

Jan. 4, 1949.

H. D. DORFMAN ET AL

2,458,151

CIRCUIT BREAKER

Original Filed June 24, 1941

2 Sheets-Sheet 1

Fig. 1.

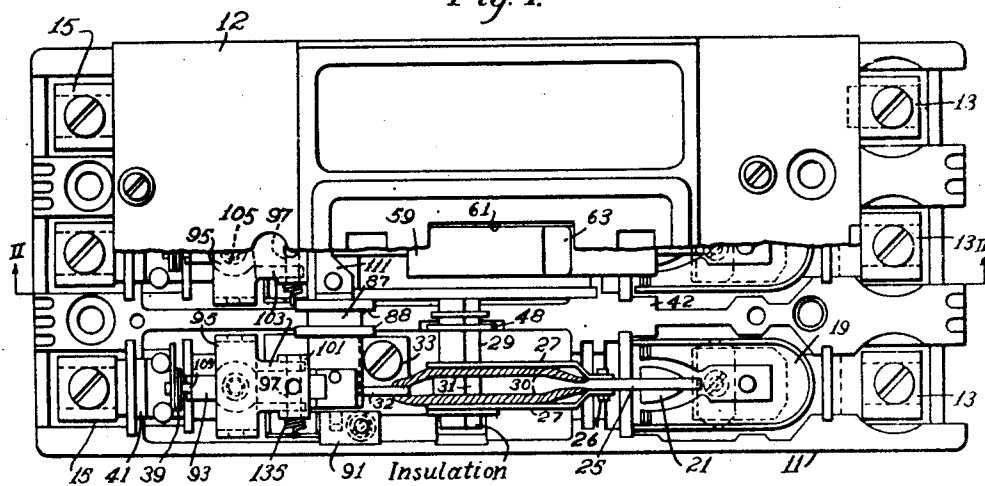
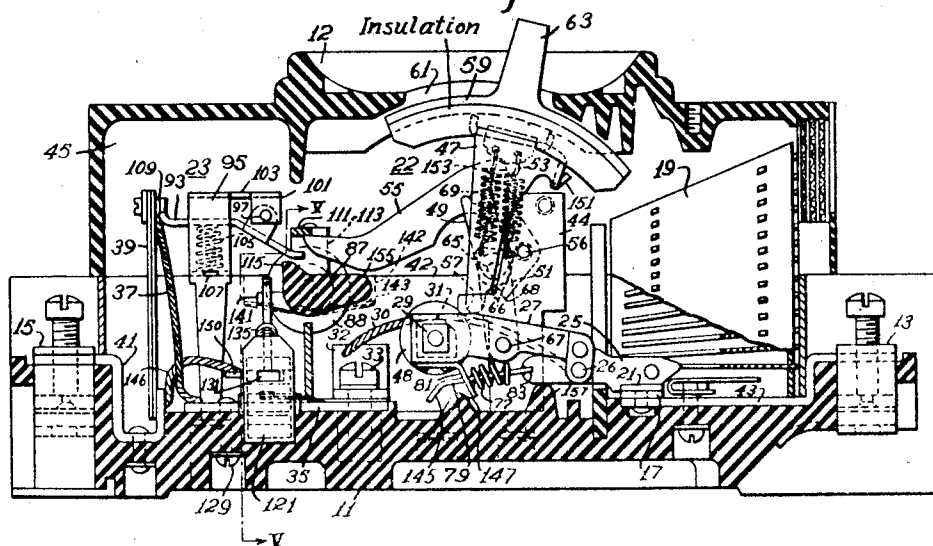


Fig. 2.



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2 Sheets-Sheet 2

Fig. 3.

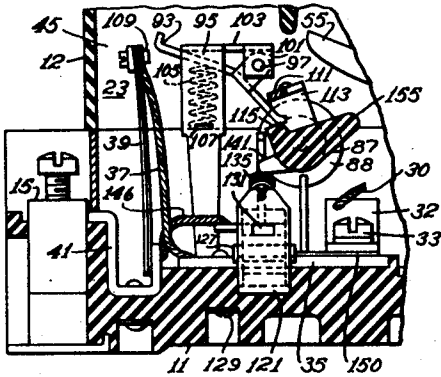


Fig. 4.

