calibration of the thermally responsive means thereof.

Another object of the invention is to provide such a switch structure which exhibits improved electrical contact pressure characteristics.

Among the further objects of the instant invention are the provisions of a switch which is durable, accurate, reliable in operation, compact, easily calibratable, versatile and susceptible to varying electrical ratings in diverse applications, which embodies a minimum number of parts, and which is simple in construction and economical to manufacture.

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 one of the various possible embodiments of the invention is illustrated:

FIG. 1 is a view, with parts broken away, of a thermally responsive electrical switch embodying the instant invention and showing the parts thereof in retracted contacts-open position, one part of the two-part casing being removed and certain of the parts being shown in section;

FIG. 2 is a top plan view on an enlarged scale, of the thermally responsive member of the switch;

FIG. 3 is a sectional view taken on line 3—3 of FIG. 2;

FIG. 4 is a sectional view taken on line 4—4 of FIG. 3; and

FIGS. 5, 6 and 7 are fragmentary views of a portion of the switch as shown in FIG. 1, certain of the parts being shown in full lines and in broken lines at intermediate positions during operation thereof.

Similar reference characters indicate corresponding parts throughout the several views of the drawings.

The instant application constitutes a continuation-in-part of my earlier filed copending application, Serial No. 732,550, filed May 2, 1958, now matured as U.S. Patent No. 2,912,546, issued on November 10, 1959.

Certain features of the instant application are or may be identical to those corresponding features in the above-mentioned copending application, which have the same reference numerals.

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Referring to FIG. 1, an electrical switch embodying the instant invention is shown taking the form of a circuit breaker generally indicated by the reference numeral 20. The switch includes a base or casing 22, which carries a bushing 28 having a hexagonal flange 30 mating with a correspondingly shaped recess provided by the casing 22. Mounted for slidable movement within and along bushing 28 is a member 32 forming part of the resetting means 34 of the switch. Resetting means 34 further includes a stem 36 extending through apertures provided by member 32, a push button member 38 and a flanged collar 40. The flange carried by collar 40 seats against a shoulder 42 provided by push button member 38, stem 36 is headed over against the adjacent end of collar 40, and stem 36 provides a shoulder 44 bearing against the adjacent portion of member 32 whereby the stem and members 32, 38 and 40 are fixed with respect to each other. Push button member 38 provides an annular abutment 45 engageable with the adjacent end of bushing 28 to limit downward movement of the push button as viewed in FIG. 1. An annulus or band 46 of a color contrasting with that of push button member 38 and bushing 28 is biased against the adjacent portion of push button member 38 by a compression spring 48 having one end abutting band 46 and the other end abutting an internal shoulder 50 provided by bushing 28. Bushing 28 is externally threaded at 52 for the reception of a nut or nuts (not shown) for mounting the switch on a support.

Stem 36 carried by member 32 includes an extension 54 having a flange or stop 56. Resetting means 34 further includes a member 58 having an aperture 59 through which extension 54 extends whereby member 58 is slidably mounted on the extension. Compressive resilient biasing means in the form of a compression spring 60 is disposed about the stem extension 54 and resiliently biases member 58 against stop 56 and away from member 32. Aperture 59 provided by member 58 has a substantially larger diameter than the outside diameter of stem extension 54 whereby member 58 has a loose, unconfined fit with this extension while the resetting means is in reset position, as shown in FIG. 5. Aperture 59 includes a countersink 55 engaged, under the bias of spring 60, with an interfitting beveled portion 57 provided by stop 56 when the resetting means is in the retracted position shown in FIG. 1. Resetting means 34 provides an annular abutment 61 and is movable from the position shown in FIG. 1 to the position shown in full lines in FIG. 5 to move a thermally responsive unit 262 from contacts-open to contacts-closed position as will be more fully described.

The electrical switch structure thus far described is substantially identical to that disclosed in my earlier-mentioned copending application.

The electrical switch of the instant application differs from the electrical switch disclosed in my copending application substantially only in the nature and construction of the thermally responsive unit 262 and in all other respects, is or may be substantially identical with the switch structure in my earlier-mentioned copending application.

