Jan. 22, 1952 L. C. HART 2,583,174

ELECTRIC SWITCH OR CIRCUIT BREAKER

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Fig. 1.

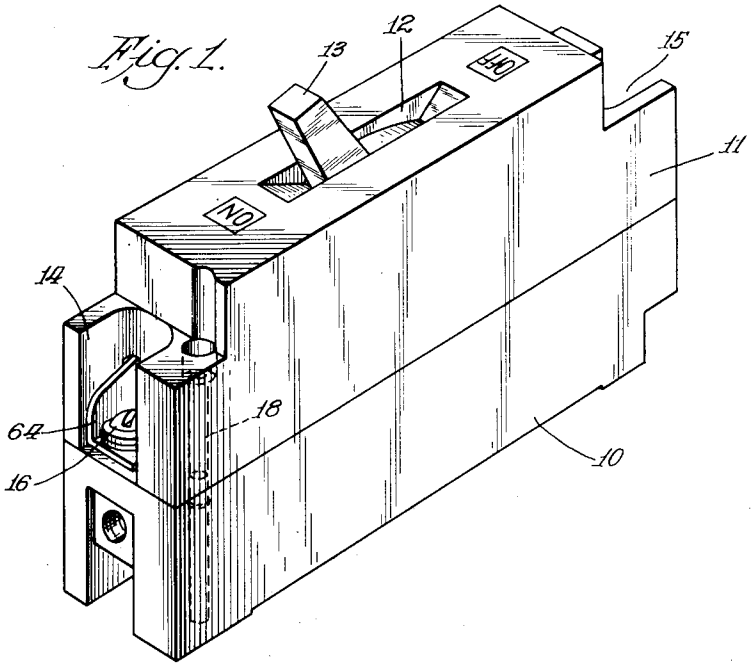

Fig. 2.

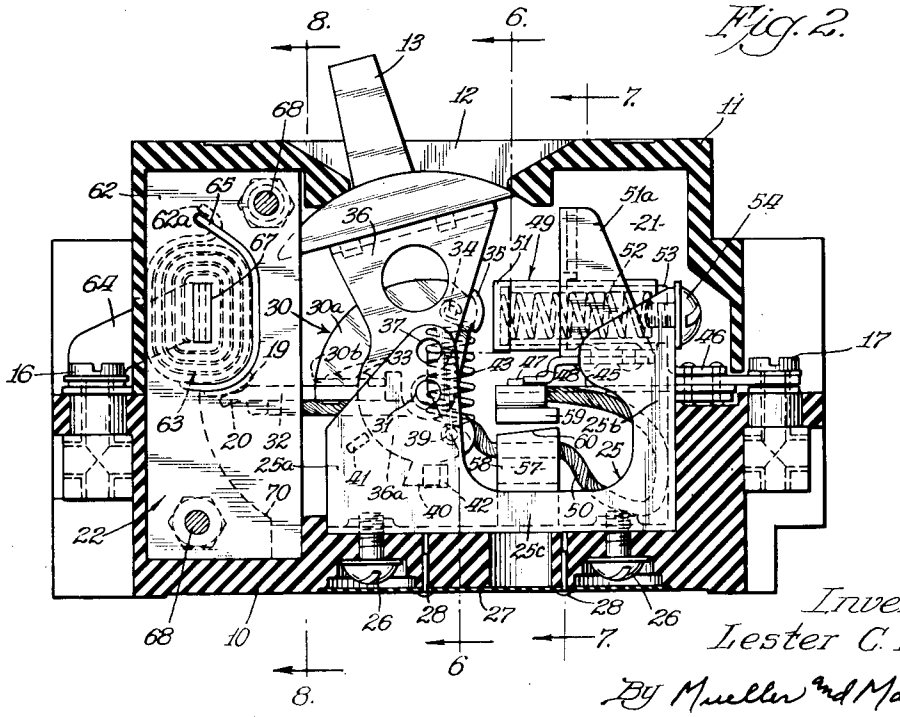

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Fig. 3.

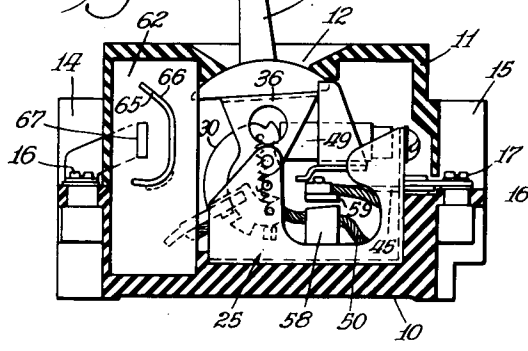
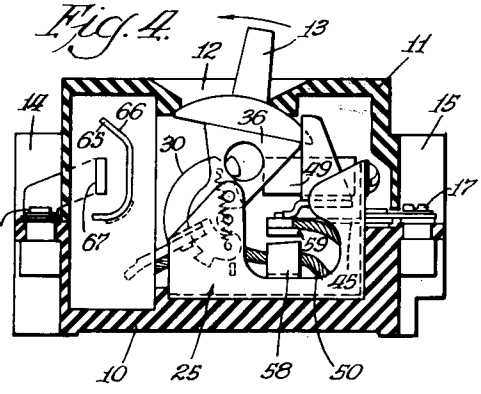


Fig. 4.



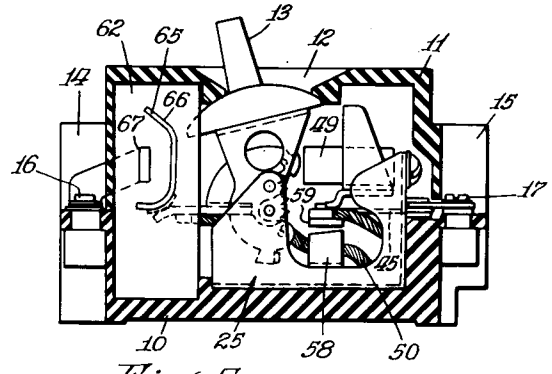


Fig. 5.

