Nov. 9, 1948. A. W. KRIEGER 2,453,235

NONFREE-TRIPPING OVERLOAD CIRCUIT BREAKER

Filed May 10, 1944 3 Sheets-Sheet 1

Fig. 1

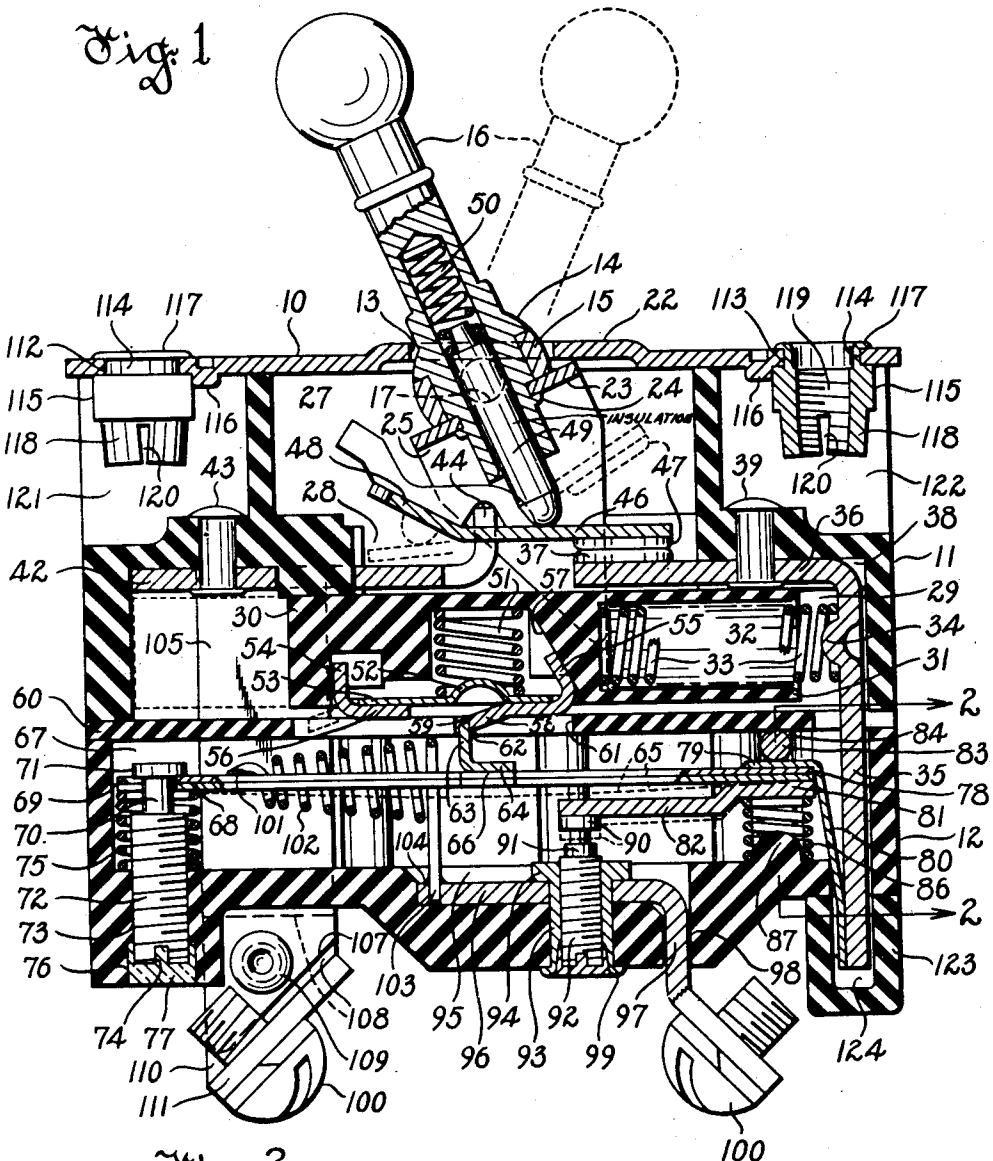
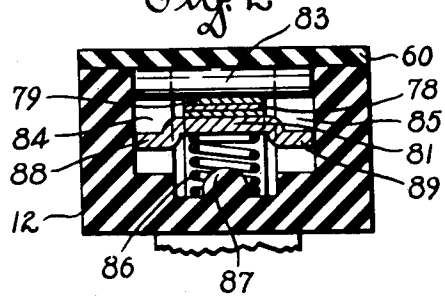