Referring now particularly to FIGS. 2–4, thermally responsive unit 262 includes a spring member 263 which generally comprises a monometallic spring-type element. Thermally responsive unit or member 262 further includes a pair of U-shaped strips 264 and 266, each of which is formed of electrically conductive material and encloses each end of spring member 263. Each of electrically conductive U-shaped strips 264 and 266 are electrically insulated from the spring member 263 by means of a layer of electrically insulating material 268, as best seen in FIGS. 2 and 3. Insulating material 268 may be any one of a number of well-known kinds. In any case, insulating material 268 is secured to and between each of the U-shaped strips and its respective end of the spring member 263. Thermally responsive unit 262 carries a pair of contacts 270 and 272, each of which are respectively electrically connected and secured to the lower surface of U-shaped strips 266 and 264. Each of U-shaped strips 264 and 266 respectively carries an arm 274 and 276, which may be integral with the respective U-shaped strip, as shown. Each of arms 274 and 276 is provided with a pair of angularly disposed tabs 278, for a purpose later to become apparent. Spring member 263 is normally flat or bowed upwardly, as seen in the dashed line configuration in FIG. 3, and arms 276 are urged outwardly, as seen in dashed lines in FIG. 3. Spring 263 is maintained in a bowed position which is opposite to its normally bowed condition (shown in dashed lines in FIG. 3) and arms 274 are maintained inwardly, as shown in solid lines in FIG. 3, by a thermally responsive member 280. Thermally responsive element 280 is electrically connected and fixedly secured, as by welding, at each of its ends to each of electrically conductive U-shaped clips 264 and 266, as clearly shown in FIGS. 2 and 3. Thermally responsive element 280 thus carries current as a bridging member between contacts 270 and 272. Thermally responsive element 280, which is exemplarily disclosed as taking the form of a monometallic cylindrical element tensionably maintains spring 263 in the bowed condition shown in solid lines in FIG. 3 against its bias and thus also maintains arms 274 and 276 inwardly, as shown in solid lines in FIG. 3 against the bias of spring 263. Thermal element 280 is adapted to expand, upon an increase in temperature thereof, so as to permit arms 274 and 276 to move apart to the dashed line position shown in FIG. 3 under the bias of spring 263, in which dashed line position spring 263 will assume its normal flat or bowed condition. The distal ends of arms 274 and 276 are engageable with abutment 61 provided by member 58 and the surface presented by this abutment is tangential to the arc traced by said distal ends as the latter move away from each other upon expansion of said thermally responsive means 280, as described above.

In many conditions of operation, it may be desirable that thermally responsive unit 262 be ambient compensated. This can be accomplished by proper selection of materials for thermally responsive element 280 and spring member 263 so that the respective coefficients of thermal expansion of these materials are such as to provide ambient compensation. The determination of the proper relationship between the respective coefficients of thermal expansion of the above-mentioned materials may depend, at least in part, on such operating conditions of the switch as for example, the rate of increase or decrease of load in the circuit, and the range and rate of variation in ambient temperature. For example, under a specified range of ambient temperature operating condition and rate of increase or decrease of load in the circuit, thermally responsive element 280 and spring 263 would preferably be formed of the same material or of materials which have substantially identical coefficients of thermal expansion so as to compensate for changes in ambient temperature. Spring member 263 and thermally responsive element 280, by compensating each other for changes in ambient temperature, ensure that relative movement due to increase in temperature will be reflected substantially only by the increase in temperature due to the electrical current passing through the thermal element. Since the device is ambient compensated, any motion of a magnitude sufficient to cause tripping that takes place by arms 274 and 276 is due primarily to the expansion of the thermally responsive element, through the heating thereof by current passing therethrough, and not by ambient temperature changes. Thus arms 274 and 276 will move out of engagement with the abutment 61 provided by member 58 at the calibrated value of current flow regardless of changes in ambient temperature.

