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T. M. COLE  
HIGH INTERRUPTING CAPACITY CIRCUIT BREAKERS  
WITH ELECTRODYNAMIC LATCH RELEASE

3,192,344

Filed Aug. 28, 1961

3 Sheets-Sheet 1

FIG. 1

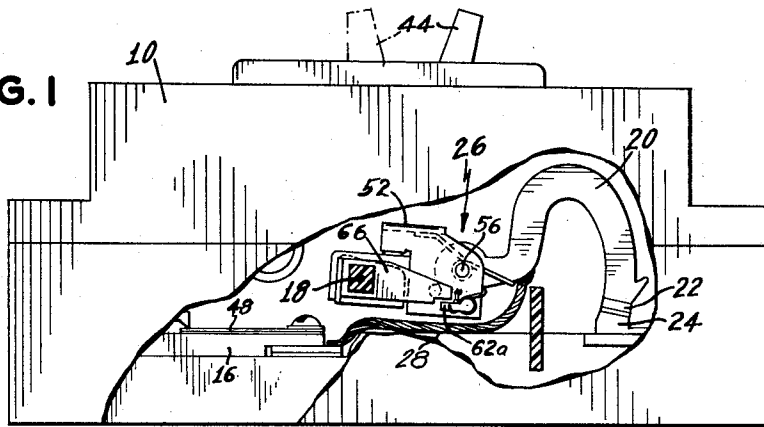


FIG. 2

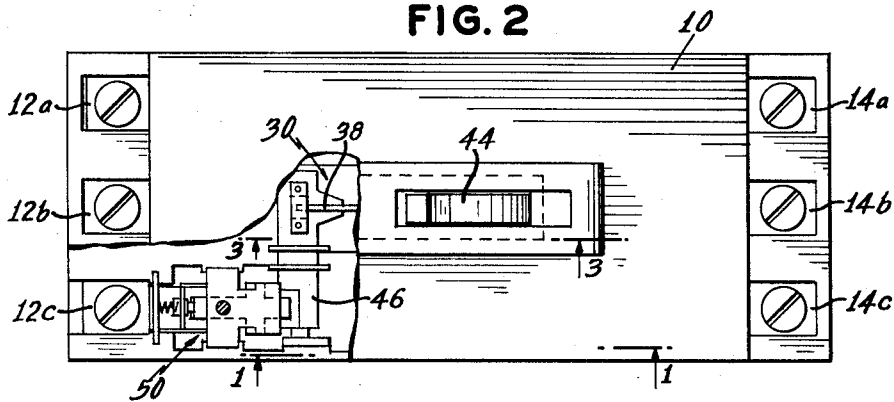
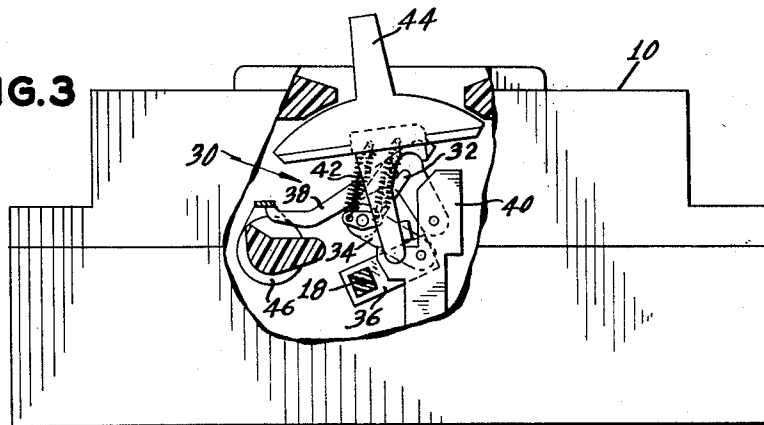