Fig. 2



Inventor
Alvin W. Krieger
By Frank N. Hubbard
Attorney

Nov. 9, 1948. A. W. KRIEGER 2,453,235

NONFREE-TRIPPING OVERLOAD CIRCUIT BREAKER

Filed May 10, 1944 3 Sheets-Sheet 2

Fig. 3

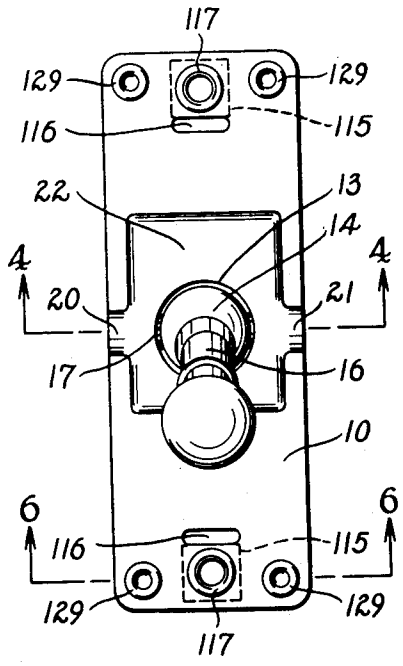


Fig. 5

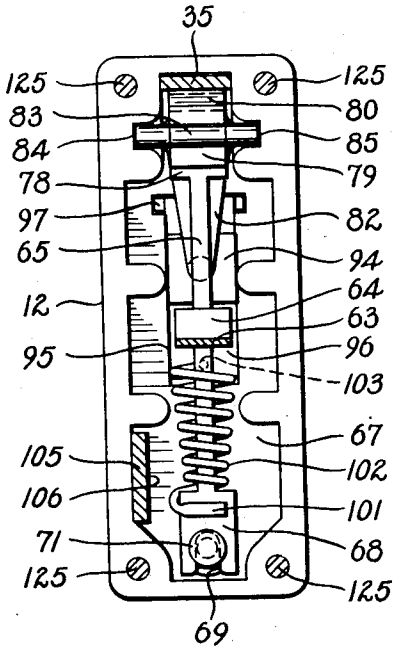


Fig. 4

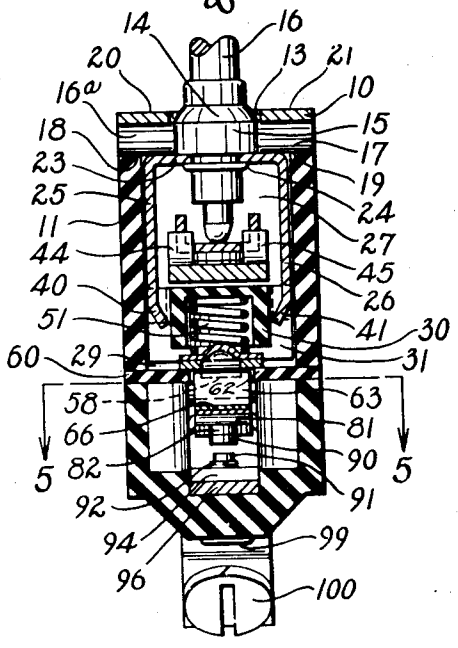
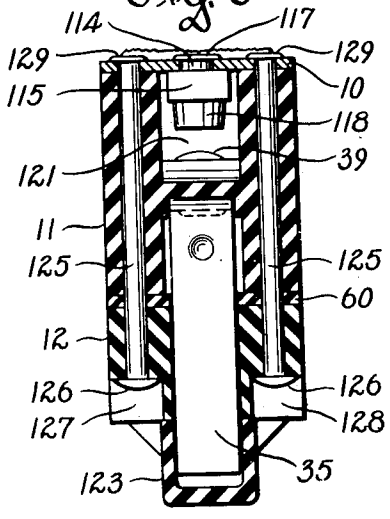


Fig. 6



Inventor
Alvin W. Krieger
By Frank H. Hubbard
Attorney

Nov. 9, 1948. A. W. KRIEGER 2,453,235

NONFREE-TRIPPING OVERLOAD CIRCUIT BREAKER

Filed May 10, 1944 3 Sheets-Sheet 3

Fig. 7

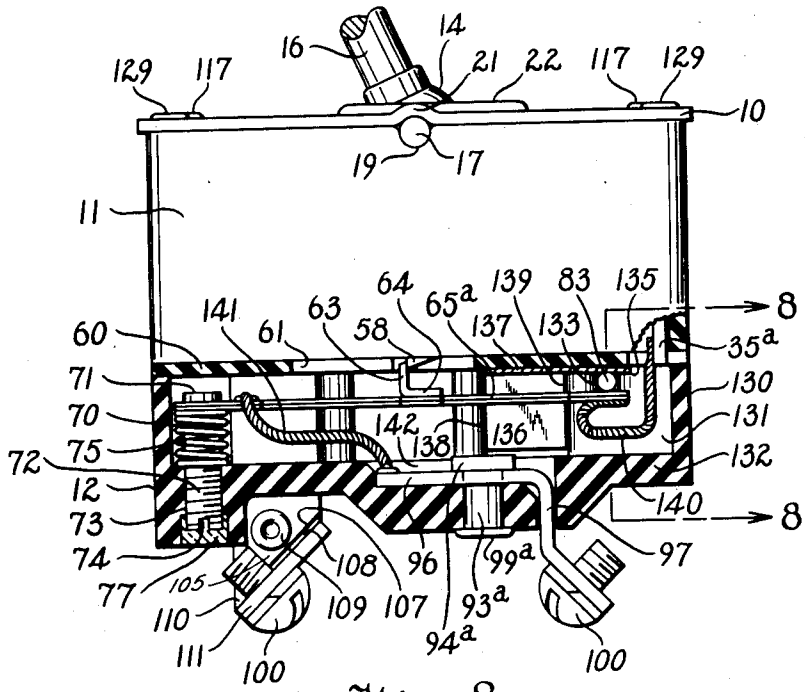
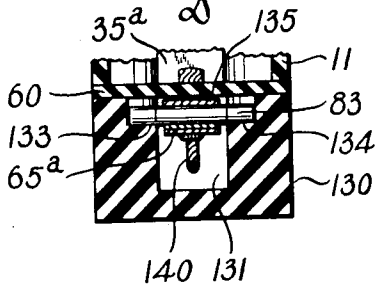


Fig. 8



Inventor
Alvin W. Krieger
By Frank A. Hubbard
Attorney

Patented Nov. 9, 1948 2,453,235

UNITED STATES PATENT OFFICE

2,453,235

NONFREE-TRIPPING OVERLOAD CIRCUIT BREAKER

Alvin W. Krieger, Milwaukee, Wis., assignor to Cutler-Hammer, Inc., Milwaukee, Wis., a corporation of Delaware

Application May 10, 1944, Serial No. 534,907

7 Claims. (Cl. 200—116)

1

This invention relates to improvements in non-free-tripping overload circuit breakers.

A primary object of the invention is to improve the details of construction and the operation of circuit breakers of the aforementioned character.

Another object is to provide novel means for protecting the thermal element against burning out under predetermined overload conditions.