The thermal unit 262 may be calibrated in various ways which include, varying the length of member 280 between its points of securement to U-shaped clips 264 and 266; and varying the electrical resistance by varying the cross-section of the thermally responsive element; or by varying the number of thermally responsive elements employed. It should be understood that it is within the purview of the instant invention to provide a plurality of thermally responsive elements 280 secured to U-shaped clips 264 and 266, either in series or parallel electrical relationship. Or, if desired, a flat plate-shaped type thermal element might be employed. It should be understood that for a higher current rating, a thermally responsive element of larger cross-section, for example, in the shape of a flat ribbon or strip or a plurality of "hot-wire" elements such as thermally responsive element 280 as illustrated may be employed either in parallel or series electrical relationship with each other.

Referring again to FIG. 1, thermally responsive unit 262 is resiliently biased from the contacts-closed position (shown in full lines in FIG. 5) to the contacts-open position as shown in FIG. 1 by means of a compression spring 94. One end of spring 94 abuts the closed end of a socket 96 provided by casing member 22 and the other end of this spring abuts the closed end of a socket-providing member 98 which interfits with and is telescopically slidable along socket 96 whereby member 98 is biased against the adjacent portions of U-shaped members 264 and 266 of thermally responsive unit 262. Casing 22 provides a pair of abutments 99, 99 for limiting the extent of movement of thermally responsive unit 262 from contacts-closed to contacts-open position by the engagement thereof with U-shaped members 264 and 266 carried by thermally responsive unit 262.

Casing 22 provides recesses 100 for the reception of terminals 102 and 104, respectively. Terminal 102 carries a fixed contact 106 for cooperation with movable contact 270 and terminal 104 carries a fixed contact 108 for co-operation with movable contact 272. As is apparent from the drawing, thermally responsive unit 262 provides a bridging member electrically connecting contacts 106 and 108 when the thermally responsive unit is in the contacts-closed position as shown in FIG. 5.

It will be noted that member 98, thermally responsive unit 262, and members 58 and 32 are prevented from rotation about their respective axes and with respect to the casing by the engagement of respective surfaces thereof with the adjacent portions of the casing.

Referring to FIG. 1, it will be apparent that the marginal edges presented by the thermally responsive unit 262 engage the adjacent surfaces of the casing to prevent undue lateral shifting thereof as well as to prevent rotation thereof. In addition, push buttom member 38 is prevented from rotating relative to member 32 by means of a rib 116 integral with and projecting from member 32 into an interfitting recess 118 provided by member 38.

Switch 20 further includes a pair of latch spring members 120, 120 for retaining member 32 and the parts fixed with respect thereto in reset position until released as will be more particularly described. Each of latch members 120 includes a leg 122 disposed in a recess 124 provided by casing members 24 and 26 whereby the latter are mounted on the casing. Each of latch members 120 further includes a second leg 126 having a return-bent portion or corner 128 engageable with an angularly disposed abutment 130 provided by member 32. In addition, each of legs 126 of the latch members 120 provides a cam surface 132 for co-operation with angularly disposed tabs 278 of the arms 274 and 276 provided by the thermally responsive unit 262.

The operation of circuit breaker 20 will now be described. With the parts in the respective positions shown in FIG. 1, thermally responsive unit 262 is in the retracted, contacts-open position, member 58 is in the retracted position and biased by spring 60 against the stop 56 provided by the extension 54 of stem 36, and member 32, along with the parts fixed with respect thereto, is biased to the retracted position under the bias of compression spring 48 whereby band 46 which is formed of a color contrasting with that of push button member 38 is visible from outside the casing. Push button 38 is depressed to the advanced or reset position whereby the parts take the respective positions shown in full lines in FIG. 5. As movement of push button member 38 from the position shown in FIG. 1 to that shown in FIG. 5 ensues, the abutment 61 provided by member 58 moves into engagement with the distal ends of each of arms 274 and 276 provided by thermally responsive unit 262. Continued movement of push button 38 results in continued compression of spring 48, outward deflection of latch spring arms 126, 126 due to movement of member 32 against and slidably along these arms, and movement of the thermally responsive unit to the contacts-closed position shown in full lines in FIG. 5. It will be noted that movement of thermally responsive unit 262 to the contacts-closed position shown in FIG. 5 occurs against the resilient bias exerted by compression spring 94. With further movement of push button 38 to the reset position shown in FIG. 5 after engagement of movable contacts 270 and 272 with fixed contacts 106 and 108, member 58 is prevented from further downward movement and compression spring 60 is compressed as member 32 continues movement with the push button. Just before the shoulder 45 provided by push button 38 comes into engagement with the adjacent portion of bushing 52 to limit downward movement of the push button and the parts fixed with respect thereto, legs 126, 126 of latch spring members 120, 120 move under their inherent resilient bias into engagement with angularly disposed abutment 130 provided by member 32. When push button 38 is released, latch members 120, 120 retain member 32 and the parts fixed with respect thereto against the bias of springs 60 and 48 tending to move the member 32, push button 38, etc. from the reset position to the retracted position. With the parts in the reset, contacts-closed position shown in FIG. 5, member 58 retains thermally responsive unit 262 in the contacts-closed, advanced position under the bias exerted by compression spring 60. It may be noted at this point that none of the force exerted by compression spring 48 is transmitted to or directly affects the forces on or action of the thermally responsive unit 262.