FIG. 3



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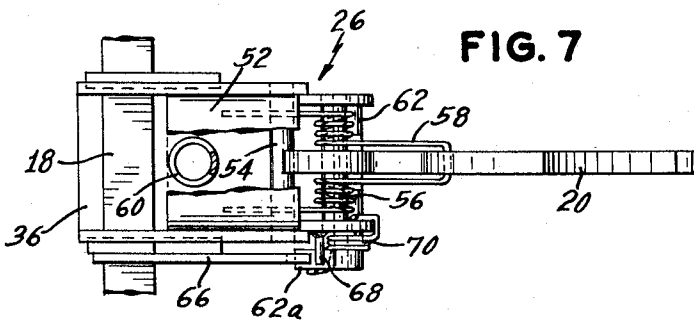
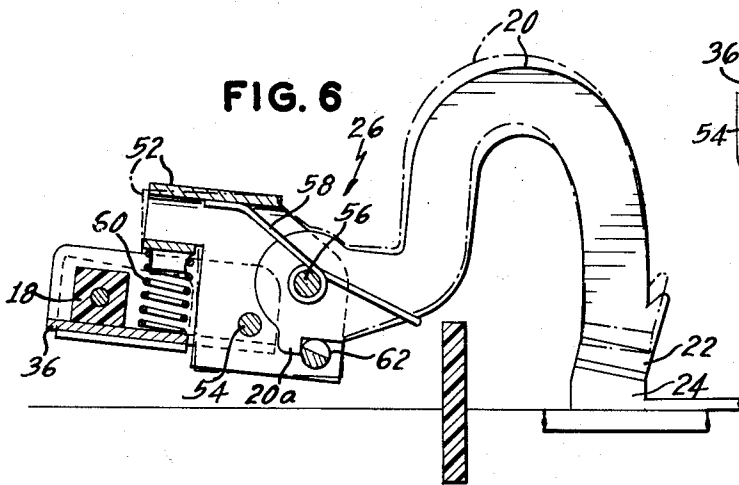
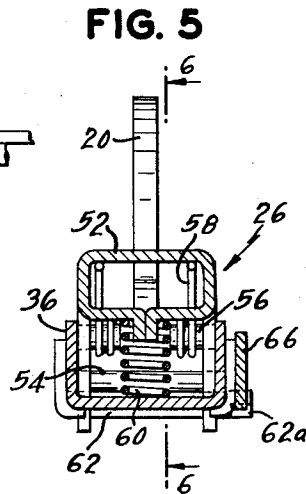
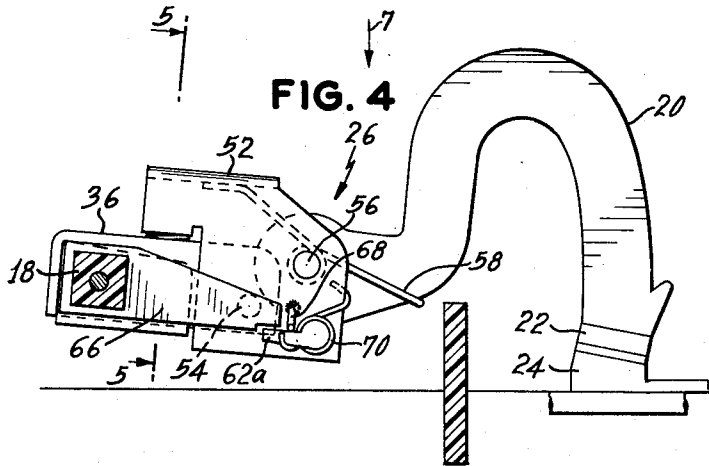
