

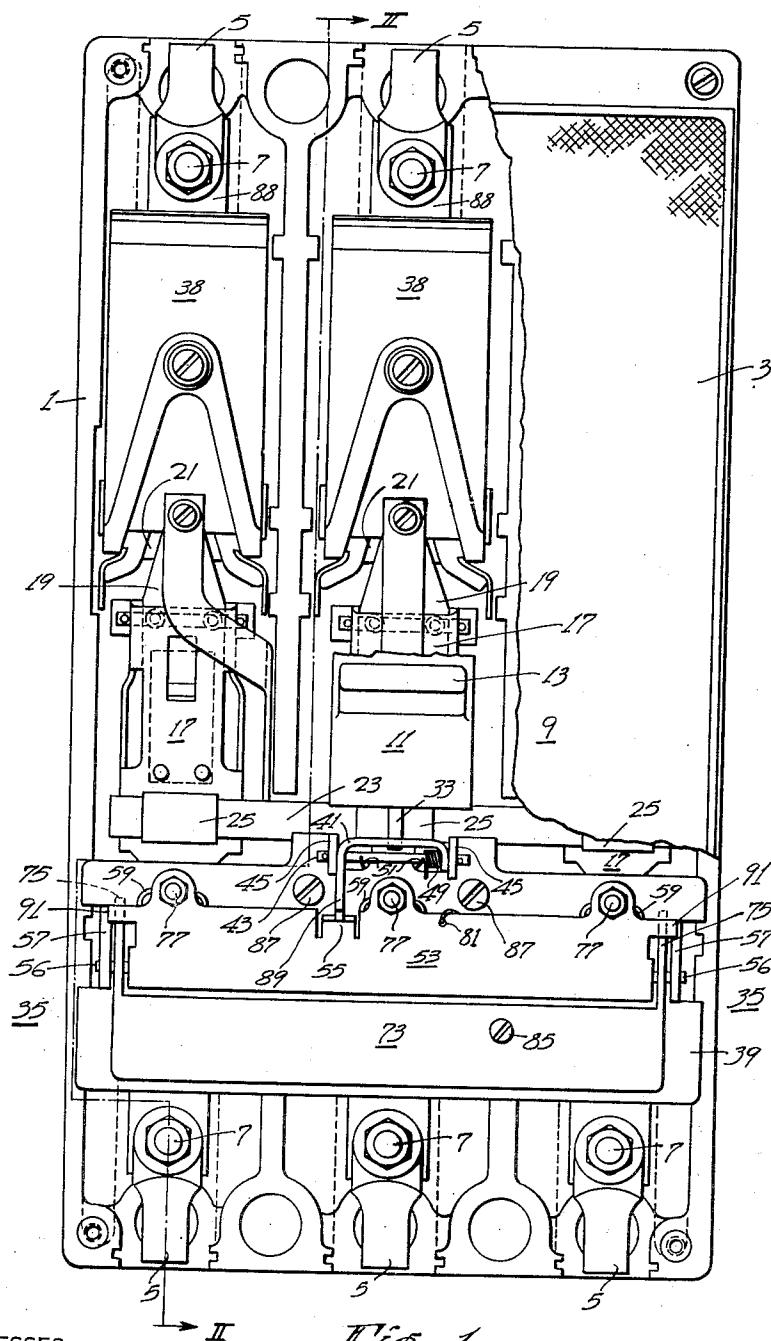
Jan. 17, 1939.

H. J. LINGAL
CIRCUIT BREAKER

2,144,501

Filed Jan. 19, 1935

4 Sheets-Sheet 1



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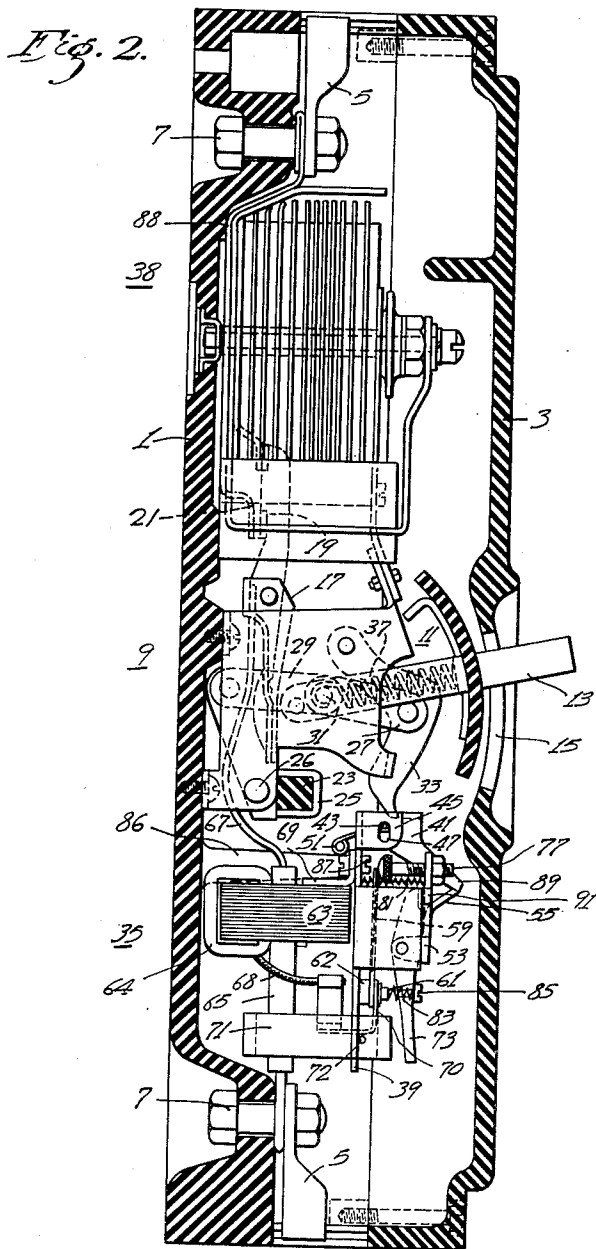
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2,144,501