Another object is to provide improved and simplified means for varying the normal degree of sensitivity of the bimetallic thermal element to given overload current conditions, whereby the normal current controlling capacity of the circuit breaker may be reduced to a relatively low value if desired.

Another and more specific object of the invention is to provide a novel form of switch which is operable automatically by the bimetallic thermal element to intermittently shunt the latter in the event of an overload above a given value, during manual retention of the controlled circuit in closed condition, whereby possibility of destruction of said thermal element is substantially eliminated.

Another object is to provide means for facilitating assembly and support of the bimetallic thermal element with respect to other elements of the device.

Another object is to minimize the number of elements required to secure all parts of the device in assembled relation.

Another object is to provide improved means for effecting attachment of the complete device to a panel or other suitable support.

Another object is to provide novel means affording an insulating enclosure for certain parts, which are initially exposed to facilitate attachment thereof to each other.

Another object is to insure a large degree of separation of exposed conducting parts of opposite polarity.

Other objects and advantages of the invention will hereinafter appear.

The accompanying drawings illustrate certain embodiments of the invention which will now be described; it being understood that the embodiments illustrated are susceptible of modification within the scope of the appended claims.

In the drawings,

Figure 1 is an enlarged vertical sectional view of a circuit breaker constructed in accordance with my invention.

Fig. 2 is a fragmentary sectional view, on the line 2—2 of Fig. 1.

2

Fig. 3 is a top plan view of the circuit breaker illustrated in Fig. 1.

Fig. 4 is a sectional view, on the line 4—4 of Fig. 3.

Fig. 5 is a sectional view, on the line 5—5 of Fig. 4.

Fig. 6 is a sectional view, on the line 6—6 of Fig. 3.

Fig. 7 is a view, partly in side elevation and partly in vertical section, of a slightly modified form of the device shown in Figs. 1 to 6, and

Fig. 8 is a fragmentary sectional view, on the line 8—8 of Fig. 7.

The non-free-tripping circuit breakers herein disclosed are in general of the character described and claimed in my prior Patent No. 2,342,945, granted February 29, 1944, for Circuit breaker. In the devices of Patent No. 2,342,945, however, it was found that upon manual retention of the controlled circuit closed under certain overload conditions of relatively high value, there was danger of the bimetallic thermal element burning out or fusing, with resultant creation of an unnecessary fire hazard. This is especially true in respect of relatively low capacity circuit breakers wherein bimetallic thermal elements of small caliber are employed; and the use of an automatically operable switch adapted to periodically shunt the thermal element, as shown in Figs. 1 to 6, hereof, provides for overcoming this difficulty.

Also in accordance with the disclosure of said Patent No. 2,342,945 four rivets were employed to secure the upper and lower insulating bases to each other, and four additional rivets were molded or embedded in the upper base to provide for rigid attachment of the metal support or cover plate thereto. In accordance with the present invention only four rivets are required to secure said bases and the cover plate in assembled relationship to each other.

Referring first to the circuit breaker shown in Figs. 1 to 6, the numerals 10, 11, and 12 respectively designate the metal support or cover plate and the upper and lower molded insulating bases. Plate 10 is punched and stamped to the form thereof illustrated in Figs. 1, 3, 4, and 6; the same having a relatively large centrally located circular opening 13 which is adapted to provide clearance for the intermediate enlargements 14 and 15 upon an operating lever 16 which is essentially like that shown in Patent No. 2,342,945. Thus the enlargement 15 consists of a separately formed metal ring having integral diametrically opposed cylindrical lugs 16a and 17, which jointly serve as a pivot for said lever.

Lugs 16a and 17 are adapted to seat within open pivotal bearings 18 and 19 formed in the upper surface of base 11 (see Figs. 4 and 7); said lugs projecting slightly above said surface, and plate 10 being offset upwardly at 20 and 21 to provide parts of the bearings therefor.

In practice plate 10 is provided with a rectangular upwardly offset portion 22 the flat upper surface of which is coplanar with the upper extremities of offset portions 20 and 21 (as best illustrated in Fig. 7). Such offsets 20, 21 and 22 thus provide a relatively large flat or coplanar area to seat against the lower surface of a panel or the like (not shown) to which the complete unit may be attached in the manner hereinafter set forth. As best illustrated in Fig. 1, the lower surface of offset portion 22 is so positioned as to provide clearance for element 23 carried by lever 16 upon movement of the latter to its opposite extreme positions.

Element 23 is of substantially inverted U-shape, as best illustrated in Fig. 4; the perforated connecting portion thereof fitting onto a reduced portion of lever 16, which reduced portion is peripherally upset over the inner surface of said connecting portion, as indicated at 24 in Figs. 1 and 4, to rigidly and non-rotatably secure element 23 and ring 15 to lever 16. As shown in Fig. 4 the arms 25 and 26 of element 23 are positioned closely adjacent, but are freely movable with respect to, the opposite side walls of the switch recess 27 which opens to the upper surface of base 11. As shown in Fig. 1, the lower end portions of arms 25 and 26 are of inverted triangle form, the opposite side edges of said triangles being respectively engageable with the walls of the opening 28 between switch recess 27 and the lower recess 29 in which the molded insulating plunger 30 is slidable. Plunger 30 is provided with an enlarged head portion 31 (Fig. 4) which is slidable between and guided by the opposed side walls of recess 29, the relatively narrower left-hand end portion of plunger 30 (Fig. 1) being also slidable between and guided by vertical shoulders (not shown) formed upon the walls of recess 29.

Plunger 30 is provided at the head end 31 thereof with a cylindrical recess 32 (Fig. 1) which is adapted to accommodate a coiled compression spring 33 the free outer end of which is adapted to surround a boss or abutment 34 formed upon the vertical arm 35 of an inverted L-shaped metal member, the horizontal arm 36 of said member having a contact tip 37 of fine silver or the like spot-welded or otherwise rigidly attached to the upper surface thereof, said arm 36 being positioned within a groove 38 in the upper end wall of recess 29 and rigidly attached to base 11, as by means of a rivet 39.