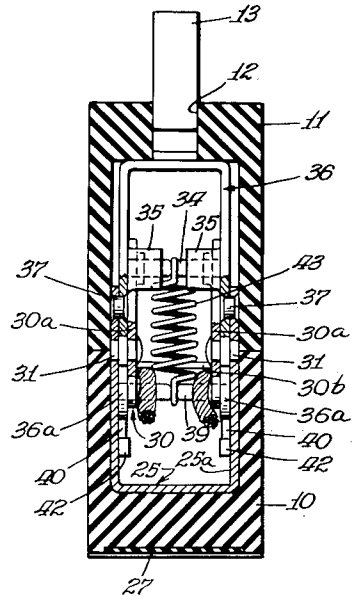


Fig. 6.

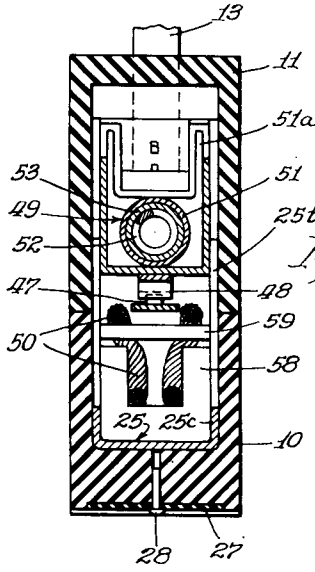


Fig. 7.

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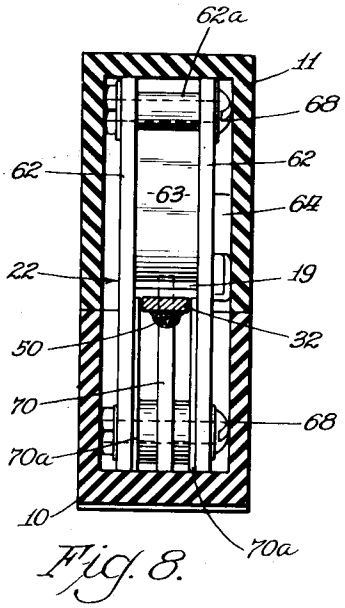

Fig. 8.

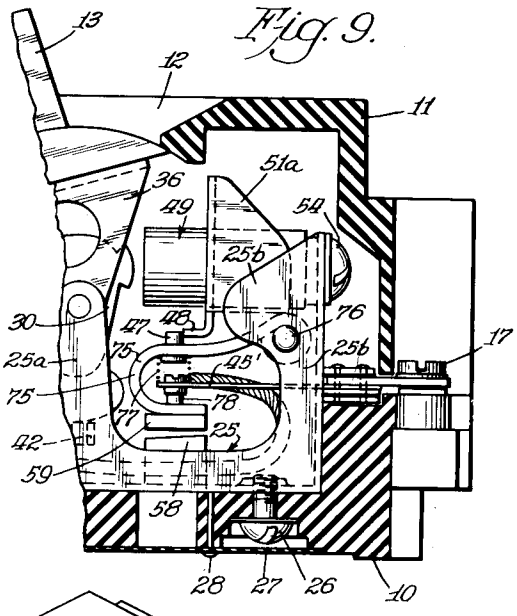

Fig. 9.

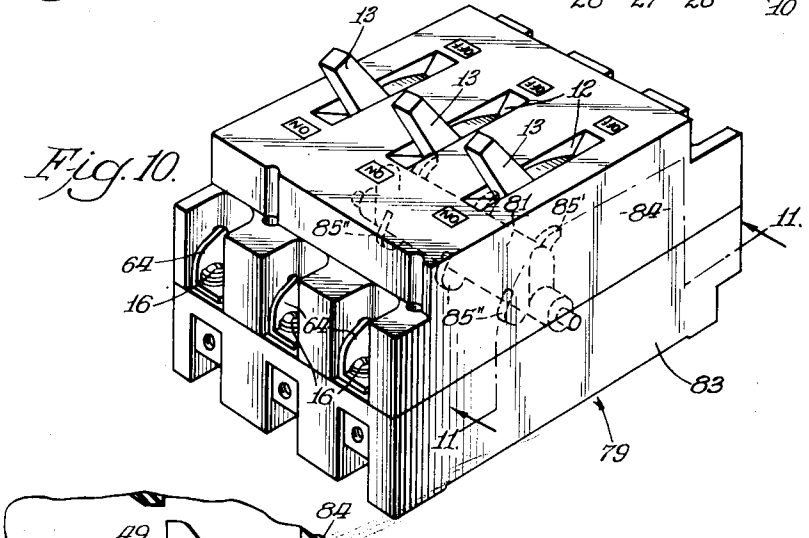

Fig. 10.

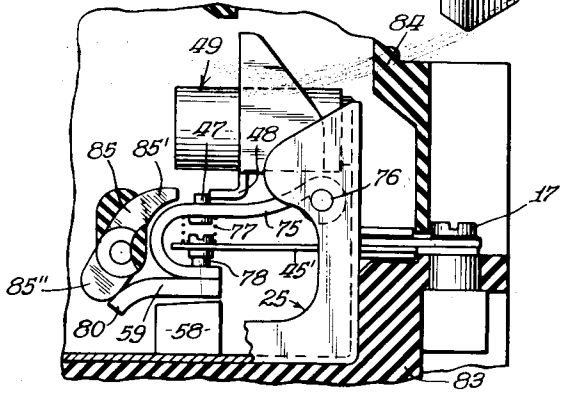

Fig. 11.

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UNITED STATES PATENT OFFICE

2,583,174

ELECTRIC SWITCH OR CIRCUIT BREAKER

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Application August 14, 1946, Serial No. 690,382

12 Claims. (Cl. 200—88)

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The present invention relates to electric switches or circuit breakers and more particularly to circuit breakers for use in controlling lighting or moderate power distribution circuits.

