June 19, 1962 A. R. NORDEN 3,040,144

CIRCUIT BREAKERS

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FIG. 1

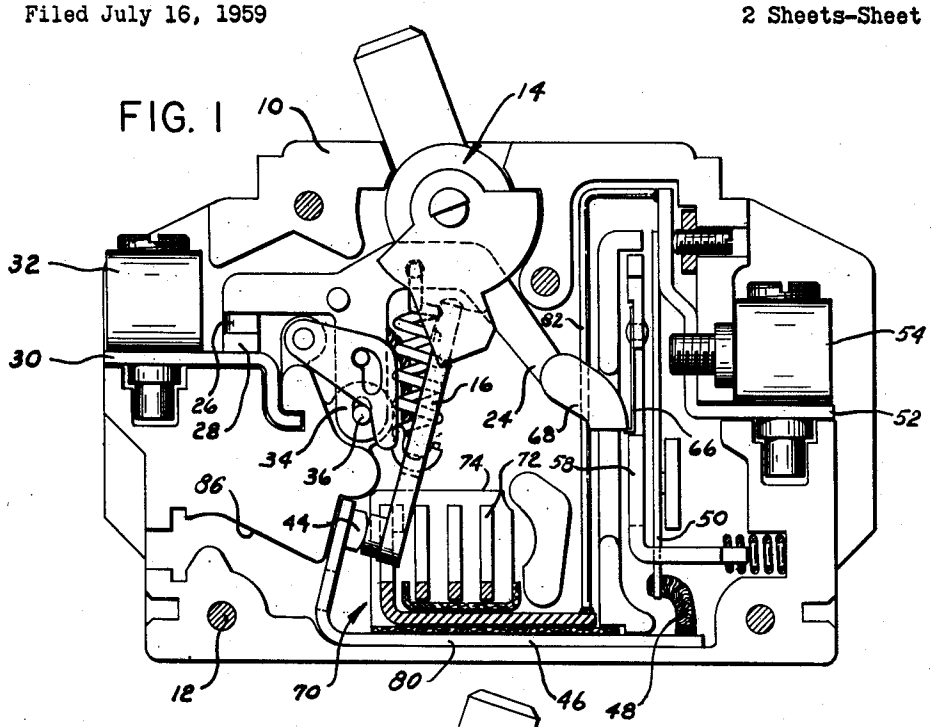
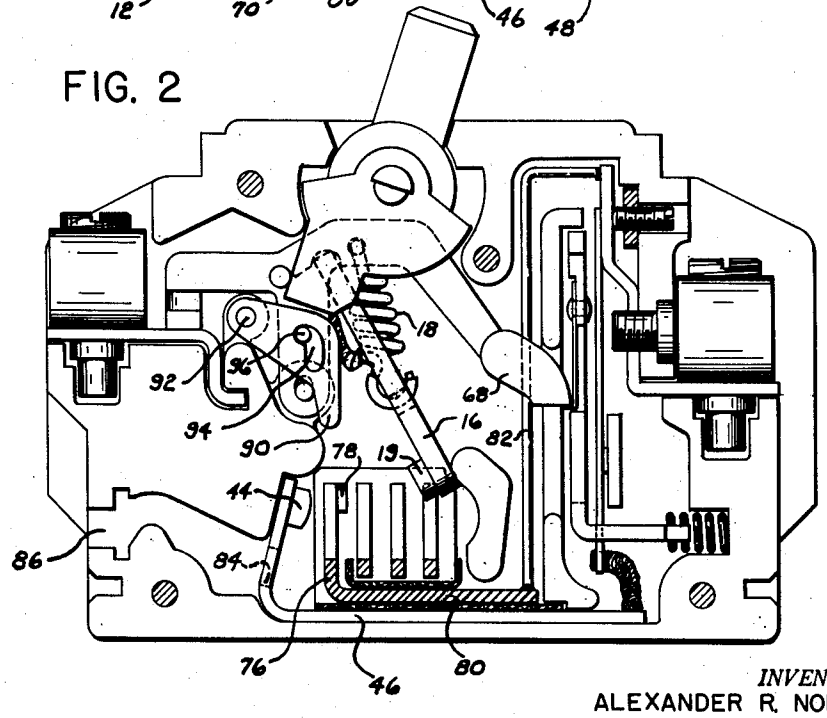