CIRCUIT BREAKER

Filed Jan. 19, 1935

4 Sheets-Sheet 2



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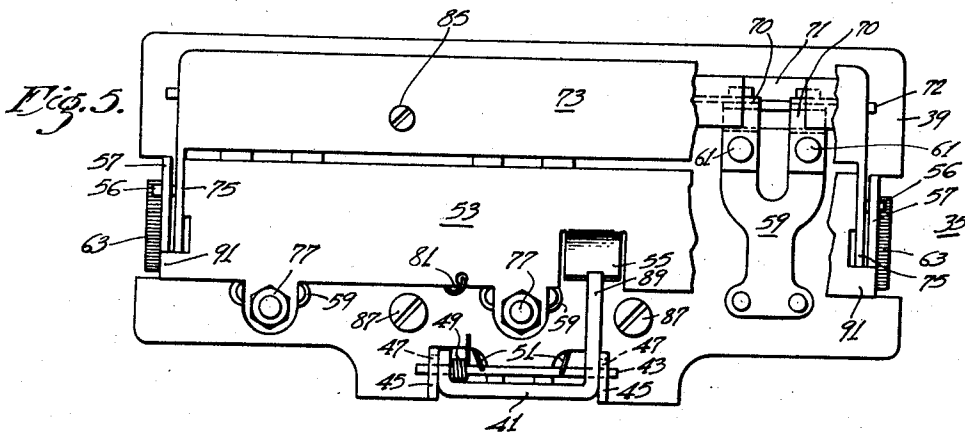
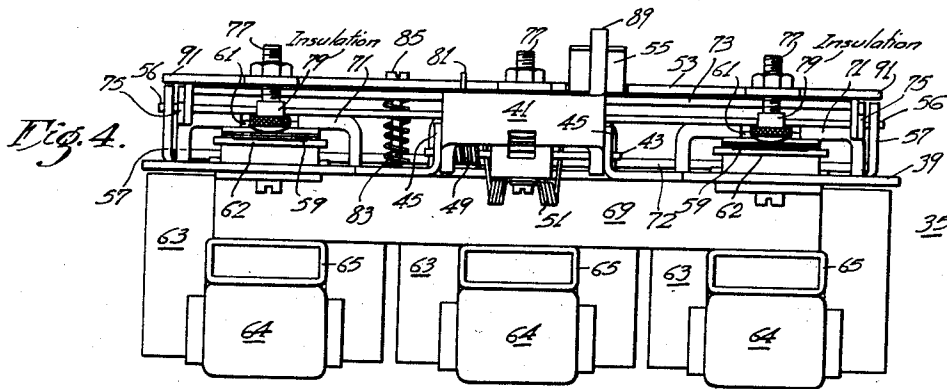
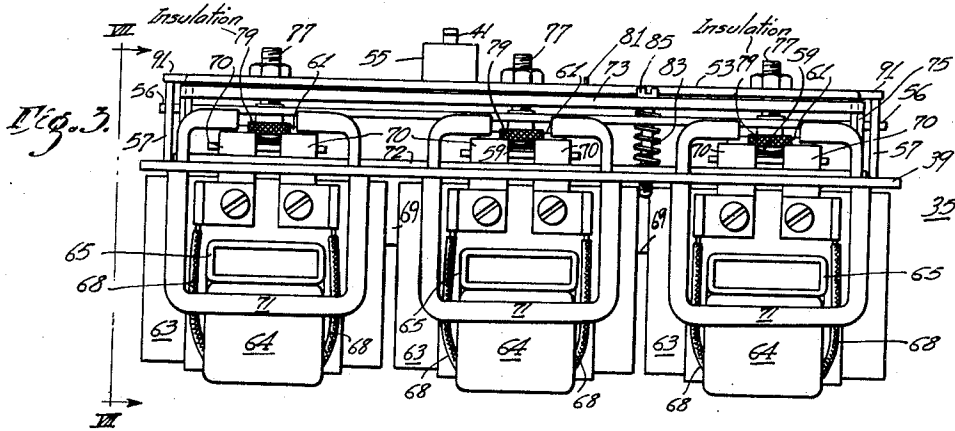
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CIRCUIT BREAKER

Filed Jan. 19, 1935

4 Sheets-Sheet 3



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CIRCUIT BREAKER

Filed Jan. 19, 1935

4 Sheets-Sheet 4

Fig. 6.

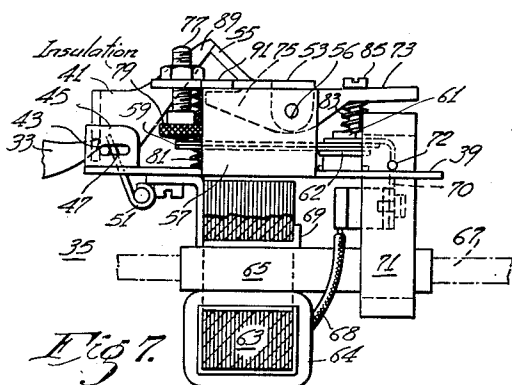
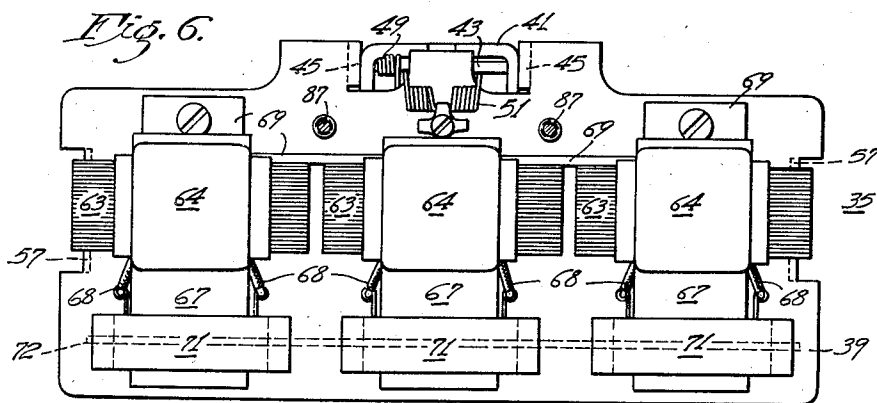


