Jan. 2, 1968 L. W. BRACKETT 3,361,888

TRIP-FREE CIRCUIT BREAKER WITH THERMALLY RESPONSIVE SNAP ACTION SWITCH

Filed March 1, 1966 3 Sheets-Sheet 1

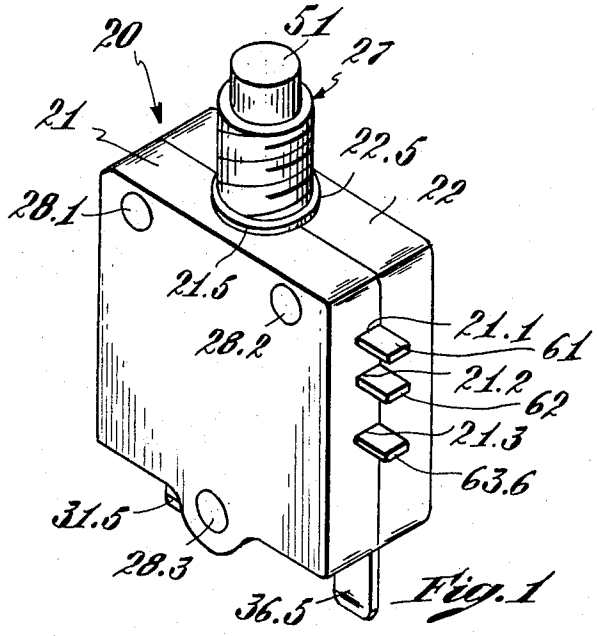


Fig. 1

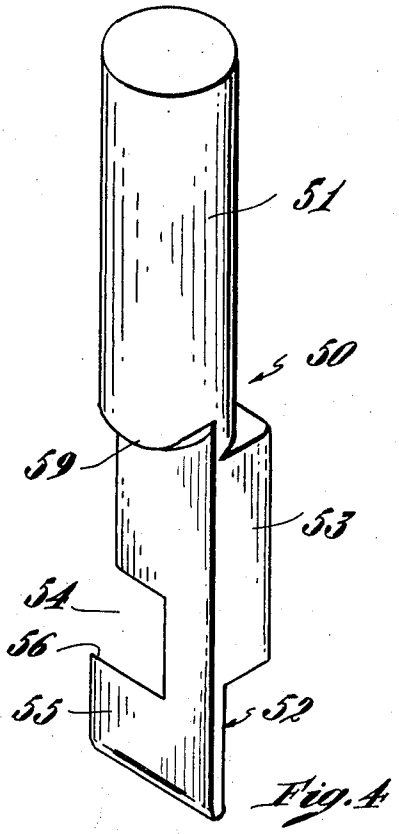


Fig. 4

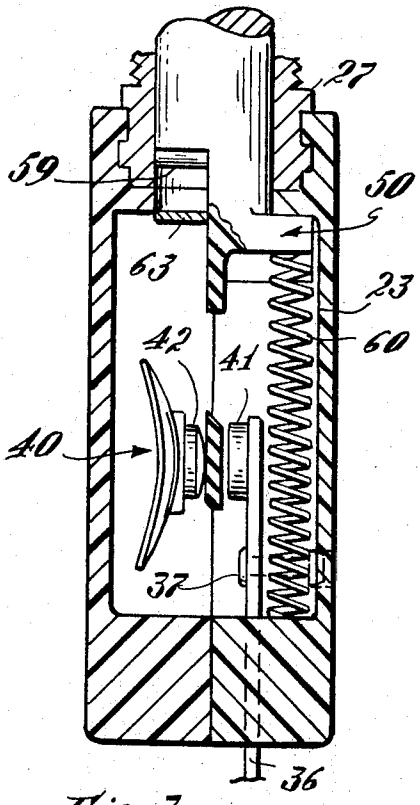


Fig. 7