With the parts in the contacts-closed, reset positions shown in FIG. 5, an electrically conductive path is established leading from terminal 102 through, in succession, contact 106, contact 270, the thermally responsive element 280, contact 272, contact 108 and terminal 104. Upon the flow of current of sufficiently high values along the electrically conductive path just described, thermally responsive elements 280 is heated by the current passing therethrough and expands and permits arms 274 and 276 to move outwardly under the bias of spring 263 which moves to a flat or an upwardly bowed position, as shown in the broken line positions in FIG. 3. When the thermally responsive member 280 expands, as described above, and the arms 274 and 276 move outwardly to the broken-line position shown in FIGS. 3, 5 and 6, the distal ends of arms 274 and 276 move out of engagement with abutment 61 provided by member 58 to the broken-line position shown in FIGS. 5 and 6; member 58 moves to the broken-line position shown in FIG. 5 under the bias of spring 60 and thermally responsive unit 262 is no longer restrained in the contacts-closed position and immediately begins movement to the contacts-open, retracted position shown in FIG. 1 under the resilient bias exerted by compression spring 94. Referring to FIG. 6, as thermally responsive unit 262 moves toward the contacts-open position from the contacts-closed position, angularly disposed tabs 278 provided by each of arms 274 and 276 move into camming engagement with cam surfaces 132, 132 provided by legs 126, 126 of latch spring members 120, 120. Under the kinetic energy of spring 94 and the thermally responsive unit 262, tabs 278 strike and cam arms 126, 126 away from each other releasing portions 128, 128 of arms 126, 126 from angular abutment 130 of member 32 whereby member 32 and the parts fixed with respect thereto quickly move to the retracted position shown in FIG. 1.

Immediately after tripping of circuit breaker 20 from the condition shown in FIG. 5 to the condition shown in FIG. 7, thermally responsive unit 262, as shown in FIG. 7, will still be heated and, due to the expansion of the thermally responsive element 280, arms 274 and 276 will be disposed in the outwardly displaced positions shown in FIG. 7. Accordingly, upon depression of push button 38 from the retracted position shown in FIG. 7 while the thermally responsive element 280 is still in the heated condition and therefore arms 274 and 276 are still deflected outwardly as shown in this figure under the bias of spring 263, downward movement of member 58 fails to bring abutment 61 into engagement with the distal ends of arms 274 and 276 whereby the thermally responsive unit 262 remains in its retracted, contacts-open position. This feature is advantageous in that movable contacts 270 and 272 cannot be closed against fixed contacts 106 and 108, respectively, on the fault which caused tripping of the circuit breaker until the thermally responsive element 280 has cooled for a sufficient time interval and has contracted so as to bring arms 274 and 276 into alignment for engagement by abutment 61. Also, upon depression of the push button from retracted to advanced position while the thermally responsive element is still in the expanded condition as shown in FIG. 7, arms 274 and 276 retain latch spring members 120, 120 out of latching engagement with abutment 130 of member 32 whereby the latter member and the parts carried thereby are free to move from advanced to retracted position under the bias of spring 48 upon the release of the push button.