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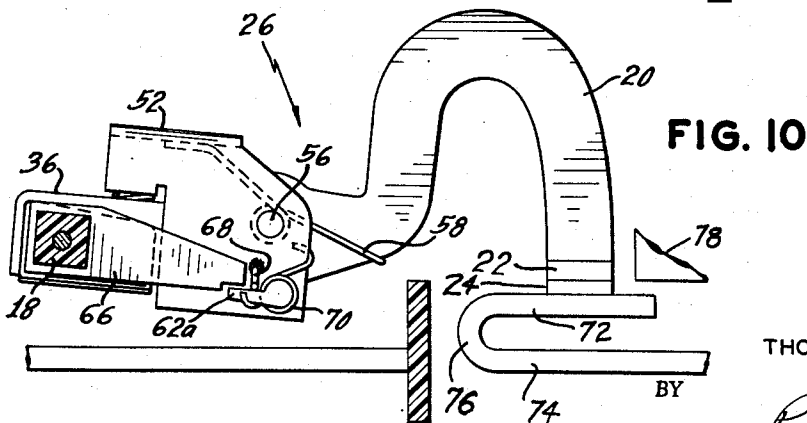
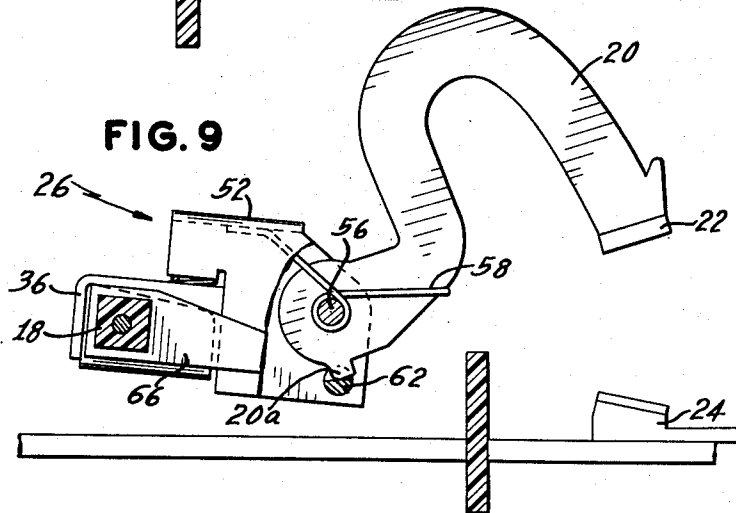
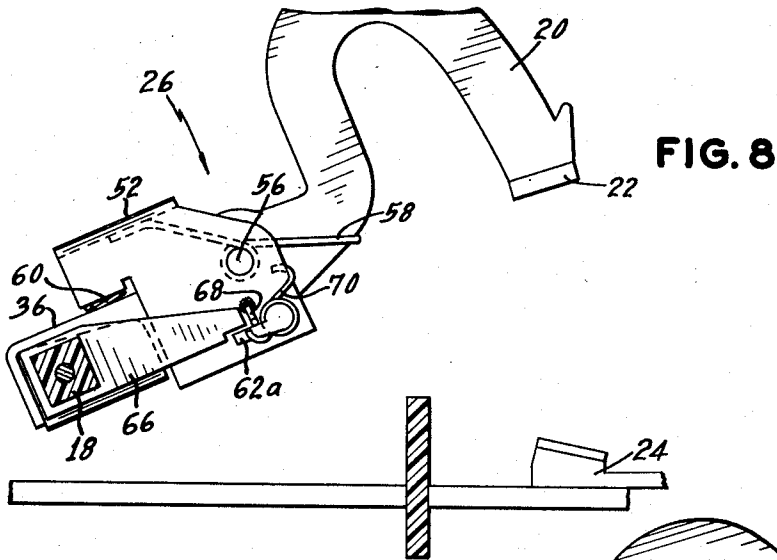
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3 Sheets-Sheet 3