FIG. 2



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FIG. 3

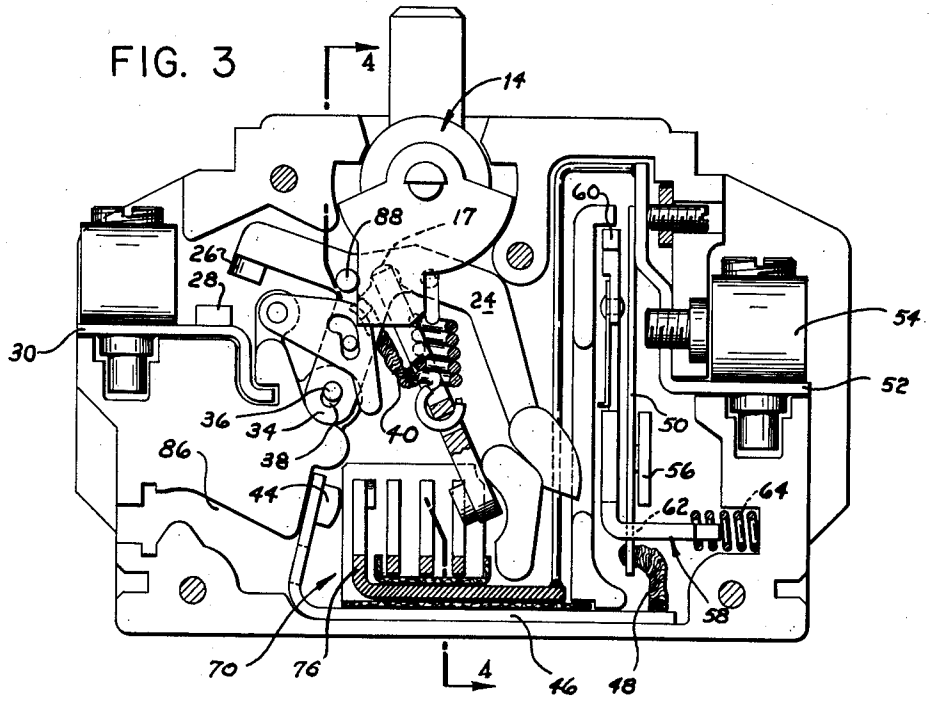
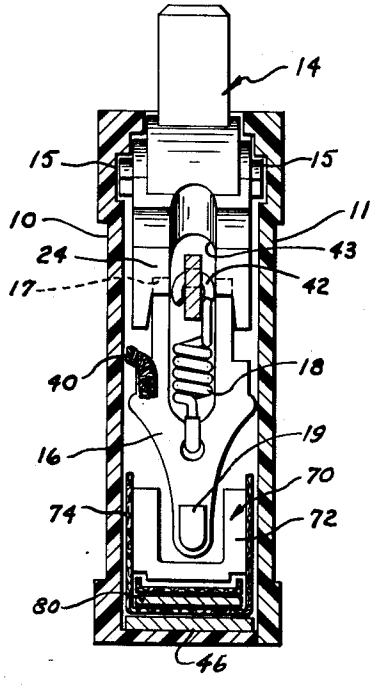


FIG. 4



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3,040,144

CIRCUIT BREAKERS

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10 Claims. (Cl. 200—88)

The present invention relates to automatic circuit breakers and more particularly to the type of self-contained circuit breakers having a manually operable handle for opening and closing the contacts and containing automatic overload release means.

An object of the present invention is to improve single-break circuit breakers so as to adapt them to more severe current and voltage conditions, and, more particularly, to improve circuit breakers of the self-contained manually operable type. As an example, small molded-case single-pole circuit breakers commonly used in lighting panelboards are ordinarily rated for interrupting a short-circuit current of 5,000 amperes in a 110 volt A.C. line. Circuit breakers of comparable construction, improved in accordance with the present invention, can be made for effective current interruption in a 240 volt A.C. line capable of supplying 10,000 amperes. Circuit breakers of known construction designed for heavier service than the 5000 ampere 110-volt rating can also be improved for still more severe conditions by utilizing the present invention. The novel features of the invention also provide improvement in the direct-current interruption ratings of such conventional circuit breakers.