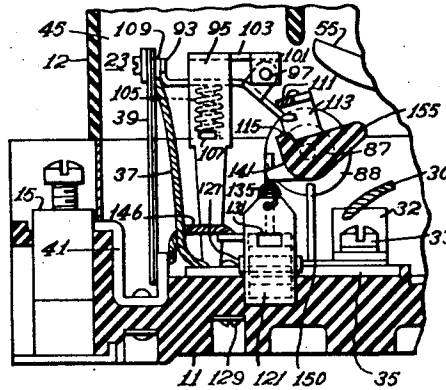
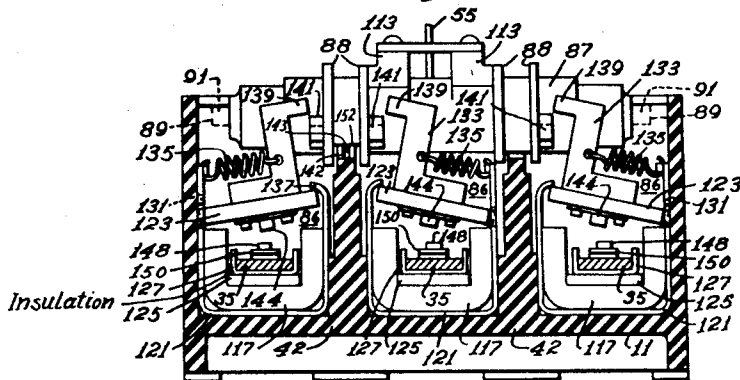


Fig. 5.



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2,458,151

CIRCUIT BREAKER

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Original application June 24, 1941, Serial No. 399,457, now Patent No. 2,419,125, dated April 15, 1947. Divided and this application May 18, 1944, Serial No. 536,138

11 Claims. (Cl. 200—88)

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This invention relates to circuit breakers and more particularly to multipole circuit breakers of the type which are tripped instantaneously on overload currents of predetermined magnitude and after a time delay on lesser overloads.

This application is a division of copending application Serial No. 399,457, filed June 24, 1941, by H. D. Dorfman and Gerald J. Freese, and assigned to the assignee of the instant application. Said copending application has resulted in Patent No. 2,419,125, dated April 15, 1947.

One object of the invention is to provide a compact circuit breaker of improved construction which is simple and inexpensive to manufacture, and safe and reliable in operation.

Another object of the invention is to provide a multipole circuit breaker with improved means for electrically isolating the several poles from each other to prevent flashover between adjacent poles.

Another object of the invention is to provide a multipole circuit breaker with an improved trip member of one piece moulded construction having a plurality of members moulded integral therewith cooperating with a partition wall forming separate compartments for the several poles of the breaker to more completely isolate adjacent compartments against flashover.

Another object of the invention is the provision of a circuit breaker having a trip device operated by a spring actuated trip member which is normally restrained by a thermally responsive bi-metal element, also operated by an electromagnet which is arranged so that the air gap of the electromagnet can be relatively small without limiting or interfering with the resetting movement of the trip device.

Another object of the invention is the provision of a circuit breaker having a rotatably mounted trip element, a spring actuated tripping lever normally restrained by a thermally responsive bi-metal element and which is releasable to move the trip element to trip the breaker and which is resettable by a reverse movement of the trip element, in combination with a hinge type electromagnet operable at times to move the trip element to trip the breaker, the electromagnet having a small air gap and being disposed so that it does not limit or interfere with resetting movement of the trip element.

Another object of the invention is to provide a circuit breaker with an improved magnetic trip device having an armature disposed for operation in a plane parallel to the axis of a trip member and engageable with a projection on said mem-

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ber, said armature being normally out of the path of said projection to permit movement of the trip member to reset the trip device.

The novel features that are considered characteristic of the invention are set forth in particular in the appended claims. The invention itself, however, both as to structure and operation, together with additional objects and advantages thereof, will be best understood from the following detailed description of one embodiment thereof when read in conjunction with the accompanying drawings, in which:

Figure 1 is a front elevational view of the breaker with a part of the cover broken away to more clearly show some of the parts;

Fig. 2 is a vertical sectional view of the circuit breaker taken on line II—II, Fig. 1, and looking in the direction of the arrows, the breaker being shown in closed circuit position;

Fig. 3 is a detailed view of the trip device with the trip bar operated in response to operation of the thermal element;

Fig. 4 is a detailed view of the trip device with the trip bar operated by the electromagnetic trip means; and

Fig. 5 is a sectional view taken substantially along the line V—V of Fig. 2 and showing the assemblage of the electromagnets and the trip bar.

