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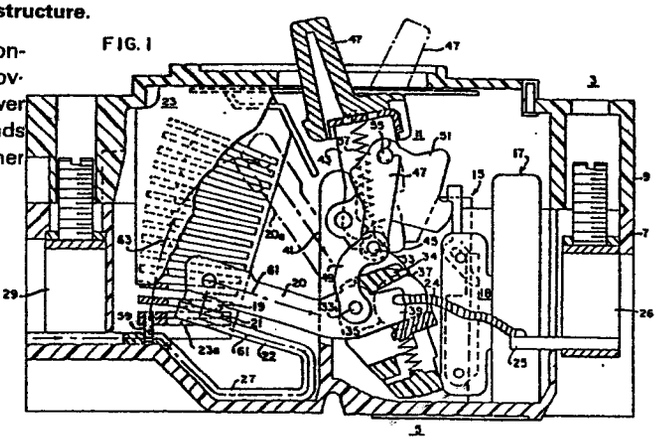
(54) **Current limiting circuit breaker with arc commutating structure.**

(57) A circuit breaker characterized by a pair of separable contacts, one of which is carried by a movable contact arm, movable within an arc chute having arc plates including a lower arc plate adjacent to the other contact. A link conductor leads to the other contact and electrically connected to the other contact.

FIG. 1



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CURRENT LIMITING CIRCUIT BREAKER WITH ARC COMMUTATING STRUCTURE

This invention relates to a circuit breaker and, in particular, it pertains to a means for commutating any arc occurring between separating contacts from the stationary contact to an arc chute.

Circuit breakers are used extensively in industrial, residential, and commercial installations to provide protection against damage due to overcurrent conditions. As usage of electrical energy has increased, the capacity of sources supplying this energy has increased correspondingly. For this reason large currents can flow through distribution circuits where a short circuit condition occurs. Under these conditions conventional circuit interrupters are incapable of preventing severe damage to apparatus connected downstream from the interrupter, as well as to the interrupter itself.

An extreme overcurrent condition through a circuit breaker generates electromagnetic force upon the contact arms sufficient to rapidly pivot them in opposite directions to separate the contacts. Thus, an arc is stretched to provide a high arc voltage and arc resistance and current limiting action. An accompanying trip means then rapidly releases an operating mechanism from the closed to the open position before the contact arms can return to the closed position, thereby preventing reignition of the arc.

According to the present invention, a circuit breaker comprises an insulating housing having a line terminal and a load terminal, separable contacts disposed in the housing for opening and closing a circuit between the terminals, an operating mechanism having a pivoting carriage and means adapted for manual operation to pivot the carriage between open and closed positions, contact support means including first and second pivoting contact arms each supporting one of the contacts, the first contact arm being pivotally attached to the carriage, means for restricting relative motion between the carriage and the first contact arm to rotation, a conductor extending between the line terminal and the second contact arm, arc extinguishing means around the path of travel of the first contact arm and the means including spaced arc-absorbing plates, electrical connector means between the conductor and one of the arc-absorbing plates for commutating any arc from the second contact arm to said one arc-absorbing plate.

Conveniently, there is provided a current limiting circuit breaker comprising an insulating housing having a line terminal and a load terminal; separable contacts disposed in the housing for opening and closing a circuit between the terminals; an operating mechanism having a pivoting carriage and means adapted for manual operation to pivot the carriage between open and closed positions; contact support means including first and second pivoting contact arms each supporting one of the contacts, the first contact arm being pivotally attached to the carriage, and means for restricting relative motion between the carriage and the first contact arm to rotation; bias means on the carriage for urging the first contact arm into a first position with respect to the carriage to enable the first contact arm and the carriage to rotate as a unit to open and close the separable contacts; a conductor extending between the line terminal and the second contact arm; arc extinguishing means around the path of travel of the first

contact arm and means including space arc-absorbing plates; and electrical connector means between the conductor and one of the arc-absorbing plates for commutating an arc from the second contact arm to one arc-absorbing plate.

The device of this invention provides an advantage of enabling higher arc voltage, better arc interruption, and