Circuit breakers to which the invention has its principal application have a handle that is operable to close and open the circuit breaker manually, in the manner of a switch, and these circuit breakers also contain an overload release means for producing automatic operation of the mechanism for opening the circuit breaker in response to an overload.

In the following disclosure of a preferred embodiment of the invention, the broad concepts are applied to a type of circuit breaker in which an over-center spring mechanism is utilized for causing snap-opening and snap-closing of the usual contacts, and in this mechanism a releasable member is also arranged to cause over-centering of the spring mechanism for opening the contacts automatically upon release of the releasable member in response to an overload current. As will be seen this preferred embodiment of the invention utilizes an interrupter pair of contacts additional to the usual or main contacts found in the circuit breaker. One of the interrupter contacts is physically identified with the releasable member and there is parting of the interrupter contacts virtually at the instant of release of the releasable member, which is followed by parting of the main contacts a moment later when the releasable member has operated sufficiently to cause overcentering of the contact-operating mechanism. Such an arrangement has many advantages. For example, the interrupter contacts are normally closed both when the circuit breaker is manually opened and when it is manually closed. In the normal operation of the circuit breaker, below its overload limit, the manual operation in the face of moderate load currents does not involve any arcing at the interrupter contacts, which remain closed. This in turn promotes long life and low operating temperatures for the auxiliary or interrupter contacts. Additionally, the effort involved in closing the circuit breaker is identically the same as that involved in closing a conventional circuit breaker, despite the fact that the novel circuit breaker includes double breaks when interrupting overload or short-circuit currents. No greater effort is required to close such improved circuit breaker

than that required for closing the unimproved circuit breaker, despite the inclusion of the additional pair of contacts, and the contact pressures in the improved circuit breaker are maintained unimpaired.

Further, the parting of the interrupter contacts acts to limit the short circuit current that can occur in any given installation, and because of this current-limiting feature the main contacts are protected against more severe damage that might otherwise occur in the absence of the interrupter contacts.

A related feature of practical importance in increasing the interruption capacity of small circuit breakers involves the provision of a bypass circuit that does not normally carry current but which becomes effective during automatic opening operation of the circuit breaker to send the current through a path which parallels the current responsive bimetal usually found in circuit breakers of this type. This of course protects the bimetal from severe damage such as might result from prolonged flow of severe current through the bimetal. During the contact-opening operation and while the current flow is still severe enough to produce heavy arcing, the bypass circuit comes into effect to interrupt the flow of potentially damaging current through the bimetal.

This bypass circuit has a further advantage in facilitating the interruption of the arc. By including a resistive element in the bypass circuit, the current is further reduced and arc interruption is thereby facilitated. Such resistive element is not normally in the circuit to a protected load and therefore does not limit the normal current nor produce a voltage drop such as might affect the regulation of the power that is supplied to the load; and because the resistive element does not normally carry current, it does not heat up and there is no need for dissipation of sustained heating therein.

The nature of the invention and further features and objects will be better appreciated from the following description of a preferred embodiment of the invention which is shown in the accompanying drawings forming part of this disclosure. In those drawings:

FIG. 1 is an enlarged side view, partly in section and with the cover of casing removed, showing the internal circuit breaker parts in their normal "closed" configuration;

FIG. 2 is a view similar to FIG. 1 with the circuit breaker normally "open";

FIG. 3 is a view similar to FIG. 1 with the circuit breaker "tripped" open following automatic release; and

FIG. 4 is a transverse cross-section of the circuit breaker in FIGS. 1–3 generally along the line **4—4** in FIG. 3.

In FIG. 1 there appears a circuit breaker embodying features of the present invention, with the contacts of the circuit breaker shown closed. The same circuit breaker appears in FIG. 2 with the main contacts open in condition for closing; and in FIG. 3 the same circuit breaker appears again in its tripped position. The cover is removed from FIGS. 1–3 to reveal the internal parts.