Referring to Figures 1 and 2 of the drawings, the circuit breaker includes a base 11 of moulded insulating material on which the several elements of the breaker mechanism are mounted. A cover 12 also of moulded insulating material is removably secured to the base and cooperates therewith to form an enclosing housing for the breaker mechanism.

The circuit breaker is of the multipole type, each pole comprising a pair of terminals 13 and 15, one disposed at each end of the breaker, a stationary contact 17, an arc extinguisher 19, and a movable contact 21. A common operating mechanism indicated generally at 22 is provided for simultaneously actuating the three movable contacts to open or to closed position, and a trip device indicated generally at 23 serves to effect automatic opening of the three sets of contacts in response to predetermined overload conditions in the circuit through any pole of the breaker.

Each of the movable contacts 21 is mounted on a contact arm 25 pivotally supported intermediate its ends on the free end of a pair of switch arms 27 by means of a pivot pin 28. The arms 27 for all of the poles are mounted on a

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rectangular tie bar 29 of insulating material, and each pair of the arms 27 are joined by a rectangular sleeve 31 surrounding the tie bar and secured thereto so that said tie bar and all of the switch arms 27 rotate as a unit, the tie bar being pivotally supported in the side walls of the breaker. The tie bar 29 extends transversely across the three poles of the breaker.

A flexible shunt conductor 30 connects the contact arm 25 with an angular terminal 32 secured by a screw 33 to one end of a conductor 35. The screw 33 also serves to secure the conductor 35 to the base 11. The other end of the conductor 35 is connected by a flexible conductor 37 to a point near the free end of a thermally responsive bimetal element 39. The other end of the bimetal 39 is rigidly secured to the inner end of a conductor 41, the terminal 15 being secured to the outer end of said conductor. Each of the stationary contacts 17 is mounted on the inner end of a conductor 43 having its outer end connected to the terminal 13.

The electrical circuit for each of the poles is essentially the same and extends from the terminal 13 through the conductor 43, stationary contact 17, the movable contact 21, the contact arm 25, the flexible shunt conductor 30, the terminal 32, the conductor 35, the flexible shunt conductor 37, the bimetal element 39 and the conductor 41 to the terminal 15.

Each of the three poles of the breaker is contained in a separate compartment formed by barriers 42 (Figs. 1, 2, and 5) moulded integral with the base 11 and extending the length of the breaker. These barriers 42 are in alignment with similar barriers 45 (Fig. 2), moulded integral with the cover 12 so that when the cover is in place the barriers 42 and 45 serve to insulate each compartment from the adjacent compartments and prevent flash-overs.

The tie bar 29, which extends across all three poles of the breaker, is provided with annular flanges 48 disposed in recesses in the sides of the barriers 42 to prevent flashover through the openings in the barriers 42 and 45 provided to accommodate the tie bar.

The operating mechanism for the breaker illustrated generally at 22 (Fig. 2) is disposed in the compartment housing the center pole and is supported on a pair of frames 44 secured to the center part of the base 11. The operating mechanism includes a forked operating lever 47, a toggle comprising links 49 and 51, a pair of overcenter springs 53 and a releasable cradle 55 controlled by the trip device 23. The cradle 55 is pivotally supported on the frame 44 by a pivot pin 56. The inner ends of the forked operating lever 47 are rounded and are pivotally seated in recesses in the frame 44 as indicated at 57. An insulating shield 59 for covering an opening 61 in the cover 12 is mounted on the outer end of the operating lever 47 and a manual operating handle 63 integral with said shield projects through the opening 61 to permit manual operation of the breaker mechanism.

The toggle links 49 and 51 are pivotally connected together by a knee pin 65. The link 51 is pivotally connected by a pivot pin 67 to the pair of switch arms 27 for the center pole, and the end of the link 49 is bifurcated and pivotally engages a stud 69 on the cradle 55 being retained in engagement therewith by the tension exerted by the overcenter springs 53 between the knee pin 65 and the outer end of the operating lever 47.

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Overcenter springs 77, operatively associated with the contact arms 25, surround contact arm operating members 79 and are compressed between angular brackets 81 secured to the pivoted ends of the arms 27 and shoulders 83 on the members 79. The springs 77 hold the ends of the members 79 in engagement with recesses in the inner ends of the contact arms 25. The members 79 and the contact arms form toggles for operating the contact arms 25.