Fig. 7.

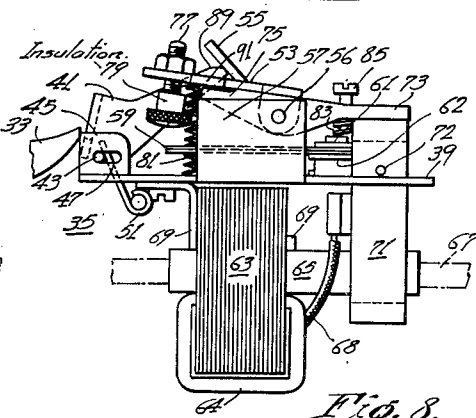


Fig. 8.

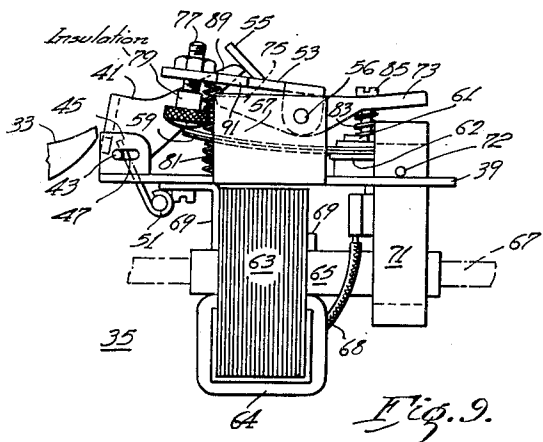


Fig. 9.

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UNITED STATES PATENT OFFICE

2,144,501

CIRCUIT BREAKER

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Pennsylvania

Application January 19, 1935, Serial No. 2,537

18 Claims. (Cl. 200—88)

My invention relates to electrical apparatus and particularly to electrical responsive devices of the type used for controlling the operation of the protective circuit breakers for power distribution or feeder network systems.

The provision of suitable circuit breakers for controlling power distribution or network circuits has always presented a rather complex problem to the electrical art. In this service, the circuit breakers must complete directly with fuse devices, hence to be commercially successful, they must be relatively inexpensive. At the same time, however, the breakers are mounted within buildings or dwellings and are operated by inexperienced persons; they must, therefore, be absolutely safe as well as simple and reliable in operation.

To further complicate the problem, the very nature of distribution service imposes a serious burden upon the circuit breaker designer. The magnitude of the normal line current of the system is comparatively small, yet due to the interconnection of a large number of circuits the overload current may reach extremely large magnitudes. Thus, to give satisfactory protection to the associated equipment, the circuit breaker must be capable of reliable and accurate operation upon the occurrence of certain predetermined low magnitude overloads, while at the same time, it must be capable of handling extremely large overloads, such as occur during short circuit conditions.

The most satisfactory method of meeting these requirements has been in the provision of a high capacity circuit breaker of large arc extinguishing capacity and a trip device which is operable, after a predetermined time, to effect the opening of the associated breaker upon the occurrence of the predetermined small overload currents and is also operable, substantially instantaneously, to effect the opening of the controlled breaker upon the occurrence of large overload conditions.

For selectively distinguishing between normal overloads of differing magnitudes, it has been customary to provide a current-carrying bimetallic element which is so calibrated that it causes the operation of the trip device (and the opening of the associated circuit breaker) only after a predetermined time delay following the occurrence of the abnormal condition, the time interval being inversely proportional to the current magnitude of the overload. When large magnitude overloads occur, it is imperative that the breaker be opened as quickly as possible,

and to accomplish this, it has been customary to provide a magnetically responsive trip element which effects the operation of the trip device substantially instantaneously following the occurrence of predetermined large magnitude overloads. In multi-pole structures, a magnetically responsive and a thermally responsive trip element were usually provided for each separate pole.

The principal object of the present invention is the improving of trip devices of this general form.

Heretofore, it has been customary to utilize current-carrying bimetallic elements which were directly connected into the circuit controlled by each of the poles of the breaker. This arrangement eliminated the necessity for external heaters for the bimetallic elements and effected a simplification of the entire device. On high voltage circuits, however the use of directly energized bimetals considerably complicated the problem of insulating the device and has necessitated the use of various complex insulation arrangements. By the present invention, I provide a separate transformer for each of the bimetallic elements, the transformer being so wound that each of those elements is insulated from the normal energizing circuit therefor, and, in addition, it is subjected to comparatively low voltages at all times. Through this means, the insulation problem for the structure is considerably simplified and a more reliable and more positive device is attained.

Another important beneficial result which follows from the provision of separate transformers for each of the bimetallic elements of the trip device is, that on heavy overloads or short circuits in the circuits controlled by the breaker, saturation of the transformers affected takes place with the resulting limitation of the currents flowing in the secondaries and bimetallic elements connected thereto. The provision of the separate transformers therefore introduces a double safety factor to protect against the current which may traverse or affect the bimetallic elements and prevents the bimetallic element being burned out by a short circuit current.