The casing involves two parts of molded insulation which confronts each other (FIG. 4) and are parted generally in a plane parallel to the FIGS. 1 to 3. One of the casing parts **10** is united to the other part **11** (the cover) by means of four rivets **12** which appear in cross-section. The circuit breaker includes a handle **14** of molded insulation which is pivoted in appropriate bearings **15** in the confronting casing members **10** and **11**. Moving contact arm **16** pivots in suitable sockets **17** formed in handle **14** and is tensioned upwardly in such pivotal sockets by a coil spring **18**. The lower hooked end of the spring preferably (but not necessarily) is covered by insulation **20** in the region where it passes through a hole **22** in contact arm **16**.

A releasable cradle 24 extends from a latching mechanism at its right-hand end of FIGS. 1–3 to a moving contact 26 at the left end of cradle 24 for engagement with a companion contact 28 when the circuit breaker is "closed" and when it is "open" but in condition to be closed. Contact 28 is united on a terminal conductor 30 that is united to a solderless screw connector 32 for receiving and clamping a circuit wire. For convenience of reference, contacts 26 and 28 may be called "interrupter contacts."

Releasable member 24 has an arm 34 which projects downward as viewed in FIGS. 1 to 3, to a pin or pivot 36 in the casing. As seen in FIGS. 1 to 3, particularly in FIG. 3, arm 34 has an elongated opening 38 which receives pin 36.

As best shown in FIGS. 3 and 4, contact arm 16 has a flexible length of braid 40 connected to it. This braid is joined to the back face of the arm 34 of releasable member 24, which may be formed of steel or other suitable material for the most part, but which is of copper (for high conductivity) in the region between braid 40 and contact 26.

Spring 18 moves between two legs of the contact arm (FIG. 4) and moves free of contact with those legs. At its upper end, spring 18 has an insulation-covered hook 42 that is received in the hole in releasable member 24. The handle 14 has a slot 43 that allows operating clearance for cradle 24.

Contact arm 16 carries a main contact 19 that cooperates with a stationary contact 44 mounted on conductor 46. (For convenience of reference, contacts 19 and 44 may be called "main contacts.") A short length of braid 48 forms a current path from conductor 46 to current-responsive bimetal 50. At its upper end bimetal 50 is united to terminal conductor 52 that carries solderless connector 54 for circuit wiring.

Bimetal 50 carries a bar of magnetic material 56 rigidly. An armature member 58, carried by pivots 60 in suitable sockets in the molded case and cover, is disposed for the most part on the side of bimetal 50 which is opposite to magnetic element 56. Heavy current through the bimetal attracts armature member 58 to the right for tripping, as will later appear; and thermal deflection of bimetal 50 to the right resulting from flow of current therethrough also deflects the bimetal to the right. Bimetal 50 engages a shoulder 62 for carrying member 58 to the right when the bimetal is heated in response to the flow of current therethrough. Spring 64 biases shoulder 62 against the bimetal for maintaining an operative connection therebetween.

A compensating bimetal 66, arranged for deflection to the left in response to ambient temperature rises, compensates for deflection of bimetal 50 due to ambient temperature changes. Compensating bimetal 66 is riveted to member 58 as shown, with its high-expansion side facing bimetal 50. The latter has its high expansion side facing bimetal 66. In this way, the ambient temperature compensating bimetal, suitably proportioned, tends to compensate for the deflections of bimetal 50 resulting from ambient temperature variations. This is more fully disclosed and claimed in my copending application Ser. No. 526,401, filed August 4, 1955. At its lowermost end, which is the end that is free to deflect, bimetal 66 has a hook that engages and forms a latch for the insulation covered end portion 68 rigidly on releasable member 24. It is apparent from the foregoing that, either when member 58 is attracted by sufficient magnetic force or when bimetal 50 is deflected thermally to the right to the necessary extent, member 24 will be released for automatic opening of the contacts, as is more fully described below.

Main contact 19 moves in an arc chute 70 having arc splitter plates 72 between the walls of a fibre support 74. This arc chute promotes interruption of the arc that is developed upon separation of contacts 19 and 44 when

carrying current. The first splitter plate 76 (at the left in the drawings) has a pair of arcing contacts 78 at its upper extremities at opposite sides of the path of moving contact member 16, and splitter plate 76 has an integral extension 80 along the bottom of the arc chute. A resistance element 82 interconnects extension 80 and the terminal conductor 52.