As previously mentioned, the trip device 23 includes a bimetal element 39 for each of the poles of the breaker, said bimetal elements being connected in series in the circuit of their respective poles. The trip device also includes a series overload magnet 86 for each pole, and a trip bar 87 common to all of the poles. The trip bar 87 is of one piece moulded insulating material and is pivotally supported by means of pins 89 moulded in axial alignment in the ends of the trip bar and which rotatably support said bar in bearings 91 (Figs. 1 and 5) in the side walls of the circuit breaker housing.

The trip bar 87 extends across the three poles of the breaker through openings provided therefor in the barriers 42 and 45. In order to more completely insulate the compartments, the trip bar 87 is provided with a plurality of flanges 88 moulded integral with said trip bar and disposed one on each side of each of the barriers 42 and 45. These flanges are positioned close to the barriers and effectively prevent flashover through the opening provided in the barriers for the trip bar 87. Each pole of the breaker is provided with a trip member 93 pivotally supported on a U-shaped frame 95 by a pivot pin 97. The frame 95 of each pole is suitably secured to the base 11 and is separate from the frames 95 of the other poles. The pivot pin 97 which supports the trip member 93 is mounted in a pair of ears 101 formed on a projection 103 of the frame 95. A spring 105 compressed between a bar 107, supported in openings in the legs of the frame 95, and the trip member 93 biases said member in a clockwise or tripping direction. The trip member 93 is normally prevented from rotating in a tripping direction by engagement of the latch end thereof with a latch 109 on the free end of the bimetal 39.

A latch member 111 secured to projections 113 moulded integral with the trip bar 87 normally engages the latch end of the cradle 55 and thereby restrains the cradle in operative position.

When the bimetal element 39 for any one pole is heated a predetermined amount in response to an overload current, it flexes in a direction to move the free end thereof toward the left (Fig. 2) and after a time delay unlatches the trip member 93, whereupon the spring 105 rocks said trip member in a clockwise direction. During this movement the end of the trip member 93, disposed above a projection 115 moulded integral with the trip bar, strikes said projection and rocks the trip bar 87 counterclockwise causing the latch 111 to release the cradle 55. This permits the over-center springs 33 to actuate the operating mechanism and open the contacts as will be more fully described later.

The trip device is also operated electromagnetically by means of the electromagnet 86 to instantaneously trip the breaker upon the occurrence of a heavy overload for instance, 1000% or more of rated current or on short circuits in the circuit of any pole of the breaker.

For this purpose each pole of the breaker is provided with an electromagnet 86 including a

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U-shaped magnet core 117 (Fig. 5) mounted between the barriers 42 moulded integral with the base 11. A U-shaped magnet frame 121 spaces the core 117 from the base 11 and, at its upper ends, forms a mounting for an armature 123.

The conductor 35, which is secured to the base 11 by means of the screw 33 and a screw 129, extends through the U-shaped core 117 and thus secures the magnet unit to the base, the inner surface of the base being recessed to receive core 117 and magnet frame 121 as shown in Fig. 2. A spacer 125 is provided to space the conductors 35 from the magnet core and a channel-shaped length of insulation 127 between the conductor 35 and the spacer 125 insulates the core 117 from the conductor. Since the current flowing through the circuit of each of the poles traverses the conductors 35 said conductors serve to energize the electromagnets 86.

The armature 123 is pivotally mounted by means of a reduced portion 131 thereof projecting into an opening in one leg of the U-shaped magnet frame 121. A spring 135, having one end connected to a member 133 on the armature and its other end anchored on the one leg of the magnet frame, biases the armature 132 to its unattracted position. A cam 139 on the member 133 is adapted to engage an arm 141 moulded integral with the trip bar 87 upon energization of the electromagnet and cam the trip bar 87 counterclockwise (Fig. 2) to release the cradle 55.

The armature 123 is disposed for operation in a plane parallel to the axis of the trip bar 87 and when in its unattracted position the cam 139 thereon is disposed to one side and out of the path of movement of the projection 141 on the trip bar, as shown in Fig. 5, in order to permit clockwise rotation of said trip bar (Fig. 2) for the purpose of relatching the trip member 93. This arrangement of the parts permits a shorter tripping stroke of the armature and makes possible a smaller air gap which results in improved operating characteristics of the trip device and yet despite the relatively small air gap the electromagnet does not limit or interfere with resetting movement of the trip bar 87.

