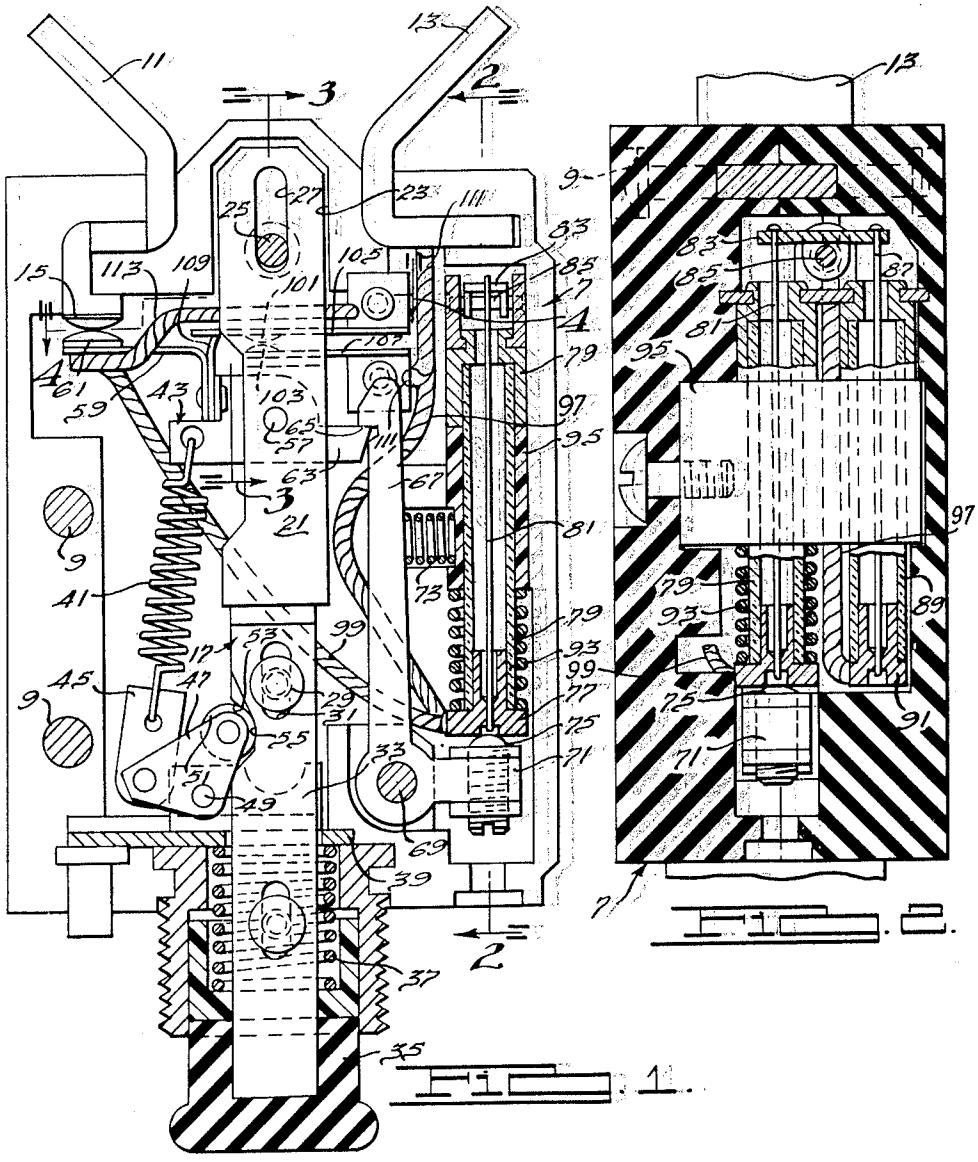
Nov. 24, 1964 R. C. INGWERSEN 3,158,715

ELECTRIC SWITCH INCORPORATING AN AUTOMATIC CIRCUIT BREAKER

Filed Jan. 18, 1961 2 Sheets-Sheet 1



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Filed Jan. 18, 1961 2 Sheets-Sheet 2