Investigations of current carrying bimetallic trip elements, have shown that the lowest power losses consistent with accurate and reliable operation exist in elements which are normally rated at from twenty-five to fifty amperes. Elements capable of continually carrying currents of substantially greater magnitude than this pos-

sess such large mass that an unreasonably large amount of power must be expended in heating them to the operating temperature; this means, also, that the normal every day loss is likewise excessively large, and the resultant heating may, under certain conditions, create a fire hazard.

Elements rated at less than twenty-five amperes must be formed from very thin bimetallic material, and as a result they are frequently incapable of exerting sufficient force during the tripping operation to assure positive operation of the trip device, this difficulty being most troublesome with the very low rating elements. By utilizing a transformer means for energizing each of the current-carrying bimetallic elements of a trip device, elements of uniform rating may be used regardless of the normal current rating of the breaker. On low current circuits a step-up transformer will be used, and a step-down transformer will be used for circuits normally carrying in excess of fifty amperes.

By this arrangement, a further object of my invention, namely the minimizing of the every day loss in current carrying trip elements for use with circuits normally carrying large magnitude currents and the increasing of the reliability of operation of elements for use with low current circuits is effected.

Another object of my invention is to provide an improved electro-responsive trip device which utilizes a plurality of thermally responsive trip elements and a plurality of magnetically responsive elements, the various structural features being arranged in a novel manner in order to effect a reduction in the space occupied by the device.

These and other objects as well as the preferred method of carrying out the invention will be made more apparent by reference to the following drawings, wherein I have set forth the structural details of a device utilizing the principles of my invention. Referring to the drawings,

Figure 1 is an elevational view of a three-pole circuit breaker and trip device wherein are embodied the features of my invention, a portion of the cover has been cut away in order to more clearly illustrate the structural features involved.

Fig. 2 is a sectional view of the breaker shown in Fig. 1, this view being taken on the line II—II of that figure.

Fig. 3 is a front elevational view of the trip structure forming a part of the breaker shown in Figs. 1 and 2.

Fig. 4 is a rear elevational view of the trip structure taken from the opposite side of the view shown in Fig. 3.

Fig. 5 is a plan view of the trip structure shown in Figures 3 and 4, a portion of the trip bar and a portion of the common armature have been cut away to show the various features of the device.

Fig. 6 is a bottom plan view of the structure shown in Figs. 3, 4 and 5.

Fig. 7 is a view taken on the line VII—VII of Fig. 3.

Fig. 8 is a view, similar to Fig. 7, illustrating the movable portions of the trip device in the tripped position following the operation of one of the magnetically responsive trip elements.

Fig. 9 is a view similar to Fig. 8 showing the position of the various movable portions of the device following a tripping operation which has been produced by one of the bimetallic trip elements.

The circuit breaker illustrated in Figs. 1 and 2 includes a base 1 of molded insulating material,

which is utilized for supporting the various other portions of the device, and a cover 3 also of molded insulating material for enclosing the conducting portions of the breaker. Six terminals 5 are provided for electrically connecting the three poles of the breaker into an electrical circuit, these terminals being supported upon suitable bolts which extend through the base 1. A single operating mechanism 9 is provided for moving the breaker to the open and to the closed circuit position, this operating mechanism 9 being actuated by the movement of a handle member 11 which has a portion 13 extending through a suitable opening 15 formed in the cover 3. Three switch arms 17, each of which is provided with a movable contact member 19, supported thereon and three stationary contacts 21, constitute the means for opening and closing the electrical circuits through the breaker.

The three switch arms 17 are mechanically interconnected by means of an insulating tie member 23 rigidly affixed to the frame of each of those members by a strap member 25. The assemblage formed by the three interconnected switch arms is pivotally supported for movement to the open and to the closed circuit positions by a pin 26 (Fig. 2) which engages the frame of the operating mechanism 9. The operating mechanism 9 engages the frame of the central switch arm 17 and by this means is made capable of simultaneously moving the three interconnected switch arms from one position to the other.

The operating mechanism includes, in addition to the handle member 11 previously described, a pair of toggle links 27 and 29 joined together at their central point by a knee pivot pin 31. The left hand end (Fig. 2) of the lower toggle link 29 pivotally engages the frame of the central switch arm 17 and the right hand end of the other link 27 is supported upon a movable cradle 33 normally adapted to be engaged and held in the position shown in Fig. 2 by the trip device 35. An over-center spring 37 operatively connects the operating member 11 with the knee of the linkage. By this arrangement, the three contacts 19 may be simultaneously moved from one position to the other with a snap action in response to movement of the operating member 11.

For aiding in the extinction of the arcs which are formed incident to the opening of the circuit controlled by each of the poles of the breaker, three arc extinguishing devices 38 of the spaced plate type are provided. The features of these extinguishers are not an important part of my invention and any suitable structures may be utilized. One particularly effective form is disclosed in Patent No. 1,896,764 which was issued on February 7, 1933 to M. W. Brainard and which is assigned to the assignee of this invention.

The electro-responsive trip device 35 is a unitary structure which is entirely built up upon its own base 39. It includes a latch member 41 for releasably engaging the cradle portion 33 of the operating mechanism 9 and thereby restraining that member in the position shown in Fig. 2. This latch member 41 is substantially U-shaped, and it is pivotally and slidably supported upon the trip base 39 through the agency of a pin 43 which extends through suitable slots 47 formed within two upstanding supports 45 integral with the base 39 itself. The latch member 41 is biased toward the latched position by a pair of suitable springs 49 and 51; the lower spring 51 serves to bias the supporting pin 43 (and with it the latch itself) in the direction of the operating mecha-

nism 9, the other spring biases the latch in a counter-clockwise direction (Fig. 2) about the pin 43. This arrangement makes possible the slidable and pivotal mounting for the latch member which is of great value in aiding in the resetting of the trip device and the reengagement of the latch by the cradle member following each tripping operation.