When the contacts of the circuit breaker are closed (FIG. 1) a current path may be traced through the circuit breaker as follows: From terminal strip 30 via interrupter contacts 26 and 28, along a portion of releasable member 24 to braid 40, thence to main contacts 17 and 44 via conductor 46 to braid 48 and bimetal 50, and to terminal strip 52. In this condition of the circuit breaker, spring 18 tensions cradle 24 against latch 66 at the right and tensions interrupter contact 26 against its companion contact 28 at the left.

For opening the circuit breaker manually, handle 14 is operated to the right. This shifts socket 17 and the upper end of contact arm 16 across the line of action of spring 18, and contact arm 16 snaps away from contact 44 into the position shown in FIG. 2.

In the event of a short-circuit or other overload, bimetal latch 66 is shifted to the right automatically to release the right-hand end of cradle 24. Spring 18 drives cradle 24 downward, slot 38 therein moving along pin 36 until its arm 34 can pivot on pin 36. Clockwise pivoting of cradle 24 about pin 36 carries the line of action of spring 18 past socket 17 in handle 14, and this over-centering causes main contacts 19 and 44 to part.

Cradle 24 gains some momentum after its release by bimetal latch 66, and when pivot pin 36 is struck by the upper end of slot 38, a mechanical impact is developed for promoting parting of contacts 26 and 28 in the event that they should be stuck together by a weak surface weld.

When the circuit breaker opens in response to an overload and an arc is struck between contact 19 and stationary contact 44. That arc quickly transfers to arcing plate 76 and contacts 78 thereon, so as to transfer the current that would normally be carried by contact 44 into a circuit including conductor 82 which bypasses bimetal 50. This transfer of the arc is promoted by the higher potential at contacts 78 (which are at the potential of terminal strip 52) as compared to that at contact 44 (which is lower than that at strip 52 by the amount of the resistive drop in bimetal 50). This arrangement is of advantage in protecting the bimetal against possibly damaging current after member 24 is first released for effecting opening of the circuit breaker. Over-heating of bimetal 50 such as would result from unnecessarily long exposure of the bimetal to short-circuit currents has a tendency of causing a permanent "set" or deformation to occur in the bimetal. Transferring the arc away from contact 44 reduces the time during which the bimetal 50 carries the overload current.

Conductor 46 which supports bimetal 44 has a hole 84 formed therein to allow gases from the arc chute 70 to vent through passage 86.

In FIG. 3 the circuit breaker is shown in its condition that exists after the circuit breaker has opened in response to an overload. In order to move the parts into their condition in FIG. 2 ready for reclosing of the circuit breaker, handle 14 is moved to the right from that in FIG. 3. In so doing a portion of handle 14 engages a pin 88 rigidly carried by member 24, driving member 24 counterclockwise and reengaging insulated portion 68 of member 24 with bimetal latch 66. During this motion, contact 26 swings through a substantial angle and engages contact with a wiping component of motion. This action, and the fact that contacts 26 and 28 make contact with each other only under no-current conditions, tends to preserve good contact surfaces and low contact resistance at contacts 26 and 28. This means that the addition of a second break in the circuit represented by these contacts (additional to the usual break as at main contacts 19 and 44)

does not produce any serious increase in voltage drop across the circuit breaker and does not tend to develop any serious internal rise of operating temperature.

A "kicker" **90** which has a fixed pivot **92** has a slot **94** therein for receiving pin **96** carried rigidly in and operated by downward extension **34** of releasable member **24**. When the releasable member **24** is unlatched by movement of bimetal latch **66** to the right, the top end of spring **18** moves to the right of socket **17** and contact arm **16** tends to snap to the right. At the same time pin **96** drives "kicker" **90** to strike contact arm **16** to better insure quick opening travel of that contact arm.

The relationship between the parts **16**, **18** and **24** as well as the operation of handle **14** are generally conventional, with the exception of insulation in mechanical connection of contact arm **16** to cradle **24** via spring **18**. This possible current path which might overheat and thereby damage spring **18** is bypassed by flexible conductive braid **40**. With insulation at the top of the spring, it becomes unimportant if some portion of the spring should brush up against the legs of contact arm **16** (see FIG. 4).