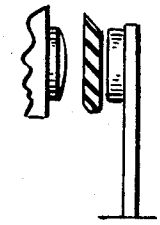


Fig. 8

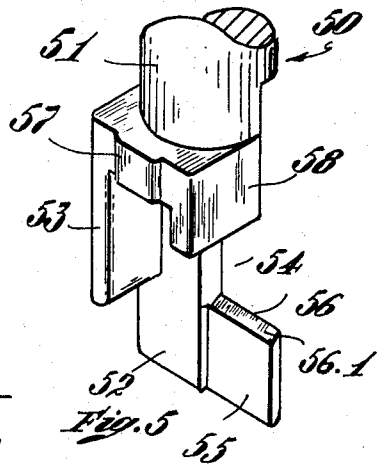


Fig. 5

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TRIP-FREE CIRCUIT BREAKER WITH THERMALLY RESPONSIVE SNAP ACTION SWITCH

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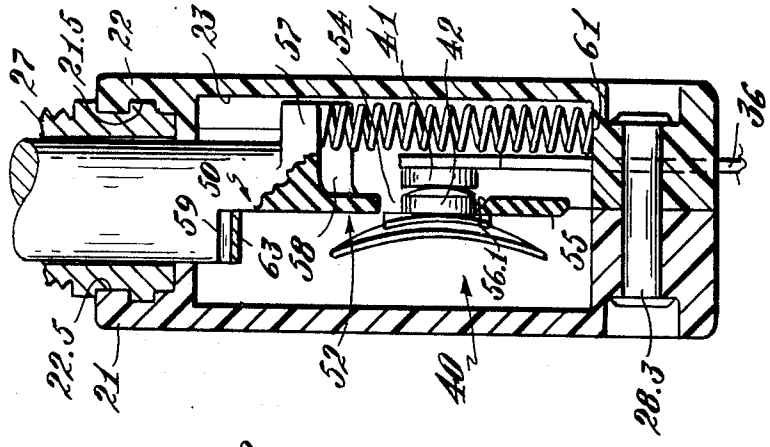