Upon cooling of the thermally responsive element 280, the latter will contract and tensionably urge spring member 263 from its normally flat or bowed position shown in the dashed lines of FIGS. 3 and 5 to a bowed condition of opposite configuration as shown in solid lines in FIG. 3 and move arms 274 and 276 against the bias of the spring 263 to a condition wherein the distal ends of the arms are engageable with abutment 61, which positions and conditions are shown in FIG. 1 wherein the device is ready for resetting of the circuit breaker as just described.

Circuit breaker 20 is further capable of being manually actuated for use as an on-off electrical switch. In this regard, with the parts in the reset, contacts-closed positions as shown in FIG. 5, push button member 38 may be grasped and forcibly pulled outwardly toward retracted position whereby the reaction of angularly disposed ledge 130 of member 32 against portions 128, 128 of latch members 120, 120 forces legs 126, 126 outwardly and away from each other whereby member 32, the parts fixed with respect thereto and member 58 move to their retracted positions, and the contacts 270 and 272 carried by thermally responsive unit 262 are separated from their mating contacts 106 and 108 under the resilient bias exerted by compression spring 94 against the thermally responsive unit.

As noted above, the latching forces exerted to retain member 32 and the parts fixed with respect thereto in the reset position are independent of the forces on thermally responsive unit 262. This is advantageous in that repeated latching and unlatching due to manual on-off switching of the circuit breaker does not upset calibration of the thermally responsive unit.

Circuit breaker 20 is "trip-free" in that thermally responsive unit 262 cannot be retained in contacts-closed position by forcibly retaining push button 38 in the advanced position upon the occurrence of a current overload through thermally responsive element 280. If member 32 is restrained in the advanced position by forcibly holding push button 38 in the depressed, advanced position when the thermally responsive element 280 expands sufficiently to permit disengagement under the bias of spring 263 of the distal ends of arms 274 and 276 with abutment 61, the thermally responsive unit 262 will move to contacts-open position under the bias of spring 94 (member 32 will, of course, remain in the advanced position) and member 58 will move away from member 32 and against stop 56 of stem extension 54 (from the full-line position shown in FIG. 5 to the broken-line position of FIG. 5 and full-line position of FIG. 6) under the bias of spring 60. FIG. 6 shows the respective positions of the parts after tripping of thermally responsive unit 262 from contacts-closed to contacts-open position while member 32 and the push button are forcibly retained in the advanced, contacts-closable position. It will be noted from FIGS. 6 and 7 that members 32 and 58 will then move to retracted position under the bias of spring 48 upon release of the push button, this being because the tabs 278 carried by arms 274 and 276 retain latch spring member 120, 120 in unlatched position with respect to member 32 until thermally responsive unit 262 cools to the contacts-closable condition as shown in broken lines in FIG. 7.

It will be noted (see FIGS. 3 and 5) that when the thermally responsive unit 262 is in the contacts-closed position and thermally responsive element 280 expands due to increased temperature thereof generated by the current flowing therethrough, U-shaped clips 264 and 266 and contacts 272 and 270 respectively carried thereby tend to move downwardly under the bias of spring 263 as it tends to return to its normal configuration (as shown in the dashed lines in FIGS. 3 and 5). Since movable contacts 270 and 272 are in engagement respectively with stationary contacts 106 and 108, the movable contacts, when in this condition, will respectively pivot thereabout and increase contact pressure therebetween at the time when arms 274 and 276 begin to move outwardly to disengage the distal ends thereof from abutment 61 to cause tripping of the device. Compression spring 94 acts against the portion of the spring member 263 thermally responsive unit 262 between contacts 270 and 272 on a line substantially perpendicular to a line connecting the latter contacts and the thermally responsive element 280 by expanding upon heating thereof in a direction to permit said portion to move upwardly under its bias to assume its normal bowed position of spring member 263 (as shown in the dashed lines of FIG. 3) results in decreasing the deflection of spring 94. Spring 94 is of conventional form which follows Hooke's Law in that the force exerted thereby is directly proportional to the deflection thereof. It will be clear that spring 94 need not follow Hooke's Law for the beneficial result to be pointed out following, but only that the force exerted thereby decrease with decrease in deflection thereof (and vice versa). Furthermore, it will be clear that the force exerted by member 58 of resetting means 34 under the bias of compression spring 60 acts against the thermally responsive unit 262. Since abutment 61 presents a surface tangential to the arc traced by the distal ends of arms 274 and 276, upon heating and expansion of said thermally responsive element, the force exerted against thermally responsive unit 262 by member 58 under the bias of spring 60 remains constant, and any decrease in the force exerted by spring 94 is reflected by an increase in the pressure between contacts 270—106 and 272—108, respectively. It will be clear, therefore, that so long as the force exerted by member 58 against thermally responsive unit 262 under the bias of compression spring 60 does not decrease as thermally responsive element 280 expands to permit arms 274 and 276 to move to their disengaged, broken-line positions shown in FIG. 5, and since any expansion of spring 94 to accommodate such motion of the thermally responsive element can result only in a decrease in the force exerted by the latter spring with a concommitant increase in the pressure exerted by contacts 270 and 272 respectively against contacts 106 and 108, no decrease in the pressure between the latter respective contacts will occur during this interim movement of the thermally responsive element until the distal ends of arms 274 and 276 move out of engagement with abutment 61 for release of the thermally responsive member to contacts-open position.