The trip device 35, being a unitary structure, is readily removable from operative engagement with the other parts of the circuit breaker and can be replaced by a suitable similarly proportioned device. By making the trip structure interchangeable with other like structures, it is possible to provide an entire line of circuit breakers with only a single contact structure and operating mechanism, a trip device having the proper characteristics being supplied for each individual breaker.

The various parts of the trip device 35, as mentioned above, are completely assembled upon the base 39, which is preferably of non-magnetic metal, this base having suitable openings and bracket portions formed therein for accommodating the several elements of the structure. A single trip bar 53 which extends across all of the poles of the breaker and which is provided with a struck-up portion 55 for engaging the latch 41 serves as the main operating member for the trip device. This bar is pivotally supported on a rod 56 which extends between suitable upstanding lugs 57 forming a part of the base 39 and is operable by any one of the thermally responsive elements or by any one of the magnetically responsive elements to effect the release of the latch 41 and, thereby, the opening of the breaker.

The thermally responsive element for each of the three poles of the breaker includes a Y-shaped, current-carrying member 59 of bimetallic material which is supported upon the base 39 by suitable rivets 61, members 62 of insulation being imposed between the base proper and the rivets 61 in order to prevent short circuiting of these elements. For energizing each of the bimetallic elements 59, I utilize a separate transformer device the core 63 of which comprises a plurality of laminations of transformer steel, each having the shape of a hollow square. A secondary winding 64 having a considerable number of turns is positioned about each of these cores 63, and a tubular insulating member 65 for accommodating one of the flexible conducting shunts 67 (shown particularly in Fig. 2) which serve to connect each of the switch members 17 with the adjacent terminals 7 of the breaker occupies the remainder of the space within the central portion of each of the cores. The core laminations are held in place and are supported upon the main base by means of a bracket member 69, as is shown particularly in Fig. 7. The secondary winding 64 of each of the transformers is permanently connected to one of the bimetallic elements 59 by a pair of flexible leads 68 and a pair of strap connectors 70.

The magnetically responsive trip elements comprise a plurality of U-shaped cores 71, of magnetic material the open ends of which extend through suitable openings in the base 39 and are retained therein by a pin 72. These cores are energized by the same shunt conductors which serve as the primary windings of the energizing transformers for the thermally responsive elements. A unitary plate member 73 of magnetic material, pivotally supported upon the same pin

56 which supports the trip bar 53 and having rearwardly extending portions 75 for engaging that bar, constitutes the movable armature for each of the magnetically responsive trip devices, this armature member 73 being attractable to any one of the core members 71 when that member has been suitably energized.

The support for the core members 71 of the magnetically responsive trip elements is unusually simple and particular attention is directed to it. As mentioned previously, an opening of slightly less width than the greatest width of each of the core members 71 is cut in the main portion of the trip base 39, and each of the core members is adapted to extend through this opening, the upper end of the two opposed pole pieces of each of these members having a slightly less width than the maximum width of the remaining portion of the core. To hold the core members against movement, a brass rod 72 extends through suitable openings formed in each of the pole pieces thereby serving as a key means for holding the cores 71 in position on the base 39.

The trip bar 53 is provided with three downwardly projecting screw members 77, each having an insulating head 79 of molded material for operatively engaging one of the three bimetallic thermally responsive trip elements 59, the threaded portion of these members allowing ready and accurate adjustment of the tripping point of each of the bimetallic tripping elements 59. The trip bar 53 is biased toward the untripped position by a suitable spring 81 and the single armature bar 73 is biased against movement toward the tripped position by a similar spring 83. A screw 85 permits adjustment of the armature bar 73.

The trip device is supported in an operative position upon the main base 1 of the circuit breaker by means of a pair of studs 87 which extend through suitable openings formed in the trip base 39, to engage upstanding support members 86 molded integral with the main base. As a further positioning means the portion of each of the shunts 67 which engages the adjacent insulating tube 65 is made of relatively stiff material and is adapted to engage the walls of the cooperating tube with a rather close fit. In effect these stiff portions are equivalent to beam members which aid in supporting the trip device 35, the studs being primarily a position means. The portion of each of the shunts 67 which connects the stiff portion to the cooperating movable contact is flexible to permit free movement of the switch members.

It will thus be seen that the electrical circuit through each of the poles of the breaker is comparatively direct. Beginning with the upper terminal 5, the current flows, successively through a strip 88 of conducting material, which serves to connect the upper terminal with the cooperating main stationary contact 21, thence through the cooperating moving contact 19, the flexible portion of the shunt 67 connected thereto, the remaining stiff portion of the shunt which extends through the hollow cores of the two electro-responsive elements for that pole of the breaker and thence to the other breaker terminal 5.

The trip device 35 is shown in the normal untripped position in Figs. 3, 4, 5, 6 and 7. In this position, the latch member 41 engages the outwardly projecting end of the cradle 33 and restrains that member from moving under the biasing action of the over-center operating

spring 37. The biasing force of the over-center spring 37 produces a torque tending to move the latch 41 toward the unlatched position. This torque is transmitted to the latch engaging portion 55 of the trip bar 53 through the rearwardly projecting portion 89 of the latch. The line of action of this force is so arranged that the trip bar 53 is biased toward the normal or untripped position by a comparatively small component of that force. The movement of the trip bar 53 toward the untripped position is limited through the engagement of the projecting outer ends 91 of the trip bar with the upwardly projecting supporting members 57 therefor. Thus, the entire device is normally in a static position.