The lower end portions of arms 25 and 26 of element 23 are bent inwardly toward each other, as shown at 40 and 41 in Fig. 4, to insure proper engagement thereof with the shoulders formed between the head 31 and the relatively narrower portion of plunger 30.

Also seated in a groove in the upper end wall of recess 29 is the horizontal portion 42 of a punched and formed sheet metal member, said portion being secured to base 11 as by means of a rivet 43. Portion 42 extends toward the right into alinement with opening 28, and has a forked end the spaced portions 44 and 45 of which are bent upwardly at substantially right angles to provide a fulcrum for an oscillatable contactor 46 to the lower surface of the right-hand end of

which a tip 47 of fine silver or the like is rigidly attached. Contactor 46 is substantially like that shown in Patent No. 2,342,945, the same having a flat portion 48 angled upwardly from the main body portion thereof at one side of the fulcrum or pivot point thereof.

Lever 16 is recessed as shown in Fig. 1 to accommodate an insulating plunger 49 which is biased outwardly from the recess by a coiled compression spring 50. With lever 16 manually moved to the full line position thereof shown in Fig. 1 contactor 46 will be correspondingly moved to and normally held in its circuit completing position as illustrated. Also upon manual or automatic movement of lever 16 to its dotted line position plunger 49 will engage the portion 48 of the contactor to move the same with a quick action to its circuit-interrupting or "off" position shown in dotted lines.

Plunger 30 is substantially like that shown in said Patent No. 2,342,945, the same being recessed as shown in Fig. 1 to accommodate a vertically positioned coiled compression spring 51 which biases plunger 30 toward the upper end wall of recess 29, and the lower end of said spring surrounds a boss 52 formed upon a relatively thin sheet metal plate 53 to bias the latter downwardly. Plate 53 is provided with notches at the respective ends thereof for engagement with integral upwardly bent relatively narrow lugs 54 and 55 formed at opposite ends of a relatively thicker sheet metal plate 56. Lug 54 projects upwardly at substantially a right angle to plate 56, and lug 55 extends upwardly and inwardly as shown for cooperation with an angular cam-like wall 57 of the recess aforementioned. Plate 56 is sheared on opposite sides of a lug 58 which is bent downwardly at a predetermined angle as illustrated; and the cut metal edge 59 of lug 58 is located in a substantially vertical plane.

A flat punched insulating plate 60 is interposed between the insulating bases 11 and 12; plate 56 being slidably movable over the plate 60, and the latter having a relatively narrow slot 61 formed therein to provide just sufficient clearance for lug 58, the width of which is shown in dotted lines in Fig. 4. Slot 61 is made relatively wider at a predetermined point in the length thereof, as indicated at 62 in Figs. 1 and 4, to accommodate the substantially vertical upstanding latch lug 63 which extends upwardly into said enlargement of the slot under normal conditions. By this means the cooperating lug 58 may be made substantially shorter, and therefore stronger, than the corresponding lug in Patent No. 2,342,945, and the overall depth of the complete device is thereby reduced to a corresponding degree.

Latch lug 63 is formed integrally with a horizontal portion 64 of corresponding width; and portion 64 is spot-welded or otherwise rigidly secured to a rectangular enlargement of corresponding size at a predetermined point in the length of a bimetallic electro-thermally responsive element 65, as indicated at 66 in Figs. 1 and 4.

As shown, the bimetallic element 65 is supported within the upwardly opening recess 67 in base 12. The left-hand end 68 of element 65 is enlarged and notched as indicated at 68 and 69 in Figs. 1 and 5. Notch 69 is adapted to fit around the reduced or neck portion 70 of a machined metal member whose head 71 is thus adapted to overlie said enlarged end 68. Said metal member is provided with an externally screw-threaded portion 72 which is ad-

justable within a threaded passage or opening 73 in the bottom wall of recess 67. The lower end of portion 72 is provided with a kerf 74 to provide for adjustment thereof as by means of a screw-driver. Interposed between the bottom wall of recess 67 and the lower surface of enlarged end 68 is a coiled compression spring 75, which biases said end against the lower surface of head 71. A countersink or recess 76 surrounds the kerfed end 74 of portion 72 to receive a quantity of cement or the like 77 to maintain head 71 in the position to which it has been adjusted at the factory.

The right-hand end of bimetallic element 65 is of enlarged rectangular contour, as indicated at 78, and is interposed between the horizontal portion 79 of an inverted substantially L-shaped sheet metal bus member (preferably a copper strip), the substantially vertical portion of which is designated by numeral 80, and the rectangular portion 81 of a punched and stamped sheet metal contactor the arm of which is designated by numeral 82. Loosely interposed between said portion 79 and the lower surface of plate 60 is the intermediate portion of a pin 83. The parts 79, 78, and 81 are rigidly connected or united, as by subjecting the same jointly to a spot welding operation; the pin 83 serving to space said parts a predetermined distance below the upper surface of base 12.

As shown in Figs. 1, 2, and 5, the opposite ends of pin 83 are adapted to fit rather snugly within a pair of opposed vertical grooves 84 and 85 extending downwardly to a plane slightly above the bottom wall of main recess 67 in base 12 (see Fig. 2). Interposed between the bottom wall of main recess 67 and the lower surface of portion 81 of the switch contactor is a coiled compression spring 86, whose lower end surrounds a boss 87 formed integrally with said bottom wall. As best illustrated in Fig. 2, portion 81 of said contactor is provided with downwardly offset lugs 88 and 89, which are also positioned within grooves 84 and 85 respectively; lugs 88 and 89 being of slightly less width than said grooves, to act as a pivot and to permit tilting of contactor 82 in the manner hereinafter described. The insulating plate 60 overlies the pin 83 (Figs. 1 and 2) to limit the upward displacement of the aforementioned parts under the bias of spring 86.