As arms 274 and 276 move away from each other upon expansion of thermally responsive element 280 due to heating of the latter when the parts are in the full-line, contacts-closed position shown in FIG. 5, it is likely, or possible at least, that one of these arms will move out from engagement with abutment 61 slightly before the other. The result will be that member 58 will tilt about the point of engagement of said other arm and abutment 61 and move laterally relative to extension 54 under the force couple effected by the bias of springs 60 and 94. This tilting and lateral movement of member 58 is permitted by virtue of the clearance as described above between the surface of member 58 defining aperture 59 and the outer surface of stem extension 54. This tilting and lateral movement of member 58 permits disengagement of said other arm from abutment 61 and movement of thermally responsive unit 262 to the retracted contacts-open position shown in full lines in FIG. 7 promptly upon disengagement of said one arm from abutment 61. Lateral and pivotal realignment of member 58 immediately after release of thermally responsive unit 262 to the retracted, contacts-open position is effected when countersunk portion 55 moves into engagement with beveled surface 57 of stop 56 under the bias of spring 60 thus forcing member 58 back to laterally and pivotally aligned relation with the remaining parts of the switch. Accordingly, abutment 61 provided by member 58 will be realigned with the distal ends of arms 274 and 276 upon cooling and return warping of thermally responsive unit 262 from the full-line position of FIG. 7 to the broken-line and full-line positions of FIGS. 7 and 1, respectively.

It should be noted that there can be a considerable amount of friction developed between the surface of abutment 61 and the distal ends of arms 274 and 276 which will tend to resist outward movement of arms 274 and 276 to disengagement with the abutment. The thermal unit 262 of the instant invention overcomes any contingency that might arise in this regard. The biasing force of spring 263, when maintained against its bias, as shown in FIG. 5, by the thermally responsive element 280 is considerably greater than the force required to overcome frictional resistance which might be developed between the engaged surface of abutment 61 and the distal ends of arms 274 and 276 when in the contacts-closed position. Thus, the switch of the instant invention provides accuracy and renders the effect of varying friction between the abutment 61 and the distal ends of arms 274 and 276 insignificant with respect to the operating characteristics of the device because of the excessive force provided by the spring bias of spring 263.

From the above it is also seen that the switch 20 also provides accuracy and renders the effect of ambient temperature insignificant with respect to the operating characteristics of the device.

It is also seen from the above that circuit breaker or switch 20 provides a device which is reliable, compact, and which is versatile and susceptible to varying electrical ratings in diverse applications, which embodies a minimum number of parts and which is simple in construction and economical to manufacture.

Another feature of the structural arrangement of the operating parts of the instant invention is that it lends itself to the use of compressive resilient biasing means which provide substantial advantages over tension-type springs and the like.

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

The dimensions of certain of the parts as shown in the drawings have been modified for the purposes of clarity of illustration.