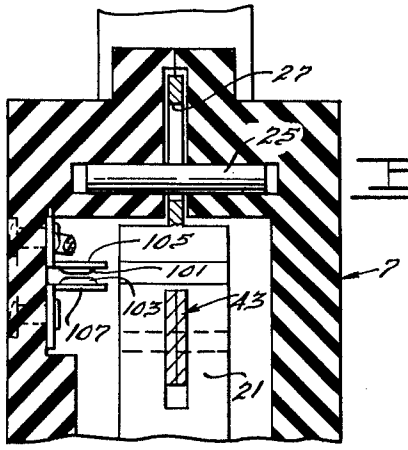


FIG. 3.

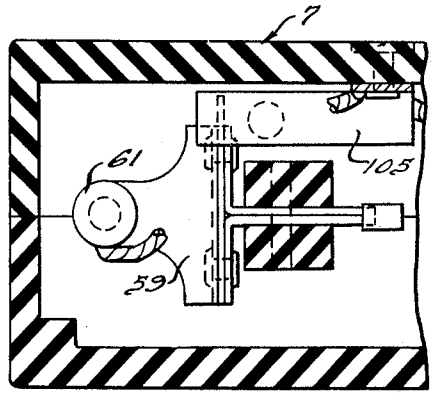


FIG. 4.

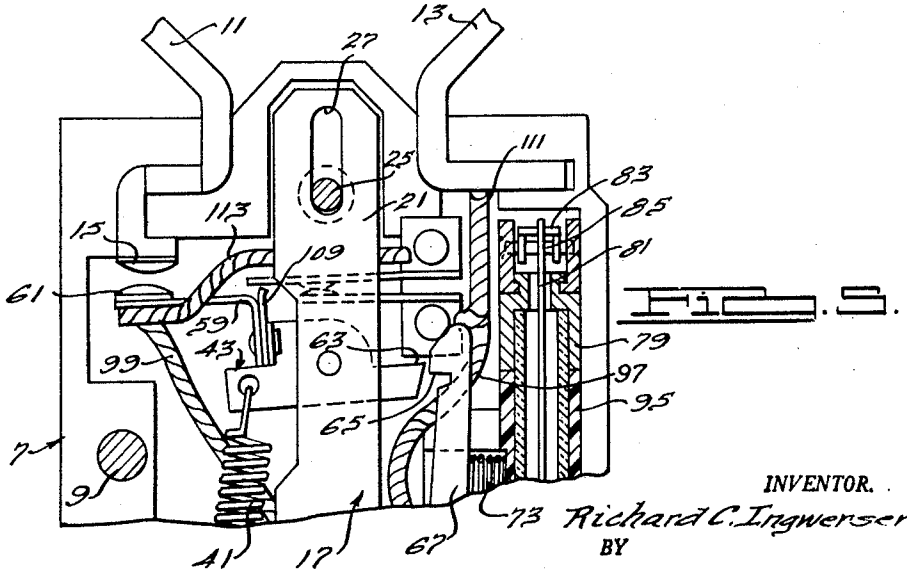


FIG. 5.

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3,158,715

ELECTRIC SWITCH INCORPORATING AN AUTOMATIC CIRCUIT BREAKER

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7 Claims. (Cl. 200—116)

This invention relates to improved electric circuit breakers and/or electric switches having automatic current overload protection.

This application is a continuation-in-part of applicant's copending application, Serial No. 823,052 filed June 26, 1959, now abandoned. In the electric circuit breaker and/or electric switch shown in applicant's Patent No. 2,943,172, a hot wire-type thermostatic element is incorporated which, upon expansion due to current overload, frees a contact for movement out of engagement with a companion stationary contact so as to interrupt current flow through the circuit breaker. This type of circuit breaker has many advantages, particularly where rapid overload response is required and where relatively low current values are to be interrupted. While the circuit breaker shown in applicant's aforementioned patent operates efficiently, is extremely sensitive and has had wide commercial use and application, it has been found that when the aforementioned circuit breaker is used in low frequency or high voltage circuits, there is a tendency for an arc to occur upon opening of the contacts which permits overheating of the hot wire thermostatic element or assembly and in some instances, severe damage or destruction of the same.