The free end of contactor 82 preferably has attached thereto a tip 90 of fine silver or the like, as by spot welding. Tip 90 is adapted for cooperation with a stationary contact tip 91 of like or similar material; tip 91 being carried at the upper end of a screw or stud 92 which is initially adjustable within the screw-threaded opening through a rivet 93 the rectangular head 94 of which is fitted snugly between the opposed side walls of an auxiliary recess 95 formed in the bottom wall of main recess 67, whereby rotation of said rivet head is positively prevented. Also positioned within auxiliary recess 95 (beneath rivet head 94) is a punched and stamped sheet metal terminal member, the horizontal portion of which is designated by numeral 96, and the initially vertical portion of which is designated by numeral 97. After downward insertion of portion 97 through a suitable opening 98 in the bottom wall of base 12 and securing of portions 96 and 97 to said base by upsetting the relatively thin-walled lower end of rivet 93, as indicated at 99 in Figs. 1 and 4, the perforated and tapped lower end of portion 97 is bent outwardly at the

desired angle to facilitate operation of the wiring terminal screw 100 as by means of a screw-driver.

Attached to the enlarged end 68 of bimetallic element 65, as by spot-welding, brazing, or the like, is a straight portion 101 of a resistance- or heater-wire 102 composed of a suitable material, such as the metal alloy known as "Nichrome." Wire 102 is spirally wound in situ around the relatively narrow portion of element 65 between enlargements 68 and 66 in coils of gradually increasing size; as by temporarily positioning the two halves of a split conical mandrel (not shown) on opposite surfaces of said element 65 so that the smaller coils will rather closely surround the left-hand end of said narrow portion and the largest coil will be located adjacent the latch lug 63, a straight or vertical portion 103 being adapted to fit into an opening of suitable size formed in portion 96 of the aforementioned terminal member, as shown in Fig. 1. Portion 103 is spot-welded, brazed, or otherwise mechanically and electrically connected with portion 96, as indicated at 104. By this means any current passing through element 65 is also required to traverse the heater coil 102, whereby element 65 is subjected to the heat of coil 102 to increase the degree of downward bending or deformation of said element under given overload conditions. By employment of the conical coil 102 the degree of radiation of heat therefrom to strip 65 is accentuated and is substantially constant (for given current conditions) in all positions assumed by said strip when in use. For this reason also the strip 65 may be of substantially heavier caliber than would otherwise be possible, while retaining the desired high degree of sensitivity thereof to given values of overload current.

As shown in Fig. 1 the aforementioned sheet metal member which provides the fulcrum or pivotal support for contactor 46 has formed integrally with the horizontal portion 42 thereof a vertical portion 105; insulating plate 60 having a correspondingly shaped rectangular opening (not shown) to provide for downward insertion of portion 105, and the bottom wall of recess 67 in base 12 having a similar opening 106 (see Fig. 5) through which said portion is adapted to extend. Portion 105 is provided at its lower end with an angular edge 107. A punched and stamped sheet metal terminal member has a vertical portion 108 (Figs. 1 and 7) which is positioned exteriorly of the lower end of portion 105, the latter and portion 108 having alined openings (not shown) to accommodate the hollow shank of a headed rivet, the end of which shank is upset as shown at 109 to secure said parts to each other. After said riveting operation a small amount of molten solder (not shown) is applied at the area designated at 110 in Figs. 1 and 7 to insure a rigid mechanical and good electrical connection between said parts. Formed integrally with vertical portion 108 and bent forwardly in a plane parallel to the lower edge 107 of portion 105 is a portion 111 which is provided with a tapped opening to accommodate the shank of a second terminal screw 100; whereby the axes of both screws are at approximately 45 degrees from the vertical, to facilitate attachment of the circuit wires.

The aforementioned metal cover and support plate 10 is provided adjacent opposite ends thereof with circular openings 112 and 113 to accommodate the reduced hollow neck portions 114 of

a pair of like machined resilient locking nuts the intermediate portions 115 of which are preferably of square contour. Extruded or pressed downwardly from plate 10 are a pair of straight elongated bosses 116 against the outer side edges of which one side of each of the portions 115 are respectively adapted to fit to positively restrain said nuts against rotation. The upper ends of neck portions 114 are spun or upset over the upper surface of plate 10, as indicated at 117, to rigidly secure said nuts in position. Each nut is initially provided at its lower end with a reduced cylindrical portion which I have designated by the numeral 118; each nut in its initial form being also provided with a screw-threaded through passage 119 (Fig. 1) of usual form. After the threading operation said portions 118 of the nuts are each provided with a diametrical kerf or sawcut 120 which extends upwardly throughout substantially the entire length thereof. Thereupon the parts of each portion 118 separated by kerf 120 are pressed or bent toward each other to provide substantially an inverted frusto-conical contour thereof, thus reducing the diameter of the lower portion of screw-thread 119 to effect resilient gripping and holding or locking of the threaded shank of a screw or bolt which fits the upper portion of screw-thread 119 in the usual manner. The upper surface of base 11 is provided at opposite ends thereof intermediate its width with upwardly and endwise opening recesses 121 and 122 (Fig. 1) to accommodate the respective lock-nuts, and to afford access to the heads of rivets 39 and 43. The longitudinal sides of base 11 remain substantially unbroken and smooth, as best illustrated in Fig. 7.

The device may be associated with a suitable panel (not shown) preferably having a circular opening of slightly larger diameter than opening 13 in plate 10, and a pair of circular openings alined with the threaded passages 119 in the locking nuts to provide clearance for the shanks of headed clamping bolts or screws (not shown) which are threaded into said passages; such shanks, of course, being of sufficient length to extend downwardly at least a substantial distance into the kerfed and deformed portions 118 of said nuts.