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.

I claim:

1. An electrical switch comprising: a base; contact means on said base; movably mounted means carrying contact means for engagement with said first-named contact means; manually operable means movably mounted in said switch for engagement with spaced means on said movably mounted means to move the latter in response to movement of said manually operable means, said spaced means being normally biased toward disengagement with said manually operable means; and thermally responsive means associated with said spaced means for maintaining said spaced means against its bias in a condition for engagement by said manually operable means.

2. An electric switch comprising: a base; contact means on said base; movably mounted means carrying movable contact means for engagement with said first-named contact means; manually operable means movably mounted in said switch for engagement with spaced portions of said movably mounted means for moving the latter in a contacts-closing direction in response to movement of said manually operable means; spring means biasing said spaced portions to a condition wherein said spaced portions are not engageable with said manually operable means; and thermally responsive means associated with said spaced portions for maintaining said portions against the bias of said spring means in a condition wherein said portions are engageable by said manually operable means.

3. An electric switch comprising: a base; contact means on said base; movably mounted means carrying movable contact means for engagement with said first-named contact means; manually operable means movably mounted in said switch for engagement with spaced portions of said movably mounted means for moving the latter in a contacts-closing direction in response to movement of said manually operable means; spring means biasing said spaced portions to a condition wherein said spaced portions are not engageable with said manually operable means; and thermally responsive means associated with said spaced portions for maintaining said portions against the bias of said spring means in a condition wherein said portions are engageable by said manually operable means, said thermally responsive means being electrically connected to said movable contact means and said spring means being electrically insulated from said movable contact means, whereby at least a portion of said thermally responsive means is adapted to expand at predetermined temperature and current conditions so as to permit said spaced portions to move out of engagement with said manually operable means under the bias of said spring means.

4. The switch as set forth in claim 3 and wherein the material forming said thermally responsive means and the material forming said spring means have such coefficients of thermal expansion so as to compensate for changes in ambient temperature.

5. The switch as set forth in claim 3 and wherein the material forming said thermally responsive means and the material forming said spring means have substantially like coefficients of thermal expansion to compensate for changes in ambient temperature.

6. The switch as set forth in claim 3 and wherein said thermally responsive means comprises at least one elongated monometallic element secured to each of said spaced portions and operative to increase its length in response to increase in temperature thereof.

7. An electric switch comprising: a base; contact means on said base; movably mounted means carrying

movable contact means for engagement with said first-named contact means, said movably mounted means comprising a spring member; electrically conductive means secured in electrically insulating relation to said spring member at spaced portions thereof, said electrically conductive means carrying said movable contact means, said electrically conductive means including a pair of spaced arms, said spring member biasing each of said arms for movement relative to each other to vary the spacing therebetween; thermally responsive means secured at spaced portions thereof to said electrically conductive means to limit said movement of said arms and maintain said arms in a first condition against the bias of said spring member; manually operable means movably mounted in said switch and normally engageable with said spaced arms when the latter are in said first condition for moving said movable contact means in a contacts-closing direction in response to movement of said manually operable means, said thermally responsive means being electrically connected to said movable contact means and at least a portion of said thermally responsive means being adapted to expand at predetermined temperature and current conditions so as to permit said spaced arms to move relative to each other under the bias of said spring member to a condition wherein said arms are not engageable with said manually operable means.

8. A thermally responsive device comprising: a spring member; electrically conductive means operatively associated with spaced portions of said spring member in electrically insulated relation therewith, said electrically conductive means being adapted for connection with contact means, said electrically conductive means including a pair of spaced arms, said spring member biasing each of said arms for movement relative to each other to vary he spacing therebetween; and thermally responsive means electrically connected and secured to said electrically conductive means for preventing said movement of said arms, said thermally responsive means being responsive to an increase in temperature thereof to expand and permit said arms to move relative to each other under the bias of said spring member.