Upon the occurrence of a large magnitude overload in the circuit controlled by any one of the poles of the breaker, the associated core member 71 is energized and serves to attract the common armature 73 thereto, i. e. the armature moves from the position shown in Fig. 7 to the position shown in Fig. 8. This movement of the armature bar 73 is transmitted to the trip bar 53 through the engagement of the rearwardly projecting portions 75 therewith and serves to move that bar so that the upwardly projecting portion 55 disengages the latch 41, the latch 41 being then free to turn under the biasing action of the force transmitted through the cradle 33 so as to release that member.

When released by the latch 41, the cradle 33 is free to move in a counter-clockwise direction (Fig. 2), under the biasing action of the over-center spring 37 and in so doing carries the central line of the upper toggle link 27 above the line of action of the spring. The toggle linkage is then in an unstable position and collapses substantially instantaneously, thereby allowing the over-center spring 37 to move the assembly of the interconnected switch arms 17 to the open circuit position. Once this movement is initiated it proceeds to completion with a constantly increasing acceleration, independently of the position of the operating handle. The breaker is thus entirely trip free at all times.

If the abnormal condition upon the circuit controlled by any one of the poles of the breaker comprises a moderate overload of considerable duration, the bimetallic current carrying element 59 which is connected into that circuit through the transformer may be heated sufficiently to cause it to move from the position shown in Fig. 7 to the position shown in Fig. 9. In this figure, the continued heating of the bimetal 59 caused by the flow therethrough of overload currents has produced a sufficient warping of that member to allow it to engage the member 79 and move the trip bar 53 to the tripped position. Any one of the bimetallic elements 59 is capable of effecting the motion of the trip bar to this position, and when such motion occurs, the latch 41 disengages the cooperating portion of the cradle 33 so as to initiate the automatic opening of the breaker contacts by the operating mechanism.

The circuit opening operation, regardless of whether it is initiated by the operation of one of the thermally responsive elements or by one of the magnetically responsive elements takes place in substantially the same manner. Due to the collapsing of the toggle which occurs following the release of the cradle 33 by the latch 41, the contacts are caused to separate with a snap action. This is highly desirable in increasing the arc interrupting capacity of the device and in thereby improving its operation characteristic.

Following each opening of the breaker as a result of the operation of the trip device, it is necessary to restore the various parts of the structure to an operative condition. This is done by moving the handle from the normal closed circuit position shown in Fig. 2 to the open circuit position. Through this movement, the cradle member is rotated in a clockwise direction from the tripped position to the normal engaged position also shown in Fig. 2. While the cradle swings about a fixed pivot, the reengagement of the latch means 41 is readily accomplished due to the fact that the latch is slidably and pivotally mounted as explained above. The biasing action on the various movable parts of the trip device is such that the trip bar 53, the armature bar 73, and the latch 41 automatically restore themselves to the normal latched position following each operation of the trip device.

From the foregoing, it will be seen that I have disclosed the structural details of a new and improved form of trip device which is particularly suitable for use with distribution circuit breakers or similar apparatus. My improved trip device includes a magnetically responsive trip element and a thermally responsive trip element, for each of the controlled circuits. A transformer is provided for energizing each of the current carrying thermally responsive trip elements in order that those elements shall not be subjected to the line voltage of the energizing circuits therefor, this arrangement simplifying the problem of insulating the devices and at the same time rendering the entire structure much safer.

As pointed out in the discussion of the objects of the invention, the provision of a separate transformer for energizing each of the current carrying bimetallic trip elements also makes possible the utilization of a single standard element over a very wide range of current values, the energizing transformer being adjusted to deliver the proper energizing current for any particular installations. This arrangement reduces the every day heating losses in the trip elements to a minimum on high current circuits, and greatly increases the reliability of operation of low current trip elements. Further, by reducing the number of bimetallic elements required in the marketing of a line of circuit breakers to one substantial manufacturing economies are effected.

By the particular arrangement of the structural elements of the trip device, I utilize a single bar conductor for energizing both the magnetically responsive and the thermally responsive trip elements, the bar serving, in effect, as a primary winding for the energizing transformers for the thermally responsive element and as an energizing winding for the core of the associated magnetically responsive element. Attention is directed to the fact that each of the conductor bars, which is threaded through the passage within one of the tubular insulating member 65 is unbroken from the associated contact 19 to the cooperating terminal of the interrupter. This arrangement, while permitting the trip device to be readily removed from operative engagement with the contact actuating mechanism assures that the resistance of the electrical circuit through each of the poles of the breaker shall be maintained at a very low value, there being a complete absence of separable joints which might become oxidized. In addition to these features particularly emphasized above, I have disclosed certain novel structural arrange-

ments which have been found particularly suitable for carrying out the objects of the invention and certain of the claims are directed to these novel arrangements.

5 While in accordance with the patent statutes, I have disclosed the foregoing details of one preferred embodiment of my invention, it is to be understood that the broad principles disclosed are capable of much wider application and that many
10 of these details are merely illustrative. I desire, therefore, that the language of the accompanying claims shall be accorded the broadest reasonable construction and that my invention shall be limited only by what is expressly stated therein
15 and by the prior art.

I claim as my invention:

1. In an electro-responsive trip device, a latch releasable to cause operation of the controlled apparatus, an armature movable to effect the release of said latch, a core member adapted, when energized, to attract and thereby move said
20 armature, a current-carrying bimetallic element having a portion which is movable to effect the release of said latch, a second core member, a winding positioned about said second core member and adapted to energize said current-carrying bimetallic member, and a single winding for energizing both of said core members.