A wire or leaf spring 143, disposed in a recess 142 in one of the barriers 42 and supported at each end in the recess of the barrier, is tensioned against a flat surface 152 on the trip bar 87 to bias the trip bar in both directions toward its normal position. The spring 143 also prevents tripping of the breaker due to shock or jar. By enclosing the spring 143 in the recess 142 in the barrier 42 it is protected against the heat and flame of the arc incident to the rupture of the current.

Each of the armatures 123 (Fig. 5) has mounted thereon a contact 144 electrically connected to the conductor 41 by a flexible shunt conductor 146. Upon the occurrence of an overload in excess of a predetermined magnitude or a short circuit, the armature 123 is attracted by the magnet core 117 and moves the contact 144 into engagement with a contact 148 mounted on one end of a resilient contact blade 150 (Figs. 2 and 5) secured to the conductor 35, thereby shunting the current around the bimetal element 39. This prevents undue heating of the bimetal and aids in preserving the calibration thereof. The arrangement of the armature 123 and of the contacts 144 and 148 is such that operation of the armature, upon energization of the magnet provides a wiping contact.

The circuit breaker mechanism is shown in

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Fig. 2 in the closed circuit position with the trip device 23 in untripped position. When the trip bar 87 is rocked in unlatching direction in response to an overload in the circuit through any one of the poles, the latch 111 disengages the cradle 55 and permits the overcenter springs 53 to rotate the cradle clockwise about its pivot 56. At the start of this rotation of the cradle 55, a projection 68 on the cradle 55 engages a stud 66 on the toggle link 51 and starts the toggle 49—51 in the direction to cause its collapse. Continued movement of the cradle 55 causes the center line of the toggle link 49 to move to the right of the line of action of the springs 53 which act to complete the collapse of the toggle. This rocks the arms 27 counterclockwise carrying the contact arms 25 and the movable contact 21 therewith to open the circuit of the breaker. This operation of the mechanism also causes the handle 63 to be moved to an indicating position intermediate the open and closed positions.

In the closed circuit position (Fig. 2) the line of action of the overcenter spring 77 is above the pivot 26 of the contact arm 25 and biases the contact arm in a clockwise direction about its pivot providing pressure for the contacts. When the arms 27 are rotated counterclockwise, as above described, a tail 145 on the toggle member 79 strikes a projection 147 on the base 11 causing the toggle 79—25 to move overcenter. This rocks the contact arm 25 counterclockwise about its pivot 26 which opens the contacts a greater distance than would be possible if the movable contact were mounted directly on the arms 27.

Following each automatic operation of the breaker due to operation of the trip device 23 in response to an overload current, it is necessary to reset the mechanism to operative condition before the contacts can be reclosed. This is effected by rotating the manual lever 47 from its tripped position to its extreme counterclockwise or open position. This movement of the lever 47 is transmitted to the cradle 55 by a hooked projection 151 engaging a portion 153 of the cradle. As the cradle 55 is rotated in a counterclockwise direction, the latch end thereof passes the latch member 111 and engages a projection 155 molded integral with the trip bar 87, rocking the trip bar clockwise slightly past its normal position to relatch the cradle 55. During the clockwise resetting movement of the trip bar 87, the projections 115 thereon engage the ends of the trip members 93 and rock said members counterclockwise to relatch them with the latches 109 on the bimetal elements 39.

After the cradle 55 has been relatched, the contacts can be closed manually by moving the lever 47 clockwise to its closed circuit position. During this movement the line of action of the overcenter springs 53 crosses to the right of the pivot 69 of the toggle link 49 causing the toggle 49—51 to move overcenter and rock the arms 27 quickly clockwise to close the contacts. As the switch arms 27 approach the closed position, the arm 25 strikes a projection 157 on the base 11 at a point to the left of the pivot 26 (Fig. 2) causing clockwise rotation of the contact arm 25 about its pivot 26 moving the spring 77 overcenter above the pivot 26. This causes the contacts to close with a snap action and applies pressure to the closed contacts after they are closed.

The contacts are opened manually by moving the lever 47 in a counterclockwise direction about its pivot to the open position. This movement carries the line of action of the springs 53 to the

left of the pivot 69 of the toggle link 49 and the force exerted by said springs now biases the toggle 49—51 away from its overcenter position. Before the lever 47 reaches its extreme counterclockwise or open position, this force becomes sufficient to cause the toggle to quickly collapse, and since the toggle link 51 is pivotally connected to the switch arms 27 for the central pole, these arms are rotated counterclockwise causing opening of the contacts for all of the poles. The contacts are closed manually in the manner previously described.