Assuming that the circuit breaker is connected in series in a circuit to be controlled, by attachment of the wires by means of the pair of screws 100, the same will function normally in substantially the same manner and for the same purposes as set forth in said Patent No. 2,342,945. That is to say, with lever 16 in the dotted line position thereof shown in Fig. 1, with consequent disengagement of contact tip 47 from tip 37, and with plunger 30 in its extreme left-hand position, manual movement of handle 16 to the full line position thereof illustrated will effect closure or completion of the circuit to be controlled. At the same time the aforementioned arms 25 and 26 will drive plunger 30 toward the right, so that lug 58 will be carried to the right beyond latch lug 63, and upon manual release of lever 16 the edge 59 of lug 58 will engage latch lug 63 (if the bimetallic strip is sufficiently cool to provide for latching positioning of the last mentioned lug), thus restraining plunger 30 against movement toward the left under the bias of spring 33. Under these conditions the contact tip 47 will be permitted to remain in engagement with tip 37 under the bias of switch spring 50. Moreover, under normal conditions the lever 16 of the switch many be manually moved to its opposite extreme positions respectively, to sequentially complete or interrupt the controlled circuit, without requiring unlatching of the plunger 30.

Closure of switch contacts 47, 37 effects completion of a circuit, which may be traced from the left-hand terminal member 111 in Fig. 1, through vertical portion 105 and horizontal portion 42 of the aforementioned metal member, through contactor 46 (and tips 47, 37) to and through horizontal portion 36 and vertical portion 35 of the other metal member, by strip 80 through bimetallic element 65, and through heater coil 102 to portions 96 and 97 of the right-hand terminal member.

Under given overload conditions bimetallic element 65 will bow downwardly (say to the dotted line position thereof shown in Fig. 1) under the heating effect of the excess current flowing therethrough and through the coil 102; and the latch lug 63 carried downwardly thereby will disengage the edge 59 of lug 58 to normally permit plunger 30 to move to its extreme left-hand position, thus effecting automatic movement of lever 16 and contact tip 47 to the circuit interrupting positions thereof shown in dotted lines in Fig. 1. However, under such overload conditions, if the lever 16 is moved to and/or held in the circuit-completing position thereof shown in Fig. 1 the relatively high current will continue to flow through bimetallic element 65 and heater coil 102, with resultant continued downward bending or bowing of element 65. The switch contactor 82, which is attached to the lower face of the right-hand end of element 65 will continue to move downwardly beyond the dotted line position thereof shown in Fig. 1 (which corresponds to the aforementioned latch-tripping position of element 65) until the tip 90 engages stationary contact tip 91. When this occurs both element 65 and coil 102 will be short-circuited, while the controlled circuit is maintained, thus insuring against overheating or fusion of element 65 and/or coil 102, whereby the fire hazard incident to burning out or destruction of such parts (which would be likely to follow in the absence of shorting switch 82, 92) is obviated. As will be understood, when element 65 and coil 102 are thus short-circuited, the former upon cooling will automatically return toward its dotted line position (Fig. 1) with consequent disengagement of contact tip 90 from tip 91, so that element 65 and coil 102 will again be subjected to the overload current, and after a given length of time (depending upon the degree or value of the overload) tip 90 will again be engaged with tip 91, with the result aforedescribed. If the overload disappears or is removed the parts will again assume the normal positions shown in full lines in Fig. 1, so that the controlled circuit will be maintained closed, if desired, without requiring manual retention of lever 16 in its circuit completing position.

As shown in Fig. 1, upon manual adjustment of screw 92 to effect the desired position of tip 91, a quantity of suitable material (such as molten lead or solder) is deposited in the hollow lower end of member 93 to cover the kerfed lower end of said screw, whereby accidental movement of said screw or further manual adjustment thereof is effectively prevented.

Also as shown at the lower right-hand end of Fig. 1, when the lower ends of portions 35 and 80 have been spot-welded, brazed, or otherwise rigidly connected to each other, I prefer to cover said exposed ends, as by means of a molded insulating member 123, which is recessed at 124 to freely

accommodate said ends. The flat upper edge or surface of cup 123 is attached to the lower surface of base 12 as by means of a suitable adhesive substance. Although I prefer to attach cup 123 in protecting position in the manner just described, it will be apparent to those skilled in the art that a similar result could be obtained by reducing one or both transverse dimensions of recess 124 whereby a press fit of cup 123 onto the otherwise exposed ends of the united metal members would be provided.

As shown in Figs. 3, 5 and 6 top plate 10, base 11, insulating plate 60, and base 12 are respectively provided adjacent the four corners thereof with alined openings or passages to accommodate, with a rather close fit, the relatively long shanks 125 (see Fig. 6) of a corresponding number of rivets the heads 126 of which are located in four corner recesses in base 12; two of which recesses are shown at 127 and 128 in Fig. 6. The hollow upper ends of rivets 125 are upset over the upper surface of plate 10, as shown at 129, to rigidly and permanently secure the aforementioned parts in assembled relation. In this manner the required number of fastening elements is only one-half as large as the number required in the devices of said Patent No. 2,342,945; and, moreover, the necessity for molded-in fastening elements or inserts in the upper insulating base is obviated.

In the modification illustrated in Figs. 7 and 8 the lever 16, top plate 10, upper insulating base 11, and all of the elements directly associated with said parts may be identical with the corresponding elements aforedescribed. The bimetallic thermally responsive element 65a is in practice of substantially heavier caliber, and therefore of greater current carrying capacity, than the element 65 aforedescribed. The left-hand end of element 65a is shaped as aforedescribed for cooperation with the supporting and adjusting elements 71, 75, 72, 74, etc., and a filling of a suitable insulating cement 77 is utilized to retain screw 72 in adjusted position. The lower insulating base 130 differs slightly from the base 12 of Figs. 1 to 6, in that the right-hand end of the bottom wall of recess 131 therein is closed, as indicated at 132 in Fig. 7; the centering abutment 87 for the coiled spring 85 of Fig. 1 is omitted from the lower base 130 in Fig. 7; and relatively shallow vertical grooves 133 and 134 are provided in base 130 to accommodate pin 83, as distinguished from the substantially deeper grooves 84 and 85 of base 12 (see Fig. 2). In the device of Figs. 7 and 8 the pin 83 is spot-welded, brazed or otherwise rigidly attached to the upper surface of the right-hand end portion of element 65a whereby said pin acts as a pair of pivot lugs, and pin 83 is biased into engagement with the bottom end walls of grooves 133 and 134 as by means of the resilient, downwardly angled tongue or extension 135 of an inverted U-shaped sheet metal member, one of whose opposite sides is designated by numeral 136 in Fig. 7, and the connecting portion of which is designated by numeral 137. Said sides (see 136, Fig. 7) are adapted to fit rather closely but slidably between the opposite side walls of recess 131 in base 130; and the vertical edges of said sides are adapted to fit between pairs of vertical shoulders formed upon the opposed side walls of recess 131; one pair of said shoulders being shown at 138 and 139 in Fig. 7. Insulating plate 60 overlies connecting portion 137 to retain the same and tongue 135 in proper position.

A multiple-strand copper wire or bus member 140 has one end thereof spot-welded or otherwise rigidly attached to the lower surface of the right-hand end of element 65a; the other end of bus member 140 being rigidly attached, as by spot-welding, to the lower end portion 35a of a metal member which preferably does not extend downwardly beyond the upper surface of base 130. In other respects portion 35a of the metal member in Fig. 7 corresponds with the aforedescribed portion 35 of the similar metal member in Fig. 1.

In like manner element 65a has spot-welded or otherwise rigidly attached to the upper surface of its left-hand enlarged end portion one end of a multiple-strand copper wire or bus member 141; the other end of bus member 141 being similarly spot-welded to the upper surface of portion 96 of terminal member 97.

Inasmuch as the aforedescribed shorting switch of Figs. 1 to 6 is not required in the device of Figs. 7 and 8, the aforementioned portion 96 is merely perforated to accommodate the shank 93a of a rivet whose square head 94a is adapted to fit non-rotatably between the straight side walls of a recess, one side wall of which is shown at 142 in Fig 7. The hollow lower end 99a of rivet shank 93a is upset over the lower surface of base 130 to secure terminal member 97 in assembled position; the head 94a and the upper portion of shank 93a of said rivet being preferably of solid or closed form.

The operation of the circuit breaker shown in Figs. 7 and 8 will be apparent to those skilled in the art; but it may be pointed out that upon connection of the circuit breaker into the circuit to be controlled, and with the switch mechanism in circuit completing position (as indicated by the position of lever 16), the lever 16 when manually released will provide for maintenance of the controlled circuit pending a given degree of downward bending or bowing of bimetallic element 65a under overload conditions of predetermined value. Also, as in my Patent No. 2,342,945, the controlled circuit may be interrupted or completed at any time at will, whether or not the circuit is subjected to overload conditions. That is to say, the circuit breaker is of the non-free-tripping type.

In each form of circuit breaker herein disclosed the means for supporting the bimetallic element (65 or 65a) have been improved to provide for easier assembly thereof than in my aforementioned Patent No. 2,342,945, while at the same time effecting a reduction in the degree of variation of the operating characteristics of the breakers resulting from normal manufacturing tolerances.

I claim:

1. In a non-free-tripping electro-thermally responsive overload circuit breaker, in combination, a switch included in the circuit to be controlled, said switch having a single pivoted lever normally operable manually to effect completion or interruption of the controlled circuit at will in the absence of overload conditions, a reciprocable plunger spring-biased to effect circuit interrupting operation of said switch, a bimetallic strip normally included in circuit with said switch, said strip and said plunger having cooperating latch members to restrain said plunger against its bias upon initial closure of said switch, said bimetallic strip being supported at each end against substantial outward longitudinal movement whereby the same is adapted to buckle or bow between said ends as an incident to overload conditions in the controlled circuit, whereby upon attainment of an overload condition of given

value said latch members are automatically disengaged to thereby tend to effect interruption of the controlled circuit, said lever being manually operable at will to insure completion of said circuit regardless of said overload conditions, an auxiliary switch associated with said strip and operable automatically thereby during manual maintenance of said circuit under overload conditions, said auxiliary switch comprising a fixed contact, and a substantially rigid sheet metal contactor attached to one end of said strip and adapted upon a given degree of bowing of the latter under overload conditions to engage said contact to thereby effect temporary short-circuiting of said strip whereby the possibility of fusion of the latter is substantially eliminated.

2. In a non-free-tripping electro-thermally responsive overload circuit breaker, in combination, a switch included in the circuit to be controlled, said switch having a single pivoted lever normally operable manually to effect completion or interruption of the controlled circuit at will in the absence of overload conditions, a reciprocable plunger spring-biased to effect circuit interrupting operation of said switch, a bimetallic strip normally included in circuit in series with said switch, said strip and said plunger having cooperating latch members to restrain said plunger against its bias upon initial closure of said switch, said bimetallic strip being supported at each end against substantial outward longitudinal movement whereby the same is adapted to buckle or bow between said ends as an incident to overload conditions in the controlled circuit, whereby upon attainment of an overload condition of given value said latch members are automatically disengaged to thereby tend to effect interruption of the controlled circuit, said lever being manually operable at will to insure completion of said circuit regardless of said overload conditions, an auxiliary switch associated with said strip and operable automatically thereby during manual maintenance of said circuit under overload conditions, said auxiliary switch comprising a fixed contact, a substantially rigid sheet metal contactor attached to one end of said strip and adapted upon a given degree of bowing of the latter under overload conditions to effect temporary short-circuiting thereof, whereby the possibility of fusion of said strip is substantially eliminated, and said bimetallic strip being so constructed and arranged that upon cooling thereof to a predetermined degree after each short-circuiting thereof said auxiliary switch is automatically reopened to temporarily remove said short-circuit, the aforementioned parts acting to continue said cycle of operations pending opening of said first mentioned switch or a predetermined reduction in value or removal of said overload conditions.

3. In a non-free-tripping electro-thermally responsive overload circuit breaker, in combination, a switch included in the circuit to be controlled, said switch having a single pivoted lever normally operable manually to effect completion or interruption of the controlled circuit at will in the absence of overload conditions, a reciprocable plunger spring-biased to effect circuit interrupting operation of said switch, a bimetallic strip normally included in circuit in series with said switch, a heater coil surrounding a portion of the length of said bimetallic strip, one end of said coil being electrically and mechanically connected with one end of said strip to form a part of the series circuit for the latter, said strip and said plunger having cooperating latch members to restrain said plunger against its bias upon initial closure of said switch, said bimetallic strip being supported at each end thereof against substantial outward longitudinal movement whereby the same is adapted to bow downwardly between said ends as an incident to overload conditions in the controlled circuit, whereby upon attainment of an overload condition of given value said latch members are automatically disengaged to thereby tend to effect interruption of the controlled circuit, said lever being manually operable at will to insure completion of said circuit regardless of said overload conditions, an auxiliary switch associated with said strip and operable automatically thereby during manual maintenance of said circuit under overload conditions, said auxiliary switch comprising a fixed contact, a substantially rigid sheet metal contactor attached to one end of said strip and adapted upon a given degree of bowing of the latter under overload conditions to effect temporary short-circuiting of the same and said heater coil whereby the possibility of fusion of said parts is substantially eliminated.

4. In an overload circuit breaker of relatively low capacity, the combination with a bimetallic electro-thermally responsive strip, of a spirally wound heater coil connected in circuit in series with said strip, said coil being of approximately cone-shape, the small end portion of said coil being located adjacent one end of the strip whereby a relatively high degree of heating of said strip by said small end portion of the coil is insured, and the large end of said coil being located at an intermediate point in the length of said strip to accommodate the latter without contact when in bowed condition.

5. In an overload circuit breaker of relatively low capacity, the combination with a switch having a single manually operable member, of a bimetallic electro-thermally responsive strip, a spirally wound heater coil connected in circuit in series with said strip, said coil being of approximately cone-shape, the small end portion of said coil being located adjacent one end of the strip whereby a relatively high degree of heating of said strip by said small end portion of the coil is insured, the large end of said coil being located at an intermediate point in the length of said strip to accommodate the latter without contact when in bowed condition, an auxiliary switch including a contactor carried by said strip and movable automatically to a degree corresponding to the degree of bowing of the latter, and a stationary contact engageable by said contactor under given conditions to temporarily effect short-circuiting of both said strip and said heater coil.

6. In an electro-thermally responsive overload circuit breaker, in combination, a switch included in the circuit to be controlled, a single manually-operated lever whereby said switch is normally operable to effect and maintain completion or interruption of the controlled circuit at will in the absence of overload conditions, means spring-biased to effect interruption of the circuit controlled by said switch, a single bimetallic strip normally included in circuit with said switch, said strip and said spring-biased means having cooperating latch members to restrain said means against its bias, said bimetallic strip being so supported at each end that the same is adapted to buckle or bow between said ends as an incident to current passage in the controlled circuit,

whereby upon attainment of an overload condition of predetermined value said latch members are automatically disengaged to thereby tend to effect interruption of the controlled circuit, said switch being manually operable at will by said lever to insure completion of said circuit regardless of said overload conditions, and an auxiliary switch associated with said strip, said auxiliary switch comprising a substantially rigid sheet metal contactor attached to one end of said strip and adapted upon a given degree of bowing of the latter during manual maintainance of said circuit under overload conditions to effect temporary short-circuiting of said strip.

7. In an electro-thermally responsive overload circuit breaker, in combination, a switch included in the circuit to be controlled, a single manually operable lever whereby said switch is normally operable to effect and maintain completion or interruption of the controlled circuit at will in the absence of overload conditions, means spring-biased to effect interruption of the circuit controlled by said switch, a single bimetallic strip normally included in circuit in series with said switch, said strip and said spring-biased means having cooperating latch members to restrain said means against its bias, said bimetallic strip being so supported at each end that the same is adapted to buckle or bow downwardly between said ends as an incident to current passage in the controlled circuit, whereby upon attainment of an overload condition of predetermined value said latch members are automatically disengaged to thereby tend to effect interruption of the controlled circuit, said switch being manually operable at will by said lever to insure completion of said circuit regardless of said overload conditions,

an auxilliary switch associated with said strip, said auxiliary switch comprising a substantially rigid sheet metal contactor attached to one end of said strip and adapted upon a given degree of bowing of the latter during manual maintenance of said circuit under overload conditions to effect temporary short-circuiting of said strip, and said strip being so constructed and arranged that upon cooling thereof to a predetermined degree after each short-circuiting of the same it will automatically effect reopening of said auxiliary switch to temporarily remove said short-circuit, the aforementioned parts acting to continue said cycle of operations pending opening of said first mentioned switch or a predetermined reduction in value or removal of said overload conditions.

ALVIN W. KRIEGER.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
1,271,558	Francis	July 9, 1918
1,966,444	Guett	July 17, 1934
2,049,354	Chapman	July 28, 1936
2,097,775	Pittman et al.	Nov. 2, 1937
2,239,829	Pittman et al.	Apr. 29, 1941
2,255,169	Ireland	Sept. 9, 1941
2,280,960	Lee	Apr. 28, 1942
2,293,179	Swingle	Aug. 18, 1942
2,342,945	Krieger	Feb. 29, 1944
2,347,014	Willmann	Apr. 18, 1944
2,357,151	Von Hoorn	Aug. 29, 1944
2,390,947	Koci	Dec. 11, 1945
2,419,072	Hall	Apr. 15, 1947