2. In an electro-responsive trip device for controlling the operation of current-carrying electrical apparatus, a base member, a pair of core members supported on said base member, a winding disposed about one of said core members, a current-carrying bimetallic element electrically connected to said winding and having a movable portion for actuating said trip device, a movable armature which is adapted to be attracted to said other core member to actuate said trip device, and a bar conductor, which is disposed in an inductive relationship with each of said core members, for connecting said trip device into an electrical circuit and for energizing said core members.

3. In an electro-responsive trip device for controlling the operation of current-carrying electrical apparatus, a base member, a pair of hollow core members supported on said base member, a winding disposed about one of said core members, a current-carrying bimetallic element electrically connected to said winding and having a portion which is movable to actuate said trip device, a movable armature which is adapted to be attracted to said other core member to actuate said trip device independently of the position of said bimetallic element, and a bar conductor, which extends through both of said hollow core members, for connecting said trip device into an electrical circuit and for energizing said core members, said bimetallic element effecting the operation of said trip device, upon the occurrence of certain predetermined conditions, and said movable armature effecting the operation of said trip device upon the occurrence of certain other predetermined conditions.

4. In a multi-pole trip device, movable means for engaging the controlled apparatus, a single trip bar, which extends across at least two of the poles of said device and which is movable from a normal inoperative position to an operative position to actuate said movable means, a plurality of current-carrying thermally responsive trip elements, each of which includes a movable portion for engaging and moving said trip bar from said inoperative to said operative position, a plurality of transformer means, each of which

is provided with a secondary winding electrically connected to one of said current-carrying trip elements, a plurality of magnetically responsive trip elements, each of which includes a core means, a single armature bar extending across
5 at least two of the poles of said device and having a portion of magnetic material disposed adjacent each of said core means, said armature bar being movable by the attraction of any one of said core means to move said trip bar from said inoperative
10 to said operative position, and a plurality of separate energizing windings, each of which energizes one of said transformers and one of said core means.

5. In a multi-pole trip device, releasable latch means for engaging the controlled apparatus, a single trip bar, which extends across at least two of the poles of said device and which is movable from a normal inoperative position to an operative position to effect the release of said latch
20 means, a plurality of current-carrying bimetallic trip elements, each of which includes a movable portion for engaging and moving said trip bar from said inoperative to said operative position, a plurality of transformer means, each of which is provided with a secondary winding electrically connected to one of said current-carrying trip elements, a plurality of magnetically responsive trip elements each of which includes a core member and means whereby movement of said trip bar from said inoperative to said operative position is effected following a predetermined energization of said core member, and a plurality of separate windings, each electrically connected in series with one of the poles of said trip device and each being adapted to serve as the primary winding for one of said transformer means and also as the energizing means for one of said core members.

6. In a circuit interrupter, a pair of electrical terminals for connecting the circuit interrupter in the circuit, contact means for opening and closing the circuit between said terminals, actuating means for said contact means, a trip device operable to cause said actuating means to open said contact means upon the occurrence of predetermined conditions, said trip device being removable as a unit from operative engagement with the other structural elements of said interrupter and having a passage therethrough, a conductor threaded through said passage and electrically connected at one end to one of said contact means and at the other end to one of said terminals, and one of said connections being disengageable to permit removal of said trip device from said conductor.

7. In a circuit interrupter, a pair of electrical terminals for connecting the circuit interrupter in the circuit, contact means for opening and closing the circuit between said terminals, actuating means for said contact means, a trip unit having a passage therethrough, a conductor threaded through said passage and electrically connected at one end to one of said contact means and at the other end to one of said terminals, and one of said connections being disengageable to permit removal of said trip unit from said conductor, said trip unit including a thermally responsive element and a magnetically responsive element each energized from said conductor and operable to cause said actuating means to open said contact means.

8. In a multi-pole circuit interrupter, cooperating contact means for opening and closing a plurality of poles, actuating means for said con-

tact means, and a trip device operable upon the occurrence of predetermined conditions to cause said actuating means to move said contact means to the open-circuit position, said trip device comprising a unitary structure, which is removable as a unit from operative engagement with the other structural features of said interrupter, and including a base, a single, pivotally mounted trip bar supported on said base so as to extend across a plurality of the poles of said interrupter, said trip bar being movable from a normal inoperative position to an operative position to effect the operation of said trip device, a plurality of current-carrying, bimetallic trip elements mounted on said base, each of which includes a movable portion for directly engaging and moving said trip bar from said inoperative to said operative position upon the occurrence of predetermined conditions, and a plurality of individual transformers, also mounted on said base and having separate primary and secondary windings, for energizing each of said trip elements in response to the current flowing in the circuit controlled by one of the poles of said interrupter while at the same time insulating that element from said controlled circuit.

9. In a multi-pole circuit interrupter, cooperating contact means for opening and for closing a plurality of poles, actuating means for said contact means, a main base upon which said contact means and said actuating means are mounted, and a trip device operable upon the occurrence of predetermined conditions to cause said actuating means to move said contact means from the closed-circuit to the open-circuit position, said trip device including a separate base removably secured to said main base, a single trip bar, which extends across a plurality of the poles of said interrupter, pivotally mounted on said separate base so as to be movable from a normal inoperative position to an operative position to effect the operation of said trip device, a plurality of current-carrying, bimetallic trip elements mounted on said separate base and each of which includes a movable portion for directly engaging and moving said trip bar from said inoperative to said operative position upon the occurrence of predetermined conditions, and a plurality of individual transformers mounted on said separate base and having separate primary and secondary windings for energizing each of said trip elements, said trip device being removable as a unit from operative engagement with the other structural elements of said interrupter and having a plurality of passageways formed therein, and a conductor threaded through each of said passages and electrically connected in series with the circuit through one of the poles of said interrupter for effecting the energization of said transformers.