The circuit breaker is trip free, i. e., operative automatically in response to predetermined abnormal circuit conditions in any one of the poles thereof irrespective of the position of the operating lever 47.

The arc extinguishers 19, there being one provided for each pole of the breaker, are of the spaced plate type and comprise, generally, a stack of slotted plates of magnetic material positioned adjacent the paths of movement of the movable contacts 21. The presence of these plates causes the arc resulting from the rupture of the circuit to be drawn in the direction toward the ends of the slots where the arc is broken up into a plurality of short arcs, and these short arcs are quickly cooled and extinguished.

Features of the circuit breaker contact means construction shown and described in this application are fully disclosed and claimed in United States Patent No. 2,318,298, issued May 4, 1943, to Hiller D. Dorfman and Gerald J. Freese, and assigned to the assignee of this invention.

Having described the preferred embodiment of the invention in accordance with the patent statutes, it is to be understood that various changes and modifications may be made in the structural details disclosed without departing from some of the essential features of this invention. It is, therefore, desired that the language of the appended claims be given as reasonably broad interpretation as the prior art permits.

We claim as our invention:

1. A trip device for a circuit breaker comprising a trip bar movable from a normal position in one direction to trip the breaker and in another direction from said normal position to reset the trip device, means biasing said trip bar to said normal position, a projection on said trip bar, and an electromagnet having a pivoted armature for engaging the projection to operate said trip bar and trip the breaker, said armature in its unattracted position being disposed out of the path of said projection to permit movement of the trip bar to reset the trip device.

2. A trip device for a circuit breaker comprising a trip bar of one-piece molded insulating material movable from a normal position in one direction to trip the breaker and from normal position in another direction to reset the trip device, said trip bar being provided with a plurality of projections molded integral therewith, an electromagnet having a pivoted armature, said electromagnet being responsive to overload conditions above a predetermined value to cause the armature to engage one of said projections and operate the trip bar to trip the breaker, a separately supported trip member biased in a tripping direction and releasable for engaging another of said projections to operate the trip bar, a bimetal element operable when heated a predetermined amount to release the trip member, said armature in unattracted position being out of the path

of the first projection to permit movement of the trip bar to reset the trip member.

3. A trip device for electrical control apparatus comprising a trip bar movable from a normal position to a tripping position and from said normal position to a resetting position, said trip bar being provided with a projection, a pivoted armature including a member for engaging the projection on the trip bar to move the trip bar to tripping position, said armature being disposed for movement in a plane parallel to the axis of the trip bar, an electromagnet responsive to predetermined circuit conditions for operating the armature, said member being disposed out of the path of movement of the projection on the trip bar when the armature is in its unattracted position to permit movement of the trip bar to resetting position.

4. In a circuit breaker, relatively movable contacts, actuating means for opening the contacts, a trip device comprising a trip bar solely of one-piece molded insulating material, said trip bar having a normal position for releasably restraining the actuating mechanism and being movable in one direction from said normal position to release said actuating mechanism and in another direction from said normal position for resetting the trip device, a plurality of projections molded integral with said trip bar, electromagnetic means responsive to circuit conditions above a predetermined value for engaging one of said integral projections to cause release of the actuating mechanism, a spring biased trip member mounted separately from said trip bar for engaging another of said integral projections and moving the trip bar to cause release of the actuating mechanism, a bimetal element operable when heated a predetermined amount to cause release of said trip member, and means engageable with a third integral projection on said trip bar for resetting said trip member.

5. In a circuit breaker, relatively movable contacts, actuating means to cause opening of the contacts, a trip device including a trip bar movable from a normal position in one direction to trip the breaker and in another direction from said normal position to reset the trip device, a projection on said trip bar, and an electromagnet having a pivoted armature for engaging the projection to trip the breaker, said armature in its unattracted position being disposed out of the path of the projection to permit movement of the trip bar to reset the trip device.

6. In a circuit breaker, relatively movable contacts, actuating means operable to cause opening of the contacts, a trip device including a trip bar movable from a normal position in one direction to trip the breaker and in another direction to reset the trip device, said trip bar being provided with a plurality of projections, an electromagnet having a pivoted armature, said electromagnet being responsive to overload conditions above a predetermined value to cause the armature to engage one of the projections and operate the trip bar to trip the breaker, a separately supported trip member biased in a tripping direction and releasable for engaging another of said projections to operate the trip bar, a bimetal element operable when heated a predetermined amount to release the trip member, said armature in unattracted position being out of the path of the first projection to permit movement of the trip bar to reset the trip member.