The provision of the interrupter contacts as additions to the main contacts usual in circuit breakers of this class promotes interruption of overload and short-circuit currents by injecting a current-limiting break in series with the main contacts. Extension of the arc in the arc chute **70** also interrupts the current at contacts **26—28** and injection of resistive element **82** into the circuit further enhances the capacity of the circuit breaker to interrupt severe overloads.

The interrupter contacts **26—28** remains closed during manual operation of the circuit breaker to open the circuit. Manual opening operation is at currents below tripping level, and any arcing that might take place at the main contacts is readily controlled. The manual effort entailed in operating the circuit breaker described, with its double breaks, is no greater than that needed in conventional single-break circuit breakers, yet there is no loss of contact pressure. The factor of ease of operation is even more important where multiple single-pole units are organized for multi-pole operation, as in the patent to L. W. Cole, No. 2,692,926 issued October 26, 1954. The effort required to operate three poles is substantial and it is desirable to avoid any further increase.

The foregoing specific description of a preferred embodiment represents an exemplary application of the various novel features of the invention. However those skilled in the art will find that various modifications and varied application of the novel concepts are readily feasible, so that the invention should be broadly construed in accordance with its full spirit and scope.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. A circuit breaker of the type having a case of molded insulation containing a main pair of contacts, manually operable mechanism including a handle having "on," "off" and "trip" positions for closing and opening said main contacts, a combined thermal and magnetic automatic overload release means and a releasable member controlled by said release means and effective upon release thereof to cause automatic opening of said main contacts and to cause said handle to assume "trip" position upon release of said releasable member, that improvement comprising a set of interrupter contacts additional to and in series with said main contacts, one of said interrupter contacts being carried by said releasable member and thereby being closed at all times when the releasable member is restrained by the overload release means whether said main contacts are closed or open, said interrupter contacts also being reclosed after a tripping operation as an incident to restoration of the releasable member to its control by the automatic release means.

2. A circuit breaker of the type having a case of molded insulation containing a main pair of contacts, manually operable mechanism for closing and opening said main contacts, a combined thermal and magnetic overload release means effective upon release thereof to cause automatic opening of said main contacts, and a pair of external terminals, that improvement comprising a set of interrupter contacts additional to the main contacts and connected in series therewith between said terminals and mechanically coordinated with said release means so as to be closed at all times when the overload release means is in its normal condition enabling the main contacts to be closed, and said interrupter contacts being mechanically coordinated with said release means for parting of the interrupter contacts upon release of the overload release means.

3. A circuit breaker of the type having a case of molded insulation containing a main pair of contacts, manually operable mechanism for closing and opening said main contacts, combined thermal and magnetic automatic overload release means, and a releasable member controlled by said release means and effective upon release thereof to cause automatic opening operation of said main contacts, that improvement comprising a set of interrupter contacts additional to said main contacts and connected in series therewith, one of said interrupter contacts being carried by said releasable member and thereby causing parting of the interrupter contacts as an incident of the release of the releasable member momentarily before the automatic opening of the main contacts, and said interrupter contacts being held closed at all times when the releasable member is restrained by the overload release means whether said main contacts are closed or open.

4. A circuit breaker having a manually operable contact-operating mechanism, a main pair of contacts opened and closed by manual operation of said mechanism, current-responsive latching means, a releasable member normally restrained by said latching means effective upon overload to cause automatic operation of said mechanism for opening the contacts, and a pair of interrupter contacts connected electrically in series with the first-mentioned contacts, one of said interrupter contacts being carried by said releasable member and arranged to be closed or open in direct dependence upon the latched or released condition of said releasable member.

5. A manually operable circuit breaker having an operating handle, contact-operating over-centering spring mechanism controlled by said handle, and a pair of contacts opened and closed by over-centering of said mechanism by said handle, current-responsive latching means, a releasable member normally restrained by said latching means but effective upon overload to cause automatic over-centering of said mechanism for opening the contacts and said handle being operatively related to said releasable member for resetting thereof in latched engagement with said current-responsive means following an overload release operation and prior to contact-closing operation of said contact-operating mechanism, and a pair of interrupter contacts connected electrically in series with the first-mentioned contacts, one of said interrupter contacts being carried by said releasable member and thereby being arranged to be closed or open in direct dependence upon the latched or released condition of said releasable member.