For instance, while the circuit breaker illustrated in applicant's aforementioned application is extremely satisfactory for use in circuits wherein the current frequency is 400 cycles per second, the aforesaid tendency toward arcing and damage or destruction of the hot wire has been noted in circuits having low frequency current of the order of 60 cycles per second.

It is therefore, an object of this invention to provide a circuit breaker having the advantages of the circuit breaker described in applicant's aforementioned patent application and which will have increased interrupting capacity over a wide range of voltages and frequencies and which will operate efficiently and for a long period of time at voltages and frequencies outside of the range for which the aforementioned circuit breaker was developed and designed.

It is a still further object of this invention to provide an improved circuit breaker of the aforementioned type without increasing the size of the same relative to the aforementioned prior circuit breaker.

These and other objects of the present invention will become apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a longitudinal view, partially in section and partially in elevation of the circuit breaker of this invention;

FIG. 2 is a fragmentary sectional view of the structure illustrated in FIGURE 1, taken along the line 2—2 thereof;

FIG. 3 is a fragmentary sectional view of the structure illustrated in FIG. 1, taken along the line 3—3 thereof;

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FIG. 4 is a fragmentary sectional view of the structure illustrated in FIG. 1, taken along the line 4—4 thereof; and

FIG. 5 is a fragmentary sectional view, similar to FIG. 1, illustrating the position of the contact elements when the circuit breaker is in its open or current interrupting position.

Referring now to the drawings, it will be seen that an electric switch is illustrated which incorporates automatic overload current protection. The illustrated circuit breaker is similar in many respects to the device illustrated in applicant's aforementioned patent and includes a hollow casing 7 which may be made of plastic or other suitable material formed in two halves secured together by suitable fastening means 9. First and second terminals 11 and 13 project from the casing or housing 7 and are adapted to be connected in an external electrical circuit so that current flows from one terminal through the circuit breaker to the other terminal and so that as the circuit breaker moves to its tripped or open position due to current overload or manual actuation, current flow through the circuit breaker is interrupted. A stationary contact 15 is supported within the housing 7 and connected with the terminal 11.

A plunger 17 is slidably supported in the housing for "in" and "out" movement. The plunger includes an inner plunger member or portion 21 which extends into a guideway 23 at the upper end of the housing 7. A pin 25, fixed to the housing, extends through a slot 27 near the upper end of the inner plunger portion 21 for limiting the travel thereof. At its lower end the inner plunger portion 21 carries a pin 29 which extends through a slot 31 in an outer plunger portion or member 33.

The outer plunger portion 33 extends through the lower or front wall of housing 7 and a knob 35, preferably formed from an insulating material such as plastic, is secured thereto exteriorly of the housing for manual actuation of the device. The outer plunger portion 33 is urged outwardly by a compression coil spring 37 fitted within the knob 35 and bearing at its inner end against a fixed abutment plate 39 within the housing 7. The inner plunger portion 21 is resiliently urged outwardly by a tensioned coil spring 41, one end of which is connected to a contact carrying arm 43 near the left-hand thereof as viewed in FIG. 1. The other end of the spring 41 is connected by means of an insulating link 45 to a lever 47 which is pivoted on a fixed pivot 49 adjacent to the plunger 17. The lever 47 carries a roller 51 which is resiliently urged by spring 41 into notches 53 and 55 in the inner and outer plunger portions 21 and 33, respectively. The spring 41 is sufficiently strong so that when it is tensioned to the position illustrated in FIGURE 1, it holds the roller 51 in the notches 53 and 55 and thereby holds the outer plunger portion 21 in its advanced position against the urging of the biasing spring 37. The notch 55 in the outer plunger portion 33 is relatively gently sloped so that when the tension of the spring 41 is relieved, the sloping side of the outer plunger portion notch 55 cams the roller 51 laterally out of both the notches 53 and 55, thus releasing both portions of the plunger for outward movement responsive to urging of the biasing spring 37. The outward force of the biasing spring 37 is then transmitted to the inner plunger portion 21 through the pin and slot connection 29 and 31 so as to move the inner plunger portion outwardly. Thus, a