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**HIGH INTERRUPTING CAPACITY CIRCUIT BREAKERS WITH ELECTRODYNAMIC LATCH RELEASE**

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 Filed Aug. 28, 1961, Ser. No. 134,199  
 2 Claims. (Cl. 200—116)

The present invention relates to circuit breakers and, more particularly, to circuit breakers of the type commonly classified as industrial molded-case circuit breakers.

Circuit breakers of the molded-case type primarily designed for use with alternating-current lines up to 600 volts, have been called upon over the years to satisfy increasing requirements for current interrupting capacity. To meet this situation, such have been redesigned to make the arc chutes more effective, and to make the enclosing cases mechanically stronger.

The present invention resides in the provision of a novel circuit breaker mechanism adapted to respond with great speed to the rise of short-circuit currents, with a view to limiting the current rise. This is an approach that has been used in protective devices which incorporate current limiting fuses in combination with circuit breakers of standard construction. An object of the present invention resides in the provision of a circuit breaker of novel construction aimed at achieving increased current-interrupting capacity; and in this connection a more specific object of the invention resides in the provision of a circuit breaker having an unusually fast-acting contact-opening mechanism.

The illustrative embodiment of the invention which is presently preferred involves a three-pole circuit breaker having the usual common operating mechanism for opening and closing the contacts of all three poles concurrently, and for releasing that mechanism automatically for concurrent opening of all three poles in response to overloads within the previous current-interrupting capacity of such circuit breakers. The improvement in the illustrative embodiment circuit breaker involves a release mechanism interposed between each contact-carrying arm and the carrier for such arm, arranged so that the fast-acting release mechanism is rendered effective for opening the contacts by actual motion of the contact arm in the contact-opening direction. Such motion is effected by the electrodynamic forces identified with the current path through the contacts and through the conductors immediately associated with the moving contact and its companion contact. Two different embodiments are disclosed in detail below both of which utilize the movement of the contact-carrying arm in its contact-opening direction under the influence of the current surge to effect individual release of a mechanism that continues the opening movement of that contact arm to open the circuit of that individual pole. The action is extremely rapid. As a result, this mechanism tends to limit the current rise below that which would otherwise occur in comparable conventional circuit breakers. The fast-acting release of one contact arm does not impede the coordinate release of the common operating mechanism, which also functions (after an inherent delay time) to open all the contacts in response to the overcurrent through the overloaded pole.

The nature of the invention and its various further features of novelty will be more fully appreciated from the detailed description of the illustrative embodiments thereof, which are shown in the accompanying drawings forming part of this disclosure. In the drawings:

FIG. 1 is a side elevation of a circuit breaker embodying features of the present invention, shown partly in section

and with the contacts closed, as viewed from the plane 1—1 in FIG. 2;

FIG. 2 is a plan view of the circuit breaker in FIG. 1, portions of the casing being removed to reveal portions of the internal mechanism;

FIG. 3 is a side elevation of the circuit breaker in FIGS. 1 and 2, partly in section as viewed from the plane 3—3 in FIG. 2 but with the operating mechanism in its "open" position;

FIG. 4 is an enlarged fragmentary view of a portion of the circuit breaker in FIG. 1, drawn to larger scale;

FIG. 5 is a cross-section of a portion of the mechanism in FIG. 4 as viewed from the plane 5—5;

FIG. 6 is a lateral view of the mechanism in FIG. 4, shown partly in section as viewed from the plane 6—6 in FIG. 5;

FIG. 7 is a top plan view of the mechanism in FIG. 4, viewed at a slight slant angle represented by the arrow 7 in FIG. 4;

FIG. 8 is a view of the mechanism in FIG. 4, in the open condition of the circuit breaker in readiness for reclosing;

FIG. 9 is a lateral view of the mechanism in FIG. 4, partly in section, with the contact arm in its automatically released configuration but with the operating mechanism in its "closed" position; and

FIG. 10 is a lateral view, partly in section, of a modification of the mechanism in FIG. 4.

Referring now to FIGS. 1 to 3 of the drawings, a 3-pole circuit breaker is illustrated having a casing 10 of molded insulation and having three pairs of terminals 12a, 14a, 12b, 14b, and 12c, 14c. A circuit may be traced through the circuit breaker in each pole, as follows: from a terminal 12 through bar 16 and flexible copper braid 28, through contact arm 20, movable contact 22, companion contact 24 and terminal 14.

Each of the three contact arms 20 is carried by an individual contact-carrier 36, each arm 20 and its contact-arm carrier 36 being coupled by an individual release mechanism 26. The three contact-arm carriers 36 are united rigidly to a common insulated square shaft 18 that is pivoted at its extremities in the molded casing.