Circuit breakers for this type of service are subjected to very severe and very exacting operating requirements. The normal current which they must carry is relatively low but the short circuit current which such a switch or circuit breaker may be required to interrupt often reaches very high values due to the fact that other circuits connected to the system feed power to the short circuit controlled by this switch or circuit breaker. Consequently, it is essential that such a circuit breaker must be capable of opening the controlled circuit practically instantaneously upon the occurrence of a short circuit. In order to maintain continuity of service, the circuit breaker must not act to interrupt the circuit upon the occurrence of moderate overloads until such overload conditions if permitted to continue would endanger the controlled circuit as well as associated apparatus. In addition to these rather severe operational requirements, a commercially successful breaker or switch of this type must be low in cost due to the large number required even in a moderate sized building or factory and furthermore because such devices compete directly with the generally used fuse and switch combination. Usually this type of breaker is manually operable to the open or closed position. For satisfactory operation, the circuit breaker should be of the "trip free" type. By this is meant that even though the circuit breaker or switch is being moved to the closed position, a short circuit condition on the line controlled by the breaker existing at the instant of closure should be capable of opening the breaker even though the operator continues to move the manual means towards the closed position or holds the manual means so that it is not free to move to the open position.

It is an object of the present invention to provide an improved circuit breaker of the above-mentioned type capable of substantially instantly interrupting the circuit in the event of a short circuit condition and yet being simple from a manufacturing standpoint and economical from a cost standpoint.

It is another object of the present invention to provide a new and improved operating mechanism for a circuit breaker of the above-mentioned type.

Still another object of the present invention is to provide new and improved current responsive tripping means for an electric circuit breaker capable of distinguishing between short circuit conditions and long time overload conditions, which will cause instantaneous operation of the breaker in the event of a short circuit condition or operation of the breaker if an overload condition persists for a predetermined length of time.

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A further object of the present invention is to provide a new and improved arc extinguishing structure for a circuit breaker of the above-mentioned type whereby the circuit breaker is capable of interrupting currents of large magnitude without visible flame or the emission of arc gases and without noise.

A still further object of the present invention is to provide a combined thermal-and electro-responsive tripping means of a very sensitive and improved construction.

It is another object of the present invention to provide a new and improved arrangement for a multi-pole breaker in which an overload on any pole of the breaker causing tripping of that pole of the breaker will automatically cause operation of the other poles of the breaker.

Further objects and advantages of the present invention will become apparent as the following description proceeds and the features of novelty which characterize this invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

For a better understanding of the present invention, reference may be had to the accompanying drawings in which:

Fig. 1 is a perspective view of a single pole switch or circuit breaker embodying the present invention;

Fig. 2 is a longitudinal sectional view of the circuit breaker shown in Fig. 1 to illustrate the operating mechanism and arc extinguishing structure thereof with the circuit breaker shown in the closed position;

Fig. 3 is a somewhat simplified semi-schematic view of Fig. 2 showing the circuit breaker in the open position, but with the automatic trip means in the operated condition indicating that the contacts were opened in response to an abnormal current condition on the controlled circuit;

Fig. 4 is a view similar to Fig. 3 with the circuit breaker in the open position and with the automatic tripping means in the charged or operative condition;

Fig. 5 is a view similar to Fig. 3 showing the

circuit breaker in the closed position substantially as shown in Fig. 2 of the drawings;

Fig. 6 is a sectional view taken on line 6—6 of of Fig. 2 assuming that Fig. 2 shows a complete structure;

Fig. 7 is a sectional view taken on line 7—7 of Fig. 2 assuming that Fig. 2 shows a complete structure;

Fig. 8 is a sectional view taken on line 8—8 of Fig. 2 assuming that Fig. 2 shows a complete structure;

Fig. 9 is a sectional view somewhat similar to Fig. 2 of a portion of an electric circuit breaker embodying a modification of the present invention;

Fig. 10 is a perspective view similar to Fig. 1 of a multi-pole breaker embodying a modification of the present invention; and

Fig. 11 is a sectional view similar to Fig. 9 taken on line 11—11 of Fig. 10.

It will be understood from the following description that the present invention is applicable to single pole or multi-pole circuit breakers and although reference was made above to the fact that circuit breakers of the type with which the present invention is concerned are primarily adapted for low or moderate power circuits, it should be understood that the invention is not necessarily limited to the protection of such circuits and it is not intended that the invention be limited except as indicated in the appended claims.

Referring now to the drawings, there is illustrated an insulated base member 10 preferably formed of molded insulating material of any suitable type which is adapted to cooperate with a suitable cover member 11 also formed of insulating material preferably molded to the desired shape. The cover 11 is provided with a suitable opening 12 through which projects the handle 13 of an operating mechanism to be described in greater detail hereinafter. As shown in Fig. 1 of the drawings, the cover 11 is provided with suitable indicia for indicating the condition of the circuit breaker when the manual operating handle 13 is in certain predetermined positions. Only the on and off positions are indicated in Fig. 1 of the drawings, but as will become apparent from the following description, an additional position of the operating handle 13 may be indicated to show that the circuit breaker has been opened in response to an abnormal condition on the circuit controlled thereby. This is a desirable feature since it warns the operator that the condition which caused the automatic opening of the circuit breaker may still exist and in certain cases, it may be desirable to investigate and remove such abnormal condition before returning the circuit breaker to the closed position. This will be more clearly pointed out in the following description. The cover 11 is also provided with notched end portions 14 and 15 to afford access to the terminals 16 and 17, respectively, which are supported at the ends of the base member 10. Suitable fastening means generally indicated at 18 may be provided for holding the cover 11 and base member 10 in the unitary relationship shown in Fig. 1 of the drawings. It should be understood that any other suitable means for accomplishing this purpose may be employed.

As best shown in Fig. 2 of the drawings, the cover 11 and the base 10 define a chamber or housing for the electric switch or circuit breaker of the present invention which comprises a pair

of relatively movable contacts 19 and 20 controlled by a suitable operating mechanism generally indicated at 21 and positioned in the major portion of the housing defined by the base 10 and the cover 11. In order to aid in the extinguishment of an arc drawn between the contacts 19 and 20 upon separation thereof, there is provided a suitable arc extinguishing structure or arc chute generally indicated at 22. One of the contacts, namely the contact 19, has been specifically indicated as a stationary contact which is supported within the arc chute 22 in accordance with a feature of the present invention which will be described hereinafter. The contact 20, on the other hand, is a movable contact which is controlled by the operating mechanism 21 in a manner described below. It will be understood that the engaging portions of the contacts 19 and 20 are preferably formed of an arc-resisting material to prevent freezing of the contacts when they are subjected to currents of such magnitude as to cause them to weld. A suitable arc-resisting material for this purpose is a silver tungsten alloy.