6. A circuit breaker having a manually operable over-center spring mechanism, a pair of contacts opened and closed by reverse over-centering of said mechanism, current-responsive overload release means in control relation to said mechanism and effective upon overload to cause automatic contact-opening operation of said mechanism, means for resetting said current-responsive means after release thereof in response to an overload and prior to contact-closing operation of said mechanism, and a pair of interrupter contacts connected electrically in series with the first-mentioned contacts, one of said interrupter contacts being mechanically coordinated with said re-

lease means and arranged to be closed or open in direct dependence upon the reset or released condition of said release means.

7. A circuit breaker having a manually operable contact-operating mechanism, a pair of contacts opened and closed by manual operation of said mechanism, current-responsive overload release means in control relation to said mechanism and effective upon overload to cause automatic operation of said mechanism for operating a movable one of said pair of contacts away from the other, said overload release means including a current responsive bimetal, having one end thereof directly connected to the other of said pair of contacts, a pair of interrupter contacts connected electrically in series with the first-mentioned contacts and with said bimetal and arranged to be closed or open in direct dependence upon the normal or released condition of said release means, an arcing electrode disposed lateral of said movable one of said first-mentioned pair of contacts, and means including a resistive element connected from said arcing electrode to the end of said bimetal remote from said one end thereof to provide a current-bypass path parallel to said bimetal, said first-mentioned contacts, said interrupting contacts, said arcing electrode and said resistive element acting to limit the current to be interrupted.

8. A circuit breaker having a manually operable contact-operating mechanism, a main pair of contacts opened and closed by manual operation of said mechanism, current-responsive latching means, a releasable member having an impelling spring and normally restrained by said latching means but effective upon overload to cause automatic operation of said mechanism for opening the contacts, and a pair of interrupter contacts connected electrically in series with the first-mentioned contacts, one of said interrupter contacts being carried by said releasable member and arranged to be closed or open in direct dependence upon the latched or released condition of said releasable member, said releasable member having a normally latched portion spaced substantially from said one of said interrupter contacts and said spring acting on said releasable member between said one interrupter contact and said latched portion so as to provide both latch pressure and contact pressure.

9. A manually operable circuit breaker having an operating handle, contact-operating over-centering spring mechanism controlled by said handle, and a pair of contacts opened and closed by over-centering of said mechanism by said handle, current-responsive latching means, a releasable member having an impelling spring and normally restrained by said latching means but effective upon overload to cause automatic over-centering of said mechanism for opening the contacts, and said handle being operatively connected to said releasable member for resetting thereof in latched engagement with said current-responsive means following an overload release operation and prior to contact-closing operation of said contact-operating mechanism, and a pair of interrupter contacts connected electrically in series with the first-mentioned contacts, one of said interrupter contacts being carried by said releasable member and thereby being arranged to be closed or open in direct dependence upon the latched or released condition of said releasable member, said releasable member having a normally latched portion spaced substantially from said one of said interrupter contacts and said spring acting on said releasable member between said one interrupter contact and said latched portion so as to provide both latch pressure and contact pressure, said latched member having a lost-motion pivotal support enabling said pressures to be established when the releasable member is latched and providing pivotal support instantly after release thereof.

10. A circuit breaker having a main pair of contacts, mechanism for operating said main pair of contacts for opening and closing the circuit therethrough, overload release means in control relation to said main contacts to effect automatic opening thereof in response to an overload, and said overload release means including an additional pair of contacts coordinated therewith so as to be closed or open in direct relation to the normal or released condition of said overload release means, said additional pair of contacts being connected in series with said main contacts.

References Cited in the file of this patent

UNITED STATES PATENTS

2,018,904	Taylor	Oct. 29, 1935
2,025,857	Guett	Dec. 31, 1935
2,055,183	Sperry	Sept. 22, 1936
2,130,904	Sandin	Sept. 20, 1938
2,760,028	Walker	Aug. 21, 1956
2,816,986	Hagdahl	Dec. 17, 1957