10. In a multi-pole circuit interrupter, cooperating contact means for opening and for closing a plurality of poles, actuating means for said contact means, a main base upon which said contact means and said actuating means are mounted, and a trip device operable upon the occurrence of predetermined conditions to cause said actuating means to move said contact means from the closed-circuit to the open-circuit position, said trip device including a separate base removably secured to said main base, a single trip bar, which extends across a plurality of the poles of said interrupter, pivotally mounted on said separate base so as to be movable from a normal inoperative position to an operative po-

sition to effect the operation of said trip device, a plurality of current-carrying, thermally responsive elements, each of which includes a movable portion for directly engaging and moving said trip bar from said inoperative to said operative position, a plurality of transformer means, each of which is provided with a core and a secondary winding which is disposed about said core and is electrically connected to one of said current-carrying trip elements, a plurality of magnetically responsive trip elements, each of which includes a core separate from said transformer core, a single armature bar extending across at least two of the poles of said interrupter and having a portion of magnetic material disposed adjacent each of the cores forming a part of said magnetically responsive trip elements, said armature bar being movable by the attraction of any one of said last-mentioned cores to move said trip bar from said inoperative to said operative position, and a plurality of separate energizing windings, each of which energizes one of said transformers and one of said core means, said trip device being removable as a unit from operative engagement with the other structural elements of said interrupter.

11. In a circuit interrupter, cooperating contact means for opening and for closing the circuit through said interrupter, actuating means including an operating member for opening or closing said contact means, a trip device operable in response to predetermined overload conditions in the circuit through said contact means to cause said actuating means to move said contact means to the open circuit position irrespective of the position of said operating member, said trip device including a bimetallic trip element for actuating said trip device upon the occurrence of said predetermined overload conditions, a transformer means having a secondary winding connected to said bimetallic trip element, and a conductor means forming a primary winding for said transformer means connected in series circuit relationship with said contact means for energizing said transformer, said trip element being electrically insulated from said conductor and the circuit through the contact means.

12. In a multi-pole circuit interrupter, a plurality of poles, cooperating contact means for opening and for closing the circuits through said poles, common actuating means for said contact means, a common unitary trip device operable upon predetermined overload conditions in the circuits through said contact means to cause said actuating means to move said contact means to the open circuit position, said trip device including a base, a plurality of bimetallic trip elements, one for each pole of the interrupter, mounted on said trip base for actuating said trip device upon the occurrence of said predetermined conditions, a separate transformer means mounted on said base for each of said bimetallic trip elements each having a secondary coil connected to its corresponding bimetallic trip element, and a separate conductor means for each of said transformers connected in series circuit relationship with the contact means for energizing said transformers, said trip elements being electrically insulated from said conductors and the circuits.

13. In a circuit interrupter, cooperating relatively movable contact means for opening and for closing the circuit through said interrupter, an operating member for opening or closing said

contact means, a trip device operable in response to predetermined overload conditions in the circuit through said contact means to effect opening of said contact means irrespective of the position of said operating member, said trip device comprising an electro-responsive trip element for actuating said trip device in response to said predetermined conditions, a transformer means having a secondary winding connected to said trip element for energizing said element and a conductor means for energizing said transformer connected in circuit with said contact means, said trip element being insulated from said conductor and said circuit.

14. In a circuit breaker, relatively movable contacts for opening or closing the circuit through said breaker, operating means for opening or closing said contacts, an actuating member releasable to cause opening of said contacts, in combination, a trip device comprising releasable means for engaging said actuating member to restrain the same, an electro-responsive trip element operable in response to an overload in the circuit through said contacts to release said engaging means and free said actuating member, transformer means having a secondary winding connected to said trip element for energizing the same, said transformer being energized in response to the current flowing through the contacts of the breaker, said trip element being electrically insulated from the circuit through said contacts.

15. In a circuit breaker, relatively movable contact means for opening and closing the circuit, an operating mechanism for said contact means, a transformer connected in circuit with said contact means, and tripping means energized by said transformer for causing opening of said contact means, said transformer having a primary and a secondary winding and said secondary winding being removable with said tripping means as a unit from the primary winding and said contact means.

16. In a circuit breaker, a base, relatively movable contact means, operating means for said

contact means, a transformer connected in circuit with said contact means, and tripping means including a bimetallic trip element energized by said transformer for causing opening of said contact means, said transformer having a primary and a secondary winding, and said secondary winding being removable with said tripping means as a unit from the primary winding and the contact and operating means.

17. In a circuit breaker, a base, relatively movable contact means, operating mechanism for said contact means, a transformer including a core of magnetic material, a conductor connected in circuit with said contact means forming a primary winding, and a secondary winding, tripping means energized by the secondary winding of the transformer for causing opening of said contact means, said contact means, operating means and conductor being mounted on said base, and said tripping means with the core and secondary winding of the transformer being removable as a unit from the conductor forming the primary winding and from the base.

18. In a multipole circuit breaker, a main base, a plurality of relatively movable contacts forming a plurality of poles, operating mechanism for said contact means, a plurality of transformers one for each pole each including a core of magnetic material, a conductor connected in circuit with the corresponding contact means forming a primary winding and a secondary winding, a trip device including a plurality of bimetallic tripping elements one for each pole, each energized by the secondary winding of its corresponding transformer for causing opening of said contact means, said contact means, operating means and the conductors forming the primary windings being mounted on said main base, said trip device together with the cores and secondary windings of said transformers being mounted on a second base removably mounted on the main base so as to be removable as a unit from the conductors and the main base.

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