Considering now the operating mechanism generally indicated at 21, the elements of which are best shown in Fig. 2 of the drawings, it is observed that the operating mechanism 21 is supported by means of a support or frame member 25 which may be fastened to the base 10 as by means of suitable screws 26 extending through the bottom wall of the base member and threadedly engaging the frame or support 25. If desired, a suitable cover member 27 may be provided to cover the recesses in which the screws 26 are disposed and the cover 27 may be held in position by suitable pin means 28 or the like. The frame or support 25 for the operating mechanism 21 comprises a pair of parallel upwardly extending leg portions 25*a* at one end thereof and a pair of parallel upwardly extending leg portions 25*b* at the other end thereof. Interconnecting the portions 25*a* and 25*b* is the portion 25*c* of the frame or support 25 which comprises a channel-shaped portion within which the current responsive tripping means to be described hereinafter are disposed. The portions 25*a*, 25*b* and 25*c* are all integral and the parallel portions 25*a* and 25*b* are each interconnected by a web portion so as effectively to present a channel-shaped construction throughout.

For the purpose of movably supporting the movable contact 20, there is provided a contact carrying element 30 which is pivotally mounted as indicated at 31 to the upwardly extending leg portions 25*a* of the frame or support 25. As illustrated, the contact carrier 30 comprises a pair of side pieces 30*a* in the form of quadrants of a circle interconnected by a base portion 30*b* which is preferably integral with the side portions 30*a*. The movable contact 20 is preferably supported on a contact supporting rod 32 suitably fastened to the base or web portion 30*b* of the contact carrier 30*a* as by means of screws or rivets 33. The other ends of the quadrant-shaped parallel disposed side pieces 30*a* of the contact carrier 30 are interconnected by a pin member 34. In addition, the contact carrier 30 is provided with integral extensions 35 for receiving a suitable hammer blow or the like from an automatic tripping device to be described hereinafter.

As pointed out above, the switch of the present invention is manually operable through actuation of a suitable handle 13. Specifically, this

handle 13, which is preferably formed of insulating material or the like, is suitably fastened to an actuating member 36 which is pivotally supported to the upwardly extending legs 25a of the frame 25 as is indicated at 37. The actuating member 36 is of somewhat U-shaped configuration with the legs of the U 36a spaced so as to fit between the upwardly extending legs 25a of the frame or support 25 and so as to receive between the legs 36a of the U the contact carrier 30. A suitable pin 39 interconnects the ends of the legs 36a of the U-shaped actuating member 36. In order to limit the maximum pivotal movement of the actuating member 36, the ends of the U-shaped legs 36a are each provided with extensions 40 which in the open circuit position engage with stop members 41 extending inwardly from the legs 25a of the frame 25 and in the closed position of the switch engage the stop members 42 extending inwardly from the legs 25a. In Fig. 2 of the drawings where the switch is in the closed position, it is noted that the extensions 40 are in engagement with the stop members 42.

Where an electric switch or circuit breaker is expected to interrupt currents of considerable magnitude such as short circuit currents, it has been common practice to cause the relatively movable contacts to separate with a snap action, thereby insuring the quick drawing and extinction of an arc. It is also customary to have these contacts close the circuit with a snap action to prevent an arc being drawn before the contacts are completely closed. Such a snap acting feature of the contacts for both opening and closing of the circuit breaker is obtained merely by interconnecting the pin 34 of the contact carrier 30 with the pin 39 of the actuating member 36 by means of a tension spring 43. With this arrangement, an over-center device is provided operatively relating the actuating element 36 and the contact carrier 30. Movement of the actuating member in one direction tends to move one of the supports for the tension spring 43 in an over-center direction so that relative movement between the contacts under the influence of the tension spring occurs prior to complete movement of the actuating member 36 in the predetermined direction. If the actuating element 36 is moved in the other direction, the same action occurs except that the contacts move in the opposite manner with a snap action. It should be understood that the particular over-center device illustrated forms no part of the present invention and any other suitable means for providing snap action operation of the contacts during both the circuit closing and the circuit opening operations may be employed.

In circuit breakers of the type described above, it is also desirable to provide suitable current responsive means which will cause relative separation of the contacts of the circuit breaker in the event that an overload condition persists for a sufficient length of time to cause damage to the associated circuit if it is permitted to continue. Thermal-responsive means in the form of a bimetallic element or the like are commonly used for this purpose and accordingly, there is illustrated in Fig. 2 of the drawings a bimetallic element 45 which is insulatingly supported from a suitable ear 46 punched out of the web interconnecting the upwardly extending portions 25b of the frame or support 25. Preferably the bimetallic element 45 has the end thereof which is fixed to the ear 46 and insulated therefrom by

suitable insulating means electrically connected to the terminal 17 of the switch in any suitable manner. The free end of the bimetallic element 45 is provided with an upwardly extending latching element 47 which is adapted to be engaged by a suitable cooperating latching member 48 supported in any suitable manner from a suitable plunger mechanism generally indicated at 49 and controlled by the bimetallic element 45. The free end of the bimetallic strip 45 is electrically connected by one or more parallel conductors 50 with the movable contact 20, thereby insuring that the circuit through the electric switch or circuit breaker from terminal 17 to the movable contact 20 includes the bimetallic element 45 and the conductor or conductors 50.

For the purpose of insuring high speed relative separation of the contacts 19 and 20 in the event of an abnormal circuit condition on the circuit controlled by the circuit breaker of the present invention, there is provided the plunger mechanism 49 which comprises a cup-shaped or cylindrical plunger member 51 having an upwardly extending yoke 51a integrally formed therewith. A suitable spring in the form of a coiled compression spring 52 contained within the cup-shaped plunger 51 normally tends to bias the longitudinally movable plunger 51 into striking engagement with the projections 35 of the contact carrier 30. The reciprocating plunger 51 is supported on a cylindrical member 53 which is nested within the plunger 51. The coiled compression spring 52 is actually contained within the nested cylindrical members 51 and 53 and tends to bias them into non-telescopic relationship. The inner supporting cylinder 53 is suitably supported as by means of a screw 54 from the web portion between the upwardly extending portions 25b of the frame or support 25. When the latch members 47 and 48 are in latching relationship as indicated in Fig. 2 of the drawings, the cylindrical members 51 and 53 of the spring biased plunger mechanism 49 are held in a substantially fully telescoped position with the compression spring 52 held in a charged condition so that upon release of the latching means, the plunger 51 of the plunger mechanism 49 is in position to hit the contact carrier 30 or the extensions 35 thereof a hammer blow causing relative separation of the contacts and insuring separation thereof even though the contacts have tended to be frozen together.

The yoke or upwardly extending portions 51a of the plunger mechanism generally indicated at 49 are provided in order to engage the actuating member 36. Upon operation of the circuit breaker to the open position in response to an abnormal current condition which causes release of the cooperating latching members 47 and 48, the extension or yoke 51a engages the actuating member 36 so as to move the actuating member to the intermediate position shown in Fig. 3 of the drawings, thus giving a clear indication to the operator that the circuit breaker is not only in the open position but furthermore, that it has been actuated to this position by virtue of an abnormal current condition existing on the controlled circuit. In addition, the extensions or yoke 51a provides a means by which a force may be transmitted from the actuating member 36 to the plunger mechanism generally indicated at 49, whereby upon moving the handle 13 from the position indicated in Fig. 3 of the drawings to the position indicated in Fig. 4, the plunger mechanism is relatched and the compression

spring 52 is recharged while the contacts of the circuit breaker remain in the open position. As soon as the plunger mechanism has been moved sufficiently from the position shown in Fig. 3 of the drawings to the position shown in Fig. 4 of the drawings, the latch member 48 will be moved into engaging relationship with the cooperating latch member 47 supported on the free end of the bimetallic element 45. It will be understood that the calibration of the bimetallic element and consequently the tripping of the circuit breaker in response to a long-time overload condition on the associated circuit may be controlled by controlling the length of the latch member 47. If desired, suitable adjustable means may be provided or on the other hand, calibration may be obtained by filing the latch member 47 to the desired height to give the desired operating characteristics.

From the above discussion, it will be apparent that if an abnormal current condition exists on the circuit controlled by the circuit breaker of the present invention for a sufficient length of time to cause the bimetal to deflect in a downward direction to an extent to free cooperating latching member 48, then relative separation of the contacts 19 and 20 will occur. Such operation will require a predetermined delay due to the time involved in heating bimetal 45 to the desired temperature. As was pointed out above, under short circuit conditions, it is essential that the circuit be interrupted substantially instantaneously. Accordingly, there is provided an additional means for releasing the plunger operated mechanism generally indicated at 49 which additional means is also current responsive and has been illustrated as an electromagnetic device generally indicated at 57 comprising a U-shaped magnetic member or core structure 58 and a cooperating movable armature member 59 which is suitably supported from the free end of the bimetal 45 in a position above the legs of the U-shaped core structure 58. The upper ends of the legs of the U-shaped core structure 58 are cut at an angle as is indicated at 60 so that when the bimetal operates in the manner of a cantilever, the armature 59 will engage the core structure 58 across the entire end surface of the legs thereof. In accordance with a feature of the present invention, the core structure 58 has a magnetomotive force applied thereto by virtue of the fact that the flexible conductor or conductors 50 pass between the legs of the U-shaped core member 58, as is best shown in Fig. 7 of the drawings, beneath the armature 59. It is apparent that the U-shaped core structure 58 and the armature 59 form a magnetic ring or band substantially completely surrounding the flexible conductor 50 except for the airgaps between the ends of the core structure 58 and the armature 59. In the event of the flow of a short circuit current through conductor 50, sufficient flux is produced in the core structure 58 and armature 59 to cause the armature 59 to move into engagement with the ends of the core structure 58, thus closing the airgaps between the two. The downward movement of the armature 59 will pull the free end of the bimetal element 45 downwardly with the resultant release of the cooperating latching members 47 and 48 and the resultant instantaneous opening movement of the circuit breaker in the manner explained above. With this arrangement, the trip mechanism provides a time interval before relative separation of the contacts under overload conditions and a substantially instantaneous trip under short circuit conditions.

Although the high speed separation of the contacts 19 and 20 by virtue of the snap acting mechanism described above will cause rapid extinguishment of any arc drawn between the contacts 19 and 20 under low current conditions, it is essential that this arc be rapidly extinguished under high current conditions as well and regardless of whether the circuit breaker is used to protect alternating current or direct current circuits. In addition and as was pointed out above, the arc extinguishing operation should occur without noise and without any evidence of flame or arc extinguishing gases. For this purpose, the arc chute 22 referred to above is provided as illustrated in the drawings and particularly with reference to Figs. 2 and 8 thereof. This arc chute 22 comprises a pair of side plates 62 which are held in spaced relationship by suitable spacing means 62*a*. Preferably the side plates 62 are formed from a suitable inorganic insulating material such as a Portland cement asbestos compound or the like. Mounted in the upper portion of the arc chute 22 and supported by the side plates 62 is a magnetic blow-out coil 63, formed of flat strip conducting material with adjacent turns separated by a layer of insulating material, which has one end thereof electrically connected as by means of a conductor 64 with the circuit breaker terminal 16. The other end of the blow-out coil 63 comprises a wider portion of conductor which extends substantially around one-half of the blow-out coil and is supported thereby. The side plates 62 may be provided with cut-out portions 66 to accommodate the wider portion 5 of the blow-out coil and support the same in position as is clearly shown in Figs. 3, 4 and 5 of the drawings. The end of the blow-out coil 63 connected to conductor 64 extends through an opening in one of the side plates 62 and if desired, a suitable extension of this conductor 64 may be provided to extend through an opening 67 in the other side plate to aid in properly supporting the blow-out coil 63 between the side plate 62 of the arc chute 22. Suitable screws 68 are provided to hold the side plates in position.

In accordance with a feature of the present invention, the stationary contact 19 is fastened as by welding or the like to the portion 65 of the blow-out coil 63. It will be understood that the blow-out coil 63 tends to move the arc drawn between contacts 19 and 20 into the arc extinguishing portion of the arc chute 22 which, as illustrated in the drawings, is near the base 10. In order to aid in extinguishing the arc, a suitable arc splitter or baffle 70 is provided between the side plates 62, which baffle has a configuration of the character shown in Fig. 2 of the drawings which cannot interfere with the free movement of movable contact 20. If desired, the baffle 70 may be formed of gas-emitting insulating material to aid in extinguishing the arc drawn. In any event, the arc drawn between the contacts 19 and 20 is forced by the blow-out coil 63 into intimate engagement with the baffle 70 to cause rapid cooling and de-ionization of the arc gases with resultant rapid extinguishment of the arc. In certain cases, it may be desirable to provide suitable inserts or liner members such as 70*a* shown in Fig. 8 of the drawings formed of gas-emitting insulating material to further cool the arc drawn and from which gases are evolved when effected by the heat of

an electric arc to aid in the arc extinguishing operation. A suitable material for this purpose is horn fiber, methyl methacrylate, or the like.

In view of the detailed description included above, the operation of the circuit breaker of the present invention will be understood by those skilled in the art. Briefly, the handle 13 may be moved manually from the positions indicated in Figs. 3, 4 and 5 of the drawings to open and close the circuit breaker with the contacts separating and engaging with a snap action. In the event of an abnormal current condition on the circuit controlled by the circuit breaker of the present invention, the contacts 19 and 20 are automatically operated. If the abnormal current condition is a long-time overload condition, the circuit breaker will be operated to the open position when the bimetal 45 has heated sufficiently to operate the latching means comprising the cooperating latching elements 47 and 48 whereupon the longitudinally movable plunger mechanism 49 comprising the plunger 51 engages the contact carrier 30 so as to move contact 20 to the open position. It should be noted that by virtue of the fact that the plunger 50 engages the contact carrier 30 directly connected to the movable contact 20, trip-free operation of the circuit breaker is permitted. Thus, even when the operator is moving the handle 13 from the position shown in Fig. 4 of the drawings to the position shown in Fig. 2 of the drawings, the circuit breaker can open at high speed regardless of the position of the handle 13. In the event of a short circuit condition, the surge current flowing through the conductor 50 will produce sufficient flux in the magnetic structure comprising the core 58 and the armature 59 to cause movement of the armature 59 with the resultant substantially instantaneous opening of the circuit breaker. If the circuit breaker is operated to the open position by either the bimetallic element of the electromagnetic means described, the extension 51*a* of the plunger mechanism 49 moves the actuating member 36 and the handle 13 to an intermediate position such as is shown in Fig. 3 of the drawings, whereby the operator is apprised of the fact that the circuit breaker has been operated to the open position in response to an abnormal condition. The operator may then take steps to determine what the abnormal condition was prior to reclosing the circuit breaker if he so desires. To reclose the breaker when opened automatically in cooperation with one of the current responsive means, it is necessary first to move the handle 13 from the intermediate position shown in Fig. 3 of the drawings to the open position shown in Fig. 4 of the drawings to recharge and relatch the plunger operated mechanism 49, whereupon subsequent movement of the actuating member 36 to the closed position will reclose the circuit breaker, with the automatic tripping mechanism conditioned to operate the circuit breaker in the event of an abnormal current condition.

From an examination of Fig. 2 of the drawings, for example, it is apparent that opening of the circuit breaker in response to operation of the electromagnetic means requires movement of the armature 59, together with flexing of the bimetallic element 45. Under certain conditions, the force required to move the bimetallic element 45 may be too high for satisfactory operation of the electromagnetic tripping device. Accordingly, in Fig. 9 of the drawings, there is illustrated a modification of the present invention wherein movement of the armature 59 in response to a short circuit condition does not require flexing of the bimetallic element 45. The corresponding parts of Fig. 9 of the drawings are designated by the same reference numerals as in the preceding figures. However, instead of the bimetallic element 45, which is designated as 45' in Fig. 9 of the drawings supporting the armature 59 and the cooperating latching member 47, there is provided an intermediate member 75 in the form of a U with one of the legs of the U having an extension pivotally mounted as indicated at 76. This leg of the U-shaped member 75 supports the latching element 47. The other leg of the U-shaped member 75 supports the armature 59 above the core structure 58 in a manner clearly shown in Fig. 9 of the drawings. A suitable compression spring 77 is disposed between the upper surface of the bimetallic element 45' and the upper leg of the U-shaped member 75. This compression spring 77 is a relatively weak spring serving merely to maintain the pivotally mounted member 75 in the position shown when no force is applied to the armature 59 and no flexing of the bimetal 45' occurs. A suitable extension 78 on the lower surface of bimetallic element 45' engages the lower leg of the U-shaped member 75. An examination of Fig. 9 of the drawings will show that the current responsive tripping means operate in the same manner as in the arrangement shown in Fig. 2 of the drawings except that the electromagnetic tripping device can cause the armature 59 to move downwardly to cause unlatching of the cooperating latching members 47 and 48 without substantially deflecting the bimetallic element 45' merely by compressing weak compression spring 77. On the other hand, deflection or flexing of the bimetallic element 45' will cause the extension 78 thereof to move the U-shaped pivotal member 75 downwardly to unlatch the latching means.

Although the circuit breaker thus far described has been illustrated specifically as a single pole circuit breaker, it will be understood that it may equally well be a multi-pole breaker such as a two phase or three phase circuit breaker. In certain applications, it is desirable that upon the automatic operation of one pole of a multi-pole circuit breaker to the open circuit position, the other associated poles of the circuit breaker also be moved to the open circuit position. This can readily be accomplished by utilizing the modification of the present invention illustrated in Figs. 10 and 11 of the drawings. In these figures there is illustrated a multi-pole circuit breaker 79, each pole of which is substantially identical with the construction shown in Fig. 9 of the drawings except for the addition of an extension on the armature 59 and the provision of a trip bar common to all poles of the circuit breaker. Each armature 59 of the multi-pole circuit breaker 79 shown in Fig. 11 of the drawings is provided with an extension 80. A suitable trip bar 81 preferably formed of molded insulating material is pivotally mounted within the housing defined by the base 83 and the upper member 84 of the multi-pole circuit breaker 79 so as to extend adjacent each of the operating mechanisms 21 of the separate poles of the multi-pole circuit breaker 79 in the manner shown in Fig. 10 of the drawings and so as to be positioned adjacent the extensions 80 of the armatures 59. Adjacent each pole of the multi-pole breaker, the trip bar 81 is provided with a suitable insert 85 having

an upwardly curved portion 85' extending into the path of movement of the latching member 48. Inserts 85 are also each provided with an extension 85'' in close relationship with respect to the associated extensions 80 of the armatures 59. From an examination of Fig. 11 of the drawings it will be apparent that in the event that any one of the latching means of the multi-pole circuit breaker is released either through operation of the bimetallic elements 45' or the electromagnetic means comprising the core structure 58 and the armature 59, the latch member 48 will engage the extension 85' of the associated insert 85, thereby rotating the trip bar 81 in a counterclockwise direction as viewed in Fig. 11 of the drawings. Such counterclockwise rotation of the trip bar 81 will cause the portions 85'' of the inserts associated with the poles not actuated to the open position in response to operation of their current responsive means to engage the extensions 80 of the corresponding armature 59 causing downward movement thereof and resultant release of all of the latching means. It is thus apparent that a simple and foolproof means is provided for automatically opening all poles of the multi-pole circuit breaker in response to automatic operation of one pole thereof. The corresponding parts of Figs. 10 and 11 are designated by the same reference numerals as in the preceding figures.

The operation of the modification illustrated in Figs. 10 and 11 will be apparent in view of the detailed description included above.

While there have been shown and described certain particular embodiments of the present invention in connection with electric switches or circuit breakers, it is not desired that the invention be limited to the construction shown and described for it will of course be apparent that changes and modifications may be made therein without departing from the present invention, and it is aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the present invention.

I claim:

1. An electric switch comprising a pair of relatively movable contacts including at least one movable contact operable between an open circuit and a closed circuit position, a pivotally mounted contact carrier for said movable contact, a manually operable actuating element, an over-center device operatively relating said actuating element and said contact carrier for causing said movable contact to move with a snap action from its open circuit to its closed circuit position and from its closed circuit to its open circuit position, a longitudinally movable plunger, means for positioning said plunger adjacent said contact carrier so as to be capable of engaging the same, spring means for biasing said plunger into engagement with said contact carrier, current responsive latch means for restraining said plunger and said spring means associated therewith in a position to strike said carrier and move said movable contact to its open circuit position upon release of said latch means, and an extension on said plunger engageable by said actuating element for resetting said plunger through movement in a predetermined direction of said actuating element following opening of said switch in response to operation of said current responsive latch means.

2. An electric switch comprising a pair of relatively movable contacts including at least one movable contact operable between an open circuit and a closed circuit position, a movable contact carrier for supporting said movable contact, a manually operable actuating element, an over-center device operatively relating said actuating element and said contact carrier for causing said movable contact to move with a snap action from its open circuit to its closed circuit position and from its closed circuit to its open circuit position, a longitudinally movable plunger, means for supporting said plunger in a position capable of being moved to engage said contact carrier, spring means associated with said plunger for biasing said plunger into engagement with said contact carrier, latching means for holding said plunger out of contact with said contact carrier and for maintaining said spring means in a charged condition, and current responsive means for releasing said latching means to cause said plunger to strike said contact carrier and move said movable contact supported thereby to the open circuit position even though said actuating element is prevented from moving to a corresponding position.

3. An electric switch comprising a pair of relatively movable contacts including at least one movable contact operable between an open circuit and a closed circuit position, a frame member, a contact carrier pivotally mounted to said frame member, means for supporting said one movable contact from said contact carrier, a manually operable actuating element pivotally supported on said frame member, an over-center device operatively relating said actuating element and said contact carrier for causing said movable contact to move with a snap action from its open circuit to its closed circuit position and from its closed circuit to its open circuit position, an energy storage mechanism comprising a longitudinally movable plunger, means for supporting said plunger in a position capable of being moved by energy stored in said energy storage mechanism into engagement with said contact carrier to strike the contact carrier and move said movable contact to the open circuit position, latching means for restraining said energy storage mechanism in a charged condition, means responsive to a predetermined abnormal current condition on the circuit controlled by said switch for substantially instantaneously releasing said latching means permitting said energy storage mechanism to cause high speed opening of said switch even though said actuating element is prevented from moving to a corresponding position and additional means associated with said energy storage mechanism engageable by said actuating element whereby said energy storage mechanism may be recharged by subsequent movement of said actuating element.

4. An electric switch comprising a pair of relatively movable contacts including at least one movable contact operable between an open circuit and a closed circuit position, a movable contact carrier for supporting said movable contact, a manually operable actuating element, an over-center device operatively relating said actuating element and said contact carrier for causing said movable contact to move with a snap action from its open circuit to its closed circuit position, a longitudinally movable plunger, means for supporting said plunger in a position capable of being moved to engage said contact carrier, spring means associated with said plunger for biasing said plunger into engagement with said

contact carrier, latching means for holding said plunger out of contact with said contact carrier and for maintaining said spring means in a charged condition, thermal means for releasing said latching means to cause said plunger to strike said contact carrier and move said movable contact supported thereby to the open circuit position even though said actuating element is prevented from moving to a corresponding position, and electro-responsive means for substantially instantaneously releasing said latching means upon the flow of short circuit current through said switch.

5. An electric switch comprising a pair of relatively movable contacts including at least one movable contact operable between an open circuit and a closed circuit position, a movable contact carrier for supporting said movable contact, a manually operable actuating element, an over-center device including a tension spring operatively relating said actuating element and said contact carrier for causing said movable contact to move with a snap action from its open circuit to its closed circuit position and from its closed circuit to its open circuit position, a longitudinally movable plunger, means for supporting said plunger in a position capable of being moved to engage said contact carrier, spring means associated with said plunger for biasing said plunger into engagement with said contact carrier, latching means for holding said plunger out of contact with said contact carrier and for maintaining said spring means in a charged condition, and current responsive means for releasing said latching means to cause said plunger to strike said contact carrier and move said movable contact supported thereby to the open circuit position even though said actuating element is prevented from moving to a corresponding position comprising a bimetallic element and an electromagnetic element, either of said elements being capable of releasing said latching means depending upon the type of abnormal current condition existing on the circuit controlled by said switch.

6. An electric switch comprising a pair of relatively movable contacts including at least one movable contact operable between an open circuit and a closed circuit position, a frame member, a contact carrier pivotally mounted to said frame member, means for supporting said one movable contact from said contact carrier, a manually operable actuating element pivotally supported on said frame member, an over-center device operatively relating said actuating element and said contact carrier for causing said movable contact to move with a snap action from its open circuit to its closed circuit position and from its closed circuit to its open circuit position, cooperating stop members on said frame member and actuating element to limit the pivotal movement in either direction of said actuating element, an energy storage mechanism comprising a longitudinally movable plunger, means for supporting said plunger in a position capable of being moved by the energy stored in said energy storage mechanism to strike the contact carrier and move said movable contact to the open circuit position, latching means for restraining said energy storage mechanism in a charged condition; means responsive to a predetermined abnormal current condition on the circuit controlled by said switch for substantially instantaneously releasing said latching means permitting said energy storage mechanism to cause high speed opening of said switch even though said actuating element is prevented from moving to a corresponding position, and means associated with said energy storage mechanism engageable by said actuating element whereby said energy storage mechanism may be recharged by subsequent movement of said actuating element.

7. An electric switch comprising a pair of relatively movable contacts including at least one movable contact operable between an open circuit and a closed circuit position, a support, a U-shaped manually operable actuating element pivotally mounted to said support, a movable contact carrier for supporting said movable contact disposed between the legs of said U-shaped actuating element and pivotally mounted to said support, an over-center device including a tension spring operatively relating said actuating element and said contact carrier for causing said movable contact to move with a snap action from its open circuit to its closed circuit position and from its closed circuit to its open circuit position, a longitudinally movable plunger, means for supporting said plunger in a position capable of being moved to engage said contact carrier, spring means associated with said plunger for biasing said plunger into engagement with said contact carrier, latching means for holding said plunger out of contact with said contact carrier and for maintaining said spring means in a charged condition, and current responsive means for releasing said latching means to cause said plunger to strike said contact carrier and move said movable contact supported thereby to the open circuit position even though said actuating element is prevented from moving to a corresponding position.

8. An electric switch comprising a terminal, a pair of relatively movable contacts including at least one movable contact operable between an open circuit and a closed circuit position, a support, a manually operable actuating element pivotally mounted to said support, a movable contact carrier for supporting said movable contact pivotally mounted to said support, an over-center device including a tension spring operatively relating said actuating element and said contact carrier for causing said movable contact to move with a snap action from its open circuit to its closed circuit position and from its closed circuit to its open circuit position, a longitudinally movable plunger, means for supporting said plunger in a position capable of being moved to engage said contact carrier, spring means associated with said plunger for biasing said plunger into engagement with said contact carrier, latching means for holding said plunger out of contact with said contact carrier and for maintaining said spring means in a charged condition, electromagnetic means for releasing said latching means to cause said plunger to strike said contact carrier comprising a magnetic loop formed of a U-shaped member and an associated armature movable relative to said U-shaped member, and a flexible conductor extending through said magnetic loop interconnecting one of said contacts and said terminal so that a short circuit current flowing through said flexible conductor causes high speed operation of said electromagnetic means to release said latching means.

9. The combination set forth in claim 2 in which said current responsive means comprises a bimetallic element and an electromagnetic element, said electromagentic element when effective causing release of said latching means without affecting said bimetallic element.

10. The combination set forth in claim 2 in

which said current responsive means comprises a bimetallic element and an electromagnetic element, and in which said latching means comprises a pivotally mounted element, said bimetallic element having a fixed end and a movable end, said bimetallic element and said electromagnetic element both being capable of causing pivotal movement of said pivotally mounted element, said electromagnetic element when effective causing pivotal movement of said pivotally mounted element without affecting said bimetallic element, and compression spring means interposed between the movable end of said bimetallic element and said pivotally mounted element for normally holding said pivotally mounted element in a predetermined position.

11. The combination set forth in claim 2 in which said current responsive means comprises a bimetallic element and an electromagnetic element, and in which said latching means comprises a pivotally mounted element, said bimetallic element having a fixed end and a movable end, said bimetallic element and said electromagnetic element both being capable of causing pivotal movement of said pivotally mounted element, said electromagnetic element when effective causing pivotal movement of said pivotally mounted element without affecting said bimetallic element, and spring means interposed between the movable end of said bimetallic element and said latching means.

12. The combination set forth in claim 4 in which the switch has a plurality of separate and independent poles, a pivotally mounted trip bar formed of insulating material extending between

the poles of said switch and including a first and second extension adjacent each pole thereof, means responsive to the release of the latching means associated with any pole of said switch for engaging the associated first extension to rotate said trip bar, and means responsive to rotation of said trip bar for causing the second extensions on said trip bar to release the latching means of all the other poles of said switch.

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REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
1,641,202	Ruppel	Sept. 6, 1927
1,683,132	Hall	Sept. 4, 1928
1,809,275	Jennings	June 9, 1931
2,027,238	Lindstrom	Jan. 7, 1936
2,089,716	Smith	Aug. 10, 1937
2,175,859	Tusing	Oct. 10, 1939
2,184,372	Von Hoorn	Dec. 26, 1939
2,200,108	Wilckens	May 7, 1940
2,325,717	Swingle	Aug. 3, 1943
2,328,458	Jackson et al.	Aug. 31, 1943
2,342,945	Krieger	Feb. 29, 1944
2,356,039	Ellis et al.	Aug. 15, 1944
2,416,163	Dyer et al.	Feb. 18, 1947
2,419,125	Dorfman et al.	Apr. 15, 1947
2,439,511	Green	Apr. 13, 1948
2,443,090	Wise	June 8, 1948