lost motion connection between the two plunger portions 21 and 33 is provided which will permit operation as set forth above and which, likewise, will permit the plunger knob 35 to be grasped and manually pulled outwardly, thus causing the roller 51 and its supporting lever 47 to be cammed laterally away from the plunger so as to permit the device to be used as a manually actuated electric switch.

The contact carrying arm 43 is pivotally connected at 57 to the inner plunger portion 21. Supported on the contact carrying arm 43 to the left side of the plunger, as illustrated in FIG. 1, is an angle-shaped resilient or spring blade 59 which carries a movable contact 61 on the outer end thereof which is adapted to be moved into and out of pressure engagement with the stationary contact 15. Projecting from the right-hand side of the contact carrying arm 43, as viewed in FIG. 1, is a ledge or shoulder 63 which is adapted to be engaged by a complementary lip or latch 65 formed adjacent the upper end of a lever 67 pivoted at 69 in the lower portion of the housing 7. The lever 67 is in the form of a bell crank and has a lower horizontal arm 71. The lever is normally urged into latch engagement with the contact carrying arm 43 by means of a coil spring 73 suitably supported in the housing and engaging the lever arm below the latch 65. The short lower arm 71 of the bell crank lever 67 carries an adjustable abutment 75 which engages a plug 77 in the lower end of a glass tube 79. One end of a conductive wire 81 is connected to the plug 77, while the other end thereof is connected to a rocker member 83 pivotally supported at 85 in the housing. Rocker 83 is made of current carrying material and a second wire 87 is connected to the rocker member on the opposite side of its central pivot from the wire 81. The wire 87 extends through a second glass tube 89 and is connected to a stationary plug 91 disposed in the bottom of the glass tube 89. The two wires 87 and 81 together with the lever 83 act in effect as a single long wire and when both wires are heated and thus expand or elongate, the rocker tips to permit the plug 77 in the lower end of the glass tube 79 to move downwardly under the urging of a coil spring 93. The spring 93 is disposed between plug 77 and a supporting block 95, which is mounted in housing 7 and supports wires 81 and 87, glass tubes 79 and 89 and appended parts as a subassembly. When the wires expand, due to heat caused by a current overload, spring 93 is freed to resiliently move plug 77 downwardly. Downward movement of plug 77 causes lever 67 to pivot in a clockwise direction, thus swinging the latch 65 at the upper end of the lever away from the shoulder or lip 63 of the contact carrying arm 43 to permit the spring 41 to rotate the contact carrying arm in a counterclockwise direction, as viewed in FIG. 1, thereby moving the movable contact 61 away from the stationary contact 15 and freeing the plunger 17 for movement by spring 37 to the "out" position as shown in FIG. 5.

The conductive wires 81 and 87 are connected to the second terminal 13 through a pigtail 97 so that an electrical conductive path or circuit through the circuit breaker is provided from the terminal 13 through the pigtail 97 to the plug 91 and wire 87, through rocker arm 83 and wire 81 to a pigtail 99 which extends from plug 77 to the movable contact 61 and thence to the stationary contact 15 and the first terminal 11.

With the construction thus described, the manually actuatable electric switch is provided with current responsive overload protection substantially as described in applicant's patent, referred to hereinabove.