A single operating mechanism 30 is disposed in the space containing the contacts and current-carrying elements of the center-pole. This mechanism rotates common shaft 18 between the closed position represented in FIG. 1 and the open position represented in FIG. 3. Mechanism 30 includes a pair of toggle links 32 and 34, the latter having a pivotal connection to the center-pole contact arm carrier 36 on shaft 18. Toggle link 32 is pivoted to releasable cradle 38, which in turn is pivoted to fixed frame 40 at the extremity of the cradle. Tension springs 42 are connected between the knee of toggle 32, 34 and a manual lever 44 that is pivoted at its lower end. Lever 44, springs 42, and toggle links 32 and 34 form an over-centering spring mechanism for snap-closing and snap-opening operation of common shaft 18 and the three contact-arm carriers 36.

Trip bar 46, of insulation, extends across the circuit breaker and releasably restrains cradle 38. When the cradle is released, at a time when the handle 44 is in its "on" position, the over-centering toggle mechanism automatically drives shaft 18 into its open-circuit position and shifts handle 44 to an intermediate trip-indicating position. By driving handle 44 further to the left, the cradle is relatched and the mechanism assumes the configuration illustrated in FIG. 3.

As mentioned above, the current path through the circuit-breaker includes bar 16 in each pole. A bimetal 48 is disposed close to bar 16 so as to respond to the heat developed during a delay time in bar 16. Upon sufficient

deflection of this bimetal 48 upward, the overload release mechanism 50 (whose details are not of concern here) causes counterclockwise rocking of trip bar 46, automatic release of cradle 38 and automatic contact-opening operation to the thermal release represented by the bimetal, such automatic release mechanisms include magnetic over-current release devices for effecting fast release in response to sudden high overload currents. Upon operation of any release mechanism 50, it is apparent that all three poles of the circuit breaker open coordinately. This inherently involves a delay time that is a large part of a cycle of 60-cycle alternating current.

Much faster response to severe overload current surges is afforded by means of the individual releasable coupling mechanisms 26. As best shown in FIGS. 4-9 inclusive, each contact-arm 20 is supported by a corresponding contact-arm carrier 36 on shaft 18. Contact-arm carrier 36 is a short metal channel having vertical side walls and a horizontal bottom web that is secured rigidly to shaft 18 which extends through square holes in the side walls of contact-arm carrier 36. The coupling mechanism 26 between each contact arm 20 and its carrier 36 includes the following details.

A formed sheet metal member 52 has a pivot 54 mounting it on contact-arm carrier 36, and contact arm 20 has a pivot 56 on member 52. A torsion driving spring 53 for contact arm 20 biases the contact arm counterclockwise as viewed in FIGS. 4, 6, 8, and 9. A compression spring 60 biases member 52 clockwise about pivot 54, relative to carrier 36. A "rolling-D" latch 62 is pivoted in member 52 and cooperates with latch portion 20a of contact arm 20.

When the circuit breaker is to be closed, contact arm carrier 36 is rocked clockwise by erecting the toggle mechanism of FIG. 3, so that carrier 36 assumes the position presented in FIG. 6. During this motion, the parts move from the position represented in FIG. 8 to that in FIGS. 4 and 6. Contact arm 20 is constrained to move as a unit with member 52 because of the engagement of latch 62 with latch portion 20a. During the closing operation, contact 22 reaches contact 24 before the toggle mechanism is fully erected; and thereafter, during the further travel or "overtravel" of carrier 36 clockwise, as the toggle reaches its fully operated condition, pivot pin 54 is driven downward. Parts 20 and 52 as a unit swing slightly counterclockwise about pivot 54, thereby compressing spring 60 and building up contact pressure at contacts 22 and 24.