9. A thermally responsive device comprising: a spring member; electrically conductive means operatively associated with spaced portions of said spring member in electrically insulated relation therewith, said electrically conductive means being adapted for connection with contact means, said electrically conductive means including a pair of spaced arms, said spring member biasing each of said arms for movement relative to each other to vary the spacing therebetween; and thermally responsive means electrically connected and secured to said electrically conductive means for preventing said movement of said arms, said thermally responsive means being responsive to an increase in temperature thereof to expand and permit said arms to move relative to each other under the bias of said spring member, said thermally responsive means and said spring member being formed of materials having such coefficients of thermal expansion so as to compensate for changes in ambient temperature.

10. The thermally responsive device as set forth in claim 9 and wherein the material forming said thermally responsive means and the material forming said spring member have substantially like coefficients of thermal expansion to compensate for changes in ambient temperature.

11. An electric switch comprising: a base; a pair of contacts on said base; movably mounted means carrying a movable pair of contacts for engagement with said first-named pair of contacts, said movably mounted means comprising an elongated spring member; a pair of electrically conductive members, each electrically insulated from and mounted on spaced portions of said spring member, each of said electrically conductive members respectively mounting one of said movable contacts, each

of said electrically conductive members supporting an arm, said arms extending in the same direction and in opposed relation to each other, said spring member biasing said arms to move in a direction away from each other; a tensioned thermally responsive element electrically connected and secured adjacent its ends to each of said electrically conductive members for preventing said arms from moving apart under the bias of said spring member in one condition of said thermally responsive element, said thermally responsive element, when heated to a predetermined amount by current flowing therethrough, being adapted to expand and permit said arms to move apart a predetermined amount under the bias of said spring member; manually operable means movably mounted in said switch for engagement with said arms to move said movable contacts therewith in a contacts-closing direction, said arms, upon moving apart in response to expansion of said thermally responsive element and the bias of said spring member, also moving out of engagement with said manually operable means.

12. The switch as set forth in claim 11 and wherein the material forming said thermally responsive element and the material forming said spring member have such coefficients of thermal expansion so as to compensate for changes in ambient temperature.

13. The switch as set forth in claim 11 and wherein the material forming said thermally responsive element and the material forming said spring member have substantially like coefficients of thermal expansion to compensate for changes in ambient temperature.

14. In a switch structure, a base having electrical contact means mounted therein; a movable member, with a part thereof carrying electrical contact means adapted for engagement with said first contact means; means biasing said member toward a contacts-open position; resetting means movable from a first position to a second position, said resetting means including means thereon engageable with spaced portions of said member to move the latter to and releasably maintain the same in the contacts-closed position when said resetting means is in its second position; means urging said spaced portions toward disengagement with said resetting means; thermally responsive means associated with said spaced portions for maintaining the latter against the bias of said urging means in a condition for engagement by said resetting means, said thermally responsive means being operable to expand at predetermined temperature and current conditions so as to permit said spaced portions to move out of engagement with said resetting means under the bias of said urging means to permit said member to move to a contacts-open position under the bias of said biasing means.

15. In a switch structure, a base having electrical contact means mounted therein; a movable member, with a part thereof carrying electrical contact means adapted for engagement with said first contact means; means biasing said member toward a contacts-open position; resetting means movable from a first position to a second position, said resetting means including means thereon engageable with spaced portions of said member to move the latter to and releasably maintain the same in the contacts-closed position when said resetting means is in its second position; means urging said spaced portions toward disengagement with said resetting means; thermally responsive means associated with said spaced portions for maintaining the latter against the bias of said urging means in a condition for engagement by said resetting means, said thermally responsive means being operable to expand at predetermined temperature and current conditions so as to permit said spaced portions to move out of engagement with said resetting means under the bias of said urging means to permit said member to move to a contacts-open position under the bias of said biasing means, said thermally responsive means comprising at least one elongated monometallic element electrically connected to said movable contact means and secured to each of said spaced portions; and said urging means being electrically insulated from said movable contact means.

16. The switch as set forth in claim 15 and wherein the material forming said thermally responsive means and the material forming said urging means have such coefficients of thermal expansion so as to compensate for changes in ambient temperature.

17. The switch as set forth in claim 15 and wherein the material forming said thermally responsive means and the material forming said urging means have substantially like coefficients of thermal expansion to compensate for changes in ambient temperature.

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