It will be appreciated from the aforementioned description that upon occurrence of a predetermined current overload, the wires 81 and 87 will expand to permit the spring 93 to actuate the lever 67 and move the same out of latching engagement or from a holding position to a release position with respect to the contact carrying arm 43, thus permitting the spring 41 to move the contact 61 away from contact 15 and permitting the plunger to move to its outer position under the impetus of the spring 37, as shown in FIG. 5. After the wires 81 and 87 have cooled and contracted to their normal length, the spring 93, plug 77, lever 67 and latch 65 will return to the normal position shown in FIG. 1. The switch can then be reset by manually pushing inwardly on the plunger knob 35. The movable contact 61 will then move back into pressure engagement with stationary contact 15 and the contact carrying arm shoulder 63 will engage the lever latch 65, and the lever 47 carrying roller 51 will be pivoted into engagement with the notches 53 and 55 in the plunger portions 21 and 33 and the switch parts will again be retained in their normal current carrying positions as shown in FIG. 1.

As previously mentioned, the switch or circuit breaker may be opened by merely pulling manually outwardly on the plunger knob 35, thus camming the roller 51 out of the way and pulling the plunger portions 21 and 33 downwardly, thereby manually moving the contact 61 out of engagement with the stationary contact 15.

As discussed hereinbefore, when the wires 81 and 87 are subjected to a predetermined overload current, they become hot instantaneously and expand, thus opening the circuit breaker. This occurs much in the same manner as in an incandescent light where the wire heats extremely rapidly. This rapid heating and expansion of the wires 81 and 87 provides an important advantage in that the device is sensitive, very rapid in operation and can be used to protect very low amperage electrical circuits and equipment. It has been found, however, that the wires can overheat and burn out when the device is used in low frequency and/or high voltage circuits unless protective means are incorporated in the structure. For example, it has been found that if applicant's prior device is employed in a low frequency circuit having a frequency of the order of, for example, 60 cycles per second or in a circuit carrying a relatively high voltage, arcing may occur between the contacts 61 and 15 during movement of the contact 61 away from the contact 15. Particularly in the case of low frequency currents, the arc may be sustained for a finite period, current continuing to flow through the circuit breaker because of the presence of the arc. Current flow through the circuit breaker for an additional small length of time often effects separation of the contacts, in some cases sufficient to overheat the wires 81 and 87 and thus damage or destroy the same. To correct this problem so as to render the circuit breaker practicable for use in low frequency and/or high voltage circuits, yet provide a circuit breaker which has an extremely fast response to current overload so as to operate satisfactorily with low amperage currents, a second conductive path is provided in the circuit breaker. While the arrangement of this invention is not necessarily limited to the circuit breaker shown in applicant's aforementioned patent, it has particular utility in conjunction therewith and provides an improved circuit breaker far superior to anything known in the art, which is extremely compact in size, light in weight and relatively inexpensive to manufacture.

Referring again to the drawings, it will be seen that a pair of shunt contacts 101 and 103 are provided which are supported in the housing 7 adjacent one end of contact carrying arms 105 and 107, respectively. The opposite ends of contact arms 105 and 107 are suitably fastened or anchored to a wall of the housing 7. The contact carrying arm 105 is made of a resilient or flexible material and is capable of flexing or moving relative to the contact 103 so that the contact 101 is movable into and out of engagement with the contact 103. The contact carrying arm 105 is biased so as to normally resiliently urge the contact 101 towards engagement with the contact 103.

When the contacts 15 and 61 are in the closed condition, the contacts 101 and 103 are maintained in the open condition, by an upstanding blade or plate 109 that is

mounted on the contact carrying arm 43 as can be best seen in FIG. 1, and adapted to engage the underside of the shunt contact carrying blade 105, laterally outwardly of the contact 101.

The contact carrying arm 107 is connected with the terminal 13 through a pigtail 111 and the contact carrying arm 105 is connected with the movable contact 61 through a pigtail 113 so that when the shunt contacts 101 and 103 are in pressure engagement with each other, as will be hereinafter described, a second conductive path or circuit for current flow is provided in the circuit breaker in addition to the conductive path previously described. This second conductive path is from terminal 13 through pigtail 111 to contact 103 to contact 101, to contact carrying arm 105, through pigtail 113, to movable contact 61, to stationary contact 15 and thence to terminal 11.

When a pedetermined current overload occurs, expansion of the hot wires 81 and 87 results in movement of the lever 67 out of latching engagement with the contact carrying arm 43, enabling the spring 41 to pull the contact carrying arm 43 downwardly separating the contact 61 from the contact 15. However, as discussed hereinbefore, in some applications, for example, when the circuit breaker is connected in a low frequency and/or high voltage circuit, an arc may be drawn between the contacts 15 and 61 that sustains an electrical circuit through the circuit breaker including the wires 81 and 87 for a finite period despite opening of the contacts 15 and 61. This condition may have a serious deleterious affect on the wires 81 and 87.

In accordance with the present invention, this condition is alleviated upon closure of the shunt contacts 101 and 103 when the upstanding plate 109 on the arm 43 moves downwardly away from the shunt carrying contact arm 105 sufficiently to permit the contact carrying arm 105 to move the shunt contact 101 into engagement with its companion contact 103. Engagement of the contact 101 with the contact 103 establishes the second conductive path or shunt circuit through the circuit breaker, as previously described.

Electrical resistance in the shunt circuit is relatively lower than the resistance of the circuit including the wires 81 and 87 so that a greater proportion of the electric current will flow through the shunt circuit thereby protecting the wires 81 and 87 from overheating and damage or destruction even if the arc continues between the contacts 15 and 61 as the separate.

When the circuit breaker is closed to the position illustrated in FIGURE 1, the upstanding plate 109 on the arm 43 will again engage the underside of the shunt contact carrying arm 105 and will move the arm 105 upwardly so as to disengage the shunt contacts 101 and 103 and maintain them in the open condition while the contacts 15 and 61 are in the closed condition. Therefore, the shunt circuit will not interfere with the rapid operation of the circuit breaker or the initial flow of current through the circuit containing the wires 81 and 87 thereby enabling the wires 81 and 87 to instantaneously heat up and expand upon the occurrence of a predetermined current overload. The shunt circuit comes into effect only to provide a second conductive path or circuit to prevent excessive heating of the wires 81 and 87 and damage thereto due to an arc drawn between the main contacts 15 and 61 upon opening thereof.

The present invention contemplates the introduction of a shunt circuit sufficiently close to opening of the contacts 15 and 61 to protect the current-responsive wires 81 and 87 upon the occurrence of a continued circuit through the circuit breaker due to the presence of an arc drawn between the contacts 15 and 61. Obviously, therefore, the shunt circuit is effective to protect the wires 81 and 87 whether the shunt contacts 101 and 103 be closed immediately prior to opening of the main contacts 15 and 61, concurrently with opening of the contacts 15 and 61 or immediately subsequently to opening of contacts 15 and 61 as long as the shunt circuit is interposed prior to damage to the wires 81 and 87. Timing of the introduction of the shunt circuit is dictated by the speed of operation of the circuit breaker in conjunction with the characteristics of the wires 81 and 87. Timing is mechanically controlled by the relationship between the length of the upstanding plate 109 and the resilience of the blade 59 on the arm 43 that supports the movable contact 61.

In some applications timing of the introduction of the shunt circuit is dictated by another consideration. When the application of the circuit breaker requires that it be capable of closure against a short circuit, the shunt circuit is preferably opened prior to closure of the main contacts 15 and 61 thereby to protect the shunt contacts 101 and 103 against burnout. Accordingly, the length of the plate 109 is preferably so determined that, upon movement of the contact 61 toward engagement with the contact 15, the shunt contacts 101 and 103 are opened approximately .010 inch when the contacts 15 and 61 come into contact with one another. This sequencing precludes burnout of the contacts 101 and 103 upon closure of the circuit breaker against a short circuit condition yet provides for closure of the shunt contacts 101 and 103 sufficiently close to opening of the main contacts 15 and 61, upon the occurrence of a predetermined electrical condition, to preclude burnout of the wires 81 and 87 due to the maintenance of an electrical circuit through the breaker because of an arc drawn between the contacts 15 and 61 on opening thereof.

When closure of the circuit breaker against the short circuit condition is not a factor that must be considered, the length of the plate 109 can be arranged to effect closure of the contacts 101 and 103 immediately prior to or concurrently with opening of the contacts 15 and 61, as desired.

It is to be understood that the specific construction of the improved electric switch incorporating an automatic circuit breaker herein disclosed and described is presented for the purpose of explanation and illustration and is not intended to indicate the limits of the invention, the scope of which is defined by the following claims.

What is claimed is:

1. An electrical circuit breaker comprising a housing, a first terminal in said housing and connectible to an external circuit, a stationary contact within said housing and electrically connected with said first terminal, a movable contact, means supporting said movable contact in said housing for movement into and out of engagement with said stationary contact and including manually operable actuating means for moving said movable contact into engagement with said fixed contact, a second terminal electrically connected to said movable contact and connectible to an external circuit, resilient means urging said movable contact away from said fixed contact, means normally retaining said movable contact in engagement with said stationary contact and including a thermostatic element electrically series connected in a circuit between said first and second terminals and actuatable in response to a predetermined current overload to free said movable contact and its supporting means for movement by said resilient means out of engagement with said stationary contact, shunt means electrically connected in the circuit between said first and second terminals to conduct current through a conductive path separate from the conductive path which includes said thermostatic element, said shunt means including a pair of contacts supported in said housing, one of said shunt contacts being movable into and out of engagement with its companion contact, means resiliently urging said shunt contacts into engagement with each other, and means operatively connected with said movable contact supporting means for moving said one shunt contact out of engagement with the other shunt contact when said first movable contact is moved into engagement with said stationary contact so that upon the occurrence

of a predetermined overload current will flow through the conductive path which includes said thermostatic element and not through the path which includes said shunt contacts, said shunt contact moving means being movable upon movement of said movable contact and its supporting means away from said stationary contact so as to free said one shunt contact for movement by its resilient urging means into engagement with the other shunt contact just prior to disengagement of said movable contact from said stationary contact, whereby any current flow within said circuit breaker housing will be through said two conductive paths.

2. An electrical circuit breaker comprising a housing, a first terminal in said housing and connectible to an external circuit, a stationary contact within said housing and electrically connected to said first terminal, a movable contact positioned within said housing for travel into and out of pressure engagement with said stationary contact, a second terminal in said housing electrically connected to said movable contact and connectible to an external circuit, resilient means urging said movable contact away from said stationary contact, a releasable latch for holding said movable contact in pressure engagement with said stationary contact against the urging of said resilient means and movable between a holding position and a release position, manually operable actuating means for moving said movable contact into engagement with said stationary contact when said latch is in its holding position, a tensioned wire electrically series connected in the circuit between said first and second terminals and operatively connected with said latch and normally retaining said latch in said holding position when said circuit breaker is not subjected to a predetermined overload electrical current, means independent of said wire freed to move said latch to said release position upon elongation of said wire due to the occurrence of a predetermined electrical current overload in said circuit breaker, whereby said latch is released and said circuit breaker is tripped responsively to an overload current of a predetermined value, shunt means in said housing and electrically connected between said movable contact and said second terminal to conduct current through a second conductive path which is separate from the conductive path which includes said wire, said shunt means including a pair of pressure engageable contacts supported in said housing, means resiliently urging one of said contacts into pressure engagement with the other of said contacts, and means operatively connected with said movable contact for holding said one shunt contact out of engagement with the other shunt contact against the action of said resilient means when said movable contact is moved into pressure engagement with said stationary contact, said shunt contact holding means being movable upon movement of said latch means to its release position to free said shunt contact resilient means for moving said shunt contacts into pressure engagement prior to disengagement of said movable contact from said stationary contact, whereby two conductive paths of flow for electrical current are provided in said circuit breaker thereby preventing overheating of said wire after disengagement of said movable contact from said stationary contact.

3. The structure as claimed in claim 2, wherein said contact supporting means includes a resilient blade biased toward said stationary contact and wherein said movable shunt contact is supported on a resilient blade biased toward its companion contact.

4. An electrical circuit breaker comprising a housing, a first terminal in said housing adapted to be connected to an external circuit, a contact stationary within said casing and electrically connected to said first terminal, a contact within said housing movable for travel into and out of pressure engagement with said fixed contact, means supporting said movable contact for said movement within said casing including a spring blade on which said contact is mounted and which is biased toward said stationary contact, a second terminal electrically connected to said movable contact and adapted to be connected to an external circuit, resilient means for urging said movable contact away from said fixed contact, manually operable actuating means for moving said movable contact into engagement with said fixed contact, means normally retaining said movable contact in engagement with said stationary contact when said circuit breaker is not subjected to a predetermined overload electrical current and including a thermostatic element electrically series connected in the circuit between said first and second terminal and actuatable upon the occurrence of a predetermined electrical current overload to free said movable contact and its supporting means for movement away from said stationary contact under the impetus of said resilient means, shunt means within said housing electrically connected between said second terminal and said movable contact means so as to provide a second conductive path within said housing which excludes said thermostatic element, said shunt means including a pair of contacts, one of said contacts being supported on a spring-like blade which is biased toward the other contact, and means on said first movable contact supporting means engageable with said shunt contact blade and moving said shunt contact out of engagement with its companion contact when said first movable contact is moved into engagement with said stationary contact, said shunt engaging means being movable away from said shunt contact blade when said movable contact and its supporting means are freed for movement away from said stationary contact, whereby said biased blade will move said shunt contact into engagement with its companion contact prior to its disengagement of said first movable contact from said stationary contact.

5. An electrical circuit breaker comprising a pair of terminals, a fixed main contact electrically connected to one of said terminals, a movable main contact engageable with said fixed contact, a releasable operating mechanism for effecting separation of the main contacts, current responsive means electrically connected to said movable contact and to the other one of said terminals operable upon the occurrence of a predetermined electrical condition to effect release of the operating mechanism, a pair of separable shunt contacts, one of said shunt contacts being electrically connected to said movable contact, the other of said shunt contacts being connected to the other one of said terminals, and means on the operating mechanism for closing said shunt contacts upon separation of said main contacts to provide a conductive path between said movable contact and said other terminal shunting said current responsive means.

6. An electrical circuit breaker comprising a pair of terminals, a fixed main contact electrically connected to one of said terminals, a movable main contact engageable with said fixed contact, a releasable operating mechanism for effecting separation of the main contacts, current responsive means electrically connected to said movable contact and to the other one of said terminals operable upon the occurrence of a predetermined electrical condition to effect release of the operating mechanism, a pair of separable shunt contacts, one of said shunt contacts being electrically connected to said movable contact, the other of said shunt contacts being connected to the other one of said terminals, and means on the operating mechanism for closing said shunt contacts prior to separation of said main contacts to provide a conductive path between said movable contact and said other terminal shunting said current responsive means.

7. An electrical circuit breaker comprising a pair of terminals, a fixed main contact electrically connected to one of said terminals, a movable main contact engageable with said fixed contact, a releasable operating mechanism for effecting separation of the main contacts, current responsive means electrically connected to said movable contact and to the other one of said terminals operable upon the occurrence of a predetermined electrical condi-

tion to effect release of the operating mechanism, a pair of separable shunt contacts, one of said shunt contacts being electrically connected to said movable contact, the other of said shunt contacts being connected to the other one of said terminals, and means on the operating mechanism for opening said shunt contacts prior to closing of said main contacts thereby to protect said shunt contacts upon closure of said circuit breaker against said predetermined electrical condition.

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