In an individual-pole releasing operation that is effected by mechanism described below, rolling-D latch 62 is rotated counterclockwise so as to release contact-arm 20 for open-circuit motion into the configuration of FIG. 9. This contact-opening motion is produced at least partly by drive by the torsional bias spring 53. The mechanism that controls the rolling-D latch 62 is as follows:

A stop member 66 is secured to carrier 36 as a unitary part thereof. A stop 68 is fixed to member 52. Rolling-D latch has an operating arm 62a (FIG. 4) which is biased clockwise toward stop 68 by a torsion spring 70.

In conventional release operation of the circuit breaker, the current responsive bimetal or the magnetic elements of each release element 50 (FIG. 2) causes counterclockwise releasing motion of trip bar 46, for release of cradle 38, resulting in concurrent opening operation of all the poles. This is a time consuming process, considered in relation to the rate of rise of short-circuit currents, and in relation to a half-cycle duration of a 60-cycle wave.

During the rise time of sudden extremely high currents, electrodynamic forces inherently develop between contacts 22 and 24 and the conductors that carry current to and from those contacts. This sudden electrodynamic "blow-off" force tends to drive contact arm 20 counterclockwise, as viewed in FIG. 6 for example. Gas pressure also theoretically develops between contacts 22 and 24 that augments the electrodynamic blow-off force. During the

rise of sudden high bursts of current, these forces overcome the bias of spring 60 and contact 22 is lifted away from companion contact 24. In so doing, contact arm 20 and member 52 which are locked together by latched parts 62 and 20a swing as a unit counterclockwise about pivot 54 to a limited extent. This is represented in FIG. 6 by dotted lines. For example, a 1/4-inch motion at contact 22 may occur, thus causing latch arm 62a to rise against stop 66. The counterclockwise movement of member 52 lifts the pivotal axis of latch 62 while stop 66 arrests latch arm 62a. After a desired stroke, such as is represented by the 1/4-inch rise of contact 22 assumed above, rolling-D latch 62 releases latch portion 20a, and contact arm 20 is snapped into the position in FIG. 9 by spring 53. This motion is effected at high speed. It is a motion that is aided by the initial blow-off motion of the contact arm, and the motion of the contact arm continues in the opening direction with added impetus from spring 53. This quick response to short-circuit conditions contributes importantly to effective current interruption since it tends to limit the rise of the fault current. This result is enhanced by use of an effective arc chute design and by using light-weight moving parts for minimum inertia.

The tendency of contact arm 20 to rise due to "blow-off" forces associated with safe currents and even moderate overloads is overcome by the bias of compression spring 60. The individual-pole tripping operation described above occurs only when the current rises instantaneously to a high value that warrants such current-limiting operation.

In the embodiment of the invention described in connection with FIGS. 1 to 9 inclusive, the initial motion of contact arm 20 in response to sudden current surges involves blow-off forces at the contacts; and when such forces exceed the bias of spring 60, the contacts start to part. Accordingly, the operation which is relied upon to start current-limiting action occurs very early during the rise time of the current surge.

FIG. 10 illustrates a modification of the foregoing. The embodiment in FIG. 10 is the same in all respects as that in FIGS. 1 to 9 except for the mounting of the nominally stationary contact that is engaged by the moving-contact arm. Contact 24 is carried by a conductor 72 that is closely spaced from a further conductor 74 that is supported on the base of the molded casing, conductors 72 and 74 being joined by a resilient bent conductor portion 76. Above the right-hand extremity of conductor 72 as shown there is a stop 78, advantageously of insulation.