7. In a circuit breaker, relatively movable contacts, actuating means operable to cause auto-

matic opening of the contacts, a trip device including a trip bar movable from a normal position to a tripping position and also movable in an opposite direction from the normal position to reset the trip device, said trip bar being provided with a projection, a pivoted armature including a portion for engaging the projection to move the trip bar to tripping position, said armature being disposed for movement in a plane parallel to the axis of the trip bar, an electromagnet responsive to predetermined circuit conditions for operating the armature, an independently supported trip member biased to a tripping position to engage and move the trip bar to cause automatic opening of the contacts, a thermal element operable when heated a predetermined amount to release the trip member, said engaging portion of said armature being disposed out of the path of the projection when the armature is in unattracted position to permit movement of the trip bar to reset the trip member.

8. In a circuit breaker, relatively movable contacts, operating mechanism for said contacts including a manual operating member movable to cause opening or closing of said contacts, and a member releasable to cause opening of said contacts, a trip device including a trip bar of one-piece molded insulating material having a normal position for releasably restraining the releasable member and being movable in one direction to release said releasable member and in another direction for resetting the trip device, said manual member being operable to cause movement of the trip bar in resetting direction, a plurality of projections molded integral with said trip bar, an electromagnet responsive to current conditions above a predetermined value and having a pivoted armature for engaging one of said insulating projections for moving said trip bar to cause release of the releasable member, a spring biased trip member mounted independently of said trip bar and operable to engage another of said insulating projections to move the trip bar to cause release of the releasable member, a bimetal element operable when heated a predetermined amount to cause release of the trip member, and means engageable with a third insulating projection on said trip bar for resetting the trip member, said armature in its unattracted position being disposed out of the path of its cooperating projection on the trip bar to permit resetting movement of the trip bar.

9. In a circuit breaker, the combination of a conductor connected in the circuit of the circuit breaker, a U-shaped magnetic member around said conductor, a trip bar rotatable about its longitudinally extending axis generally perpendicular to said conductor, an armature pivoted adjacent one leg of said magnetic member and movable toward the other leg thereof upon the flow of a predetermined current through said conductor, and said armature being pivoted for rotation in a direction extending longitudinally of said trip bar and being operable to cause rotation of the trip bar about its longitudinal axis.

10. In a multipole circuit breaker, relatively movable contact means for each pole, actuating means including a spring biased member releasable to cause opening of said contact means, a trip device comprising a rotatable trip bar of one

piece molded insulating material common to all of the poles for normally restraining said releasable member, said trip bar being rotatable in one direction to release said releasable member and in another direction to reset said trip device, a plurality of projections molded integral with said trip bar, a spring biased trip member for each pole, each trip member being independently mounted and being releasable in response to predetermined abnormal conditions in its associated pole and independently of the other poles to engage the associated projection on said trip bar and rotate said trip bar to effect release of said actuating means, electromagnetic trip means for each pole, each of said electromagnetic trip means including a pivoted armature disposed for rotation in a direction longitudinally of the trip bar, each of said armatures being operable in response to predetermined conditions in its associated pole to engage another of said projections and operate the trip bar to release the actuating means, each of said armatures in unattracted position being disposed out of the path of the cooperating projection on the trip bar to permit movement of the trip bar in resetting direction to reset any of the spring biased trip members of the other poles that are tripped.

11. In a multipole circuit breaker, relatively movable contact means, operating mechanism for opening and closing said contact means, trip means comprising a trip bar common to all of the poles operable in one direction to effect operation of the operating mechanism and in another direction to reset the trip means, a plurality of projections on said trip bar, a plurality of releasable trip members each operable independently of the others and when released engaging one of the projections on said trip bar and operating said trip bar to effect operation of said operating mechanism, an electromagnetic trip means for each pole each having a pivoted armature, and means on each armature for engaging a corresponding projection to operate the trip bar to effect operation of said operating mechanism, each of said means being normally disposed out of the paths of its cooperating projection so as to permit movement of said trip bar to reset the trip members for the other poles.

HILLER D. DORFMAN.
GERALD J. FREESE.

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