Fig. 3

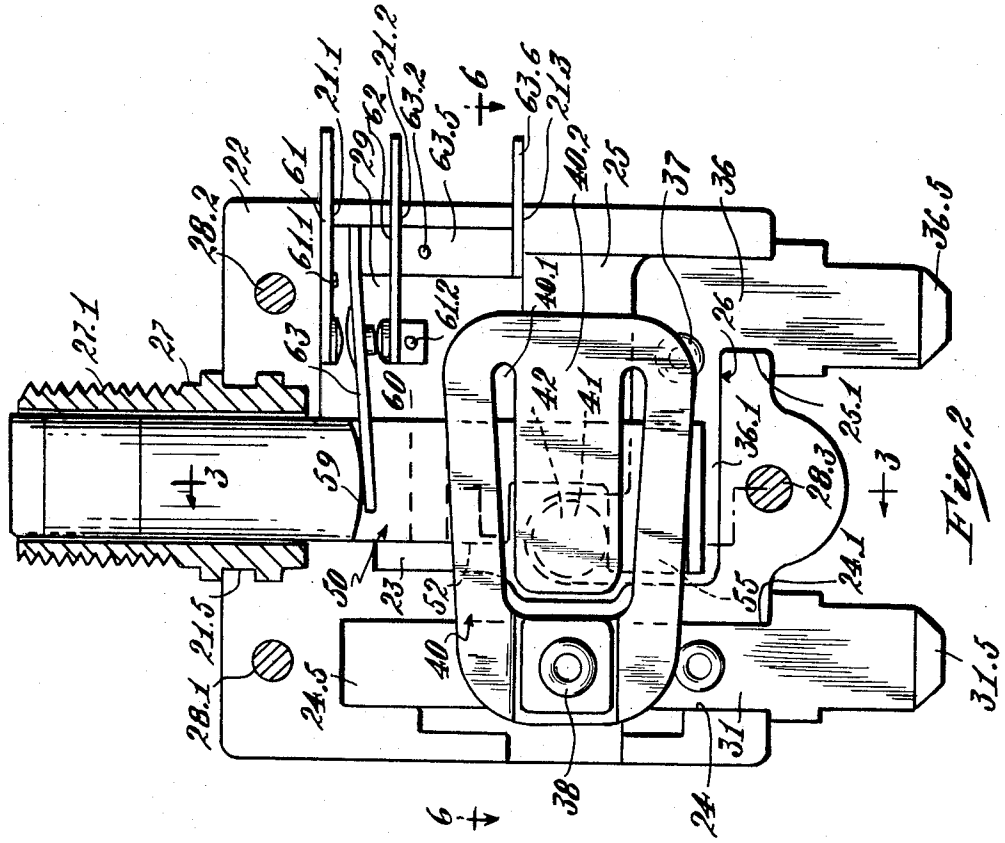


Fig. 2

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TRIP-FREE CIRCUIT BREAKER WITH THERMALLY RESPONSIVE SNAP ACTION SWITCH

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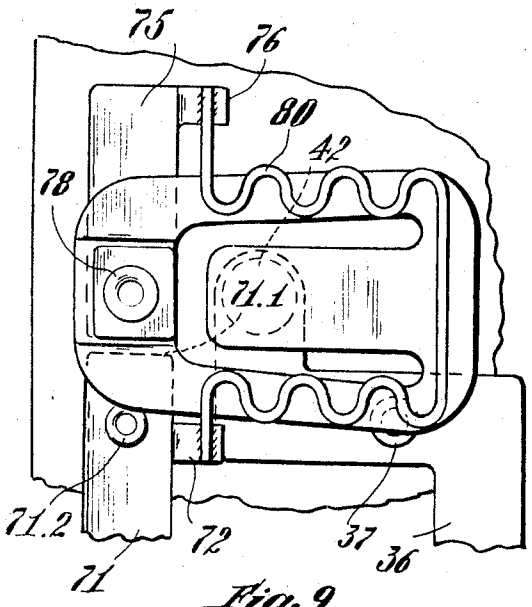


Fig. 9

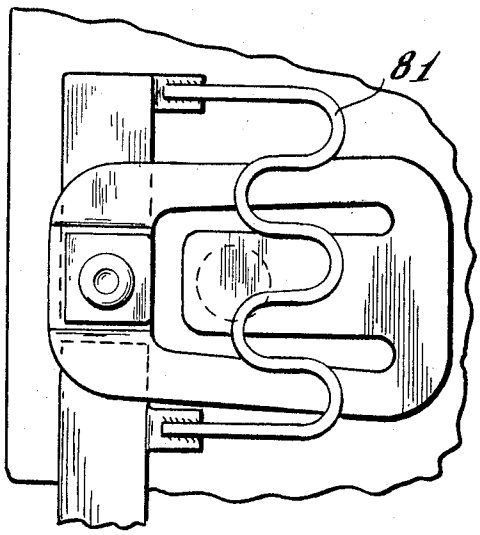


Fig. 10

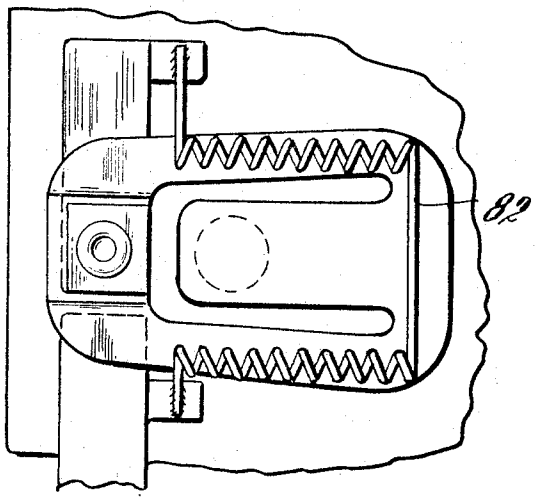


Fig. 11

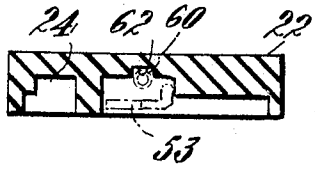


Fig. 6

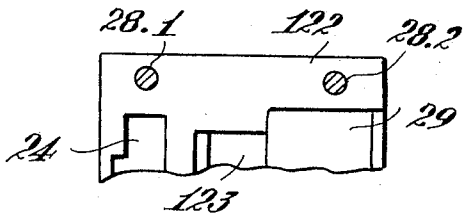


Fig. 12

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Patented Jan. 2, 1968

3,361,888

TRIP-FREE CIRCUIT BREAKER WITH THERMALLY RESPONSIVE SNAP ACTION SWITCH

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8 Claims. (Cl. 200—122)

The field of the present invention is that of circuit breakers of the type which can be manually closed only after removal of the abnormal condition that caused circuit breaking, commonly referred to as "trip-free." More particularly this circuit breaker employs a switch of the type wherein the contacts are opened and closed by thermally responsive snap action.

Circuit breakers of this type have heretofore been proposed, for example, in Patents Nos. 3,109,078 of Oct. 29, 1963, and 3,209,104 of Sept. 28, 1965, both to H. F. Malone. These circuit breakers however are not adaptable for incorporation of snap action blades having a mode of operation that is preferable for many purposes, and they do not lend themselves to inexpensive mass production manufacture.

Objects of the invention are to provide a trip-free circuit breaker which cannot be closed so long as an abnormal condition exists and cannot be manually opened, which is composed of a minimal number of optimally simple parts, which incorporates a commercially available thermally responsive snap action switch having favorable contact pressure characteristics, which is readily adaptable to various current ratings without modification of basic structure, which can be easily and conveniently mounted on conventional supporting structures and incorporated in approprite circuitry and generally to provide a circuit breaker of this type which is optimally simple, inexpensive in manufacture and assembly of its components, and yet reliable and durable in operation.

The nature and substance of the invention may be shortly stated as involving one or more of the following characteristic aspects.

Circuit breakers according to the invention include thermally responsive switches of the type such as for example described in U.S. Patent 2,503,008 of Apr. 4, 1950, to E. H. Taylor and in British Patent 657,434 of Sept. 19, 1951. It is however expressly understood that any switch element of this general construction can be substituted which will function substantially in a similar manner for the purpose intended. It is further understood that the present novel circuit breaker construction can be useful with switch components of different thermal response if they lend themselves to useful combination with the present control means. Suitable thermally responsive switches have a movable contact which makes or breaks circuit with a contact fixed to a housing upon temperature change caused by a predetermined change of current flow through the closed contacts. The movable contact is mounted on a swinging snap blade which, according to the invention, cooperates with control means, preferably made from an integral piece of molded material and having the characteristic configuration of a longitudinal block which has at one end an operator such as a cylindrical push button element capable of projecting from the housing in one switch position. At the other end the block has the general shape of a plate in a plane roughly defined by the movable contact in closed position. This plate has a notch or cut-out forming a leaf at its end. At the notch, preferably on the side of the movable contact, the leaf has an edge capable of contacting the movable contact when it is closed through the notch thus preventing movement against the contact then constituting a stop. A spring is

inserted between housing and block for biasing the control block to a position where the leaf comes in the gap between the two open contacts, and the operator projects from the housing. With the contacts closed, the operator is withdrawn and the notch edge rests on the movable contact. Upon termination of the emergency condition, the breaker can be closed by pushing the operator inwardly thus removing the leaf from between the contacts and causing the notch edge to be caught by the now closed movable contact.

In another aspect of the invention, the housing is split parallel to the plate of the control block. One-half or shell of the housing has three grooves parallel to the control block movement. The central groove contains the fixed contact and forms the guide channel for the control block, transverse to the switch blade. The side grooves extend through the opposite housing wall and accommodate terminal and contact mounting bars.

In an important aspect of the invention, the terminal and contact carrying bar in a side groove is divided; one section serves as terminal and the other carries the switch blade. To these sections can be electrically connected individual elements for heating the snap switch, accommodated within the housing adjacent to the thermally responsive switch blade.

In a further important aspect, the snap actuated trip free breaker according to the invention can be combined with an auxiliary switch arranged in a corner of the housing which is available even if separate heating elements are used and which can be actuated from a face or ledge arranged on the control block.

These and other objects, and aspects of the substance of the invention will appear together with various advantages from the following detailed description of several embodiments thereof illustrating its novel characteristics.

The description refers to drawings wherein:

FIG. 1 is an axonometric view of a circuit breaker according to the invention;

FIG. 2 is a front elevation of the circuit breaker according to FIG. 1 with one housing shell removed and showing the breaker mechanism in closed position; and incorporating an auxiliary switch;

FIG. 3 is a section on line 3—3 of FIG. 2 with both halves of the housing in place and the contacts closed;

FIG. 4 is an axonometric view of the control block from the movable contact side;

FIG. 5 is a view similar to FIG. 4 but of the lower part of the control means only and from the opposite side;

FIG. 6 is a section on lines 6—6 of FIG. 2 through the grooved housing half;

FIG. 7 is a section similar to FIG. 3 but with the contacts open;

FIG. 8 shows the contact portion of FIGS. 3 and 7 with the contacts in tripping condition;

FIGS. 9, 10 and 11 are front elevations similar to FIG. 2 but of the switch and heater portion only, showing three different modifications of externally heated snap switches; and

FIG. 12 is a partial elevation similar to FIG. 2 showing a modification serving as a relay.

Referring to FIGS. 1, 2 and 3, numeral **20** designates a housing made of insulating material in two halves designated **21** and **22**. The housing half or shell **21** can have three notches **21.1**, **21.2** and **21.3** for the three terminals of an auxiliary switch which may or may not be incorporated. The shell **22** has a control guide channel **23** and on either side thereof contact, bus bar, and terminal grooves **24** and **25** (FIG. 2). The terminal groove **25** has a branch **26** leading into the guide channel **23**. Beyond the branch **26**, the groove **25** is preferably

extended into a chamber 29 for the above mentioned tentative auxiliary switch. Both shells have semicircular recesses 21.5, 22.5 leading into the central guide channel 23 and forming a round opening for an operator. The bus grooves 24, 25 lead through the wall next to the connecting groove 26 at 24.1 and 25.1, where the bus terminals extend from the housing. A bushing 27 is held in the shell recesses 21.5 and 22.5 by appropriate shoulders. This bushing can be provided with a thread 27.1 for attaching the circuit breaker to a supporting plate in conventional manner. The two housing halves are held together in conventional manner by screws or other appropriate assembly means as indicated at 28.1, 28.2 and 28.3. If an auxiliary switch is not employed the notches 21.1, 21.2 and 21.3 can be omitted.

Within the grooves 24, 25 and branch 26 are two terminal buses 31, 36 respectively. The bus or bar 36 is Z-shaped and leads with cross piece 36.1 through groove 26 into a somewhat widened portion of the central channel 23, as indicated in FIG. 2. The bar 36 carries at its inner end the contact 41 and both bar and contact are fixed to the housing with a rivet or similar fastening means 37 (FIGS. 1 and 7). The bar 31 carries at the inner end the fixed end of the snap switch 40 to be described below, by means of a rivet or similar fastening means 38 which reaches through the housing half 22 similar to the fastening means 37 for the bar 36. The groove 24 extends beyond the fastening region at 38 for purposes of the modification to be described below with reference to FIGS. 9 to 11, as indicated at 24.5.

The snap action switch 40 which is fastened to the bar 31 and the shell 22 at 38 as described above, is of the type which is operated by means of a bimetallic element such as for example described in the above mentioned Taylor patents. The bimetallic blade of switch 40 has the general form of a rectangular sheet with a U-shaped cutout 40.1 which defines a contact finger 40.2 carrying the part 42 which constitutes the movable contact corresponding to the fixed contact 41 of bar 36. Switches of this type have the desirable property of increasing their contact pressure with increasing temperature. This characteristic is not common to snap action switches but is beneficial for many purposes and particularly well accommodated by the present control means construction which will now be described.

The control block 50 (FIGS. 4 and 5) has at one end an operator 51 extending from the housing through the bushing 27 when circuit is broken (FIGS. 1 and 7). At the other end is a plate 52 which is flat towards the movable contact and has on the other side perpendicular thereto a guide ridge 53. The plate 52 has a cutout or notch 54 which forms a leaf 55 at the end of the plate. The ridge 53 ends near the edge 56 of the leaf 55 in order to accommodate the cross piece 36.1 of the fixed contact bar 36. As shown in FIG. 5, the leaf rim 56 is chamfered to form a knife edge at the face adjacent the movable contact, for purposes which will appear below. As likewise shown in FIG. 5, the ridge 53 extends next to the operator 51 into a transverse rest 57 with a depending lip 58, for holding one end of the spring 60 which exerts its biasing force between the rest 57 and the inner terminal wall portion 61 of the shell 22, as shown in FIG. 3. A groove 62 (FIG. 6), the opposite face of plate 52, and the ridge 53 confine the spring. The control block is guided in the channel 23 of the shell as shown in FIGS. 2 and 6. At the cut-off region of the operator 51 where it leads into the plate 52 is a preferably convex face 59 for operating the auxiliary switch to be described below.

The operation of the above-described embodiment of the invention is as follows:

The normally closed position is indicated in FIGS. 2 and 3 when contacts 41 and 42 are pressed against each other within the notch 54 of the plate 52. The leaf 55 rests on the movable contact 42, the biasing spring 60 holding the control block in this position.

If an overload or other abnormal condition causes the thermal snap switch 40 to operate in known manner, separating the contacts, the leaf 55 with its edge 56 is released by contact 42 and moved into the gap between 41 and 42 by the spring 60, as shown in FIG. 8. Upon cooling of the thermal switch, the contact 42 comes to rest on the leaf 55 as shown in FIG. 7. The operator 51 will extend from the housing as shown in FIG. 1, serving as an indicator that the circuit breaker has been tripped.

The sharp edge 56 on that side of the leaf 55 which faces the movable contact 42 (the bevel 56.1 facing the fixed contact 41) provides the following functional advantages.

The edge 56 opposes minimal frictional force against movement of the contact 42 towards opening upon cooling, as well as towards closing upon the above discussed exertion of increased contact pressure with increasing temperature. Further, if the leaf 55 were squared off instead of beveled towards the fixed contact, the rim edge adjacent the fixed contact might catch the latter before the movable contact has fully opened the gap, so that the control block would not be able to move into the gap. Due to these two features, independence from frictional contact area and from the possibility of catching the fixed contact, the leaf 55 can be made thicker than if it were squared off, which is electrically and mechanically advantageous. Still further, the bevel edge upon reaching the opening gap will assist in enlarging it instead of interposing frictional resistance as a squared-off rim might under certain circumstances.

If the abnormal condition of the thermal switch persists and the operator 51 should be depressed during that period, contacts 41 and 42 will momentarily close, consequent rapid heating of the switch blade with following contact opening will ensue, and result in contact oscillation which indicates the continuing abnormal condition. Release of the operator will bring the leaf 55 back between the contacts for secure and continuous separation thereof. Thus, the "trip-free" characteristics of this circuit breaker is provided. Opening by hand, such as by pulling the operator 51 is not contemplated and it is purposely made impossible by stopping the leaf 55 on the closed movable contact as shown in FIG. 3, and by complete withdrawal of the operator during closed position of the operator as indicated in FIG. 2.

It will now be evident that the above described construction, by virtue of the knife edge 56 of the leaf 55 and the absence of any other obstructions of the movement of the control means, permits full utilization of the above-mentioned favorable characteristic of certain thermal snap switches, namely the increasing contact pressure with increasing temperature. It will also be evident that the spatial correlation, according to the invention, of the directions of movement of switch and control block with the locations of terminals and conductor bars provides a particularly compact and simple construction.

The above-mentioned auxiliary switch is shown at 60 of FIGS. 2, 3 and 7. It has in this embodiment two fixed contacts with terminal bars 61 and 62 which extend through the above-mentioned notches 21.1 and 21.2 of the shell 21. As indicated, these contacts and terminal bars are fastened to the housing shell such as by rivets 61.1 and 61.2. A movable contact with spring 63 reaches under the shoulder 59 of the operator 51 as mentioned above. It has a mounting bar 63.5 which also serves as a bus bar and leads to terminal 63.6. It is fastened to the housing with a rivet 63.2. It will now be evident that this is a single pole double break switch making contact at 62 and 63 when the operator 51 is depressed and the main circuit breaker closed as indicated in FIGS. 2 and 3, whereas this contact is broken and contact made at 61 and 63 when the main circuit breaker is open as indicated in FIG. 7. It will be evident that suitable signal or auxiliary

operating devices can be connected to the terminals **61**, **62** and **63.6**.

The above described circuit breaker is actuated only by the current flowing through the contacts of the thermal snap switch and therefore provides rather limited possibilities if operating breakers at widely varying overload current ratings. The embodiments now to be described with reference to FIGS. 9 to 11 rectify this disadvantage.

In these embodiments the bar **31** is terminated before reaching the fastening means **38** of the thermal blade switch, as indicated by the configuration of part **71** of FIGS. 9 to 11, the bar **71** terminating at **71.1** short of the fixation point and constituting a blade terminal. A third bar **75** is introduced which carries the switch at **78** in a similar manner as described above with reference to part **38**. The bar **71** is fixed to the housing by means of a rivet **71.2** or a similar provision. The bar **36** is held by the fastening means **37** as in the initially described embodiment.

A heating element **80** is connected between soldering tab **76** of bus **75** and tab **72** of bus **71** and located near the switch **40** within the shell **21** to provide effective heating thereof. In FIG. 9 a wavy heating wire is carried in two series connected sections over the outer edge portions of the switch blade. In FIG. 10 a rather coarse heating wire with a single wavy section is similarly connected and in FIG. 11 a fine heating wire **82** with two spirally wound sections is mounted similarly to the wavy sections of FIG. 9. It will be evident that current flows from fixed contact **42** (FIG. 9) to movable contact **41**, from there to fixation point **78**, through bar **75** and connection **76**, through heating wire **80** to connection **72**, and from there to the other terminal **71**. It will be noted that this arrangement is very versatile, permitting a wide choice of heating elements and that is also provides optimal heat transfer without interference with the control mechanism of the circuit breaker.

It will be evident that the materials used in the present circuit breaker have to be selected with a view to its peculiar requirements. The control block **50**, especially its bevel edge **56**, has to withstand rather severe and irregular strains, but it was found that certain synthetic materials which are not excessively expensive are quite satisfactory; one such material is melamine bonded glass fiber. The housing material is less critical but is has to be stable and suitable for molding to adequately precise dimensions; urea plastics were found to be suitable for that purpose. As mentioned above, the snap switches are commerically available. The remaining metal components are standard.

The above described manual reset circuit breaker can be easily adapted for serving as a simple non-resettable overload relay incorporating the advantages according to the invention, as follows.

For this purpose, the sliding control block **50** is omitted and the housing shells can be molded without the recesses **21.5**, **22.5** for the operator bushing **27**, unless it is desired to retain a solid stud of the shape of bushing **27** for mounting purposes. In that case the same housing shells can be used as for the circuit breaker. If no mounting stud is needed, the shell **22** can be molded to a more simple pattern as shown in FIG. 12 for shell **122**. The chamber **123** replaces channel **50** of FIGS. 2 and 3. The operation of such a relay will now be evident without detailed explanation; manual opening operation is of course impossible. The heater elements according to FIGS. 9 to 11 can be without difficulty used in such relays.

It will now be evident that identical components can be used for diverse embodiments such as circuit breakers with or without auxiliary contacts, with or without heating elements and, as a relay, without control block.

I claim:

1. A circuit breaker which incorporates a conventional temperature responsive snap action switch having a fixed contact and a blade movable in a predetermined direction and carrying a contact which makes or breaks circuit upon temperature change caused by change of current flow, comprising in combination with said switch:

a housing having means for fastening the blade, and a guide channel transversely to the direction of movement of the blade;

a control block slidingly supported in the guide channel between housing and switch and transversely to the direction of movement of the contact blade, and including a plate parallel to the contact blade and having a cutout forming a leaf at one end of the plate which leaf is retained outside the closed contacts by its cutout rim resting against the blade contact and which is capable of moving into the gap between the opened contacts, and a guide ridge extending transversely to the direction of movement of the blade, from the plate into the guide channel; and

spring means in the guide channel for biasing the control block to move the leaf between the opening contacts upon the rim having been released by the blade contact.

2. Circuit breaker according to claim **1**, wherein the cutout rim of the leaf is chamfered to form an edge at the side of the blade contact for catching the closed blade contact and permitting the spring means to move the leaf between the opening contacts.

3. Circuit breaker according to claim **1** further including a blade terminal bar and a freely suspended heating element connected on the side of the blade between the blade terminal bar and the blade fastening means.

4. Circuit breaker according to claim **1**, wherein the housing has

two grooves one on each side of the guide channel and each ending in a terminal aperture through the housing in the direction of the guide channel, and which further comprises:

terminal bars within the grooves one bar connected to the fixed contact and the other bar leading to the means for fastening the blade, the bars extending through respective terminal apertures.

5. Circuit breaker according to claim **4** wherein the bar which is electrically connected to the blade fastening means, is divided into two sections, one section forming the terminal and ending short of the switch and the second section being with the blade fastened to the housing, and which circuit breaker further comprises:

a heating element connected between the first and second sections of the bar which is electrically connected to the blade fastening means, on the side of and along the contact blade.

6. Circuit breaker according to claim **4** wherein the fixed contact groove bends from its aperture with a branch groove into the channel, and the terminal bar for the fixed contact is bent to conform to its aperture groove and to the branch groove.

7. Circuit breaker according to claim **6** wherein the housing has beyond the bend of the fixed contact groove a chamber opening into the channel and wherein the operator has a ledge facing the plate where the chamber opens into the guide channel, and which further comprises:

fastened to the housing within the chamber an auxiliary fixed contact fastened to the bent bar, and a corresponding auxiliary contact movable on a spring reaching in the path of the operator ledge.

8. Circuit breaker according to claim **1** wherein the housing has a chamber with an opening into the channel on the side opposite the direction in which the leaf of the control block extends, and the control block has a ledge adjacent the opening, and which further comprises:

an auxiliary switch fastened within the chamber and including fixed contact means and spring means carrying movable contact means and reaching into the path of and being operable by the control block

ledge, and terminal means fastened to the housing and leading to the contact means.

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