The apparatus of FIG. 10 operates somewhat differently from that in FIGS. 1 to 9. During moments of high current level, the current through the conductive loop 72, 76 and 74 tends to drive conductor 72 upward and away from the lower, stationary supported conductor 74. This drives contact 24 upward, against contact 22, and thus supplies drive to lift contact arm 20. With sufficient lifting force to overcome the bias of spring 60 and to raise contact arm 20, the individual release mechanism 26 becomes effective. The upward motion of contact arm 20 that is started under impetus from suddenly expanding conductor loop 72, 76, and 74 is continued by the contact-opening drive of spring 53 after release of latch 62. The embodiment of FIG. 10 is thus seen to operate in a somewhat different fashion from that in FIGS. 1 to 9, in that the contacts 22 and 24 remain in engagement until rolling-D latch 62 releases contact arm 20. This slightly delays the start of the current-limiting process that depends upon contact separation. The modification of FIG. 10 has the advantage that the contacts remain together during current surges that cause some movement of contact arm 20 but not enough movement to effect release of latch 62, 20a, and in this way minimizes possible arc-caused damage to the contacts. The embodiment of FIGS. 1 to 9 and that of FIG. 10 have, in common, the electrodynamic initiation of the movement of contact

5

arm 20 in its opening direction in response to current surges, and that motion continues with added impetus from spring 53 when rolling-D latch 62 is released. The resulting wide separation between the contacts that is quickly achieved in response to a severe current rise is instrumental in providing current-limiting action which facilitates arc interruption. Consequently, the improved circuit breaker can be safely used in systems having high short-circuit current capacity, where high surge currents might occur.

The foregoing represent two embodiments presently preferred for implementing the concepts of this invention, but it is evident that from this specification and the accompanying drawings further embodiments will be suggested to those skilled in the art. Consequently, the invention should be broadly construed in accordance with its full spirit and scope.

What I claim is:

1. A multipole circuit breaker having a common operating mechanism, plural contact arm carriers in respective poles operable in unison by said operating mechanism for opening and closing all the poles of the circuit breaker concurrently, plural overload release devices in said poles, respectively, arranged to cause automatic opening operation of said operating mechanism in response to an overload in one or more of the poles, contact arms in each of said poles, interposed members in each pole pivotally supporting one of said contact arms and pivotally carried by one of said contact arm carriers, releasable latching means including normally engaged parts on each contact arm and on the related interposed member, respectively, for holding each said arm against contact-opening movement relative to its interposed member in the latched condition of said latching means, individual resilient biasing means acting on each contact arm in the contact-opening direction and effective to move such contact arm in that direction upon release of said latching means, a pair of contacts in each pole including a first contact of each pair on said contact arm and a companion contact of each pair disposed for engagement by the corresponding first contact, individual resilient biasing means acting on each said interposed member for biasing the related contact arm in the contact-closing direction when the interposed member and the contact arm are latched to each other, means providing a current path through the circuit breaker when closed, the latter means including said contacts and the contact arm and having a configuration effective to produce a force tending to drive said contact arm in the opening direction and effective to move the contact arm only when the contact-closing resilient bias is overcome, and a latching-means releasing member interposed in the path of movement of the latched con-

6

tact arm and its interposed member for releasing said releasable means of that contact arm upon blow-off motion of that contact arm.

2. A circuit breaker including a contact arm, an interposed member carrying said contact arm and having a relatively movable connection thereto, latching means including latch parts on said contact arm and on said interposed member, and effective when the parts are in latching engagement to prevent contact-arm opening movement relative to said interposed member, resilient means acting on said interposed member and, when the latching means is latched, on said contact arm for biasing the latter in its closing direction, a pair of contacts including a first contact carried by said arm and a companion contact engaged by said first contact in the closed condition of the contacts, a contact-arm driving spring acting on said contact arm in the opening direction and effective to move the contact arm in that direction upon release of the latching means, means in the circuit breaker including said contact arm and said companion contact for providing a current path therethrough, the latter means being of a configuration tending to drive both said contact arm and said interposed member when latched thereto in the contact-opening direction in response to severe current surges of sufficient magnitude to overcome said resilient biasing means, and means for releasing said latching means, said releasing means including a stop element position in the path of one of said latch parts and effective to release the latching engagement of said latch parts when the latter move with the contact arm and the interposed member in response to a severe current surge, said releasing means thus being effective to release said latching means upon predetermined movement of the contact arm and the interposed member in their opening direction, the contact arm thereafter continuing its movement in the opening direction under the added impetus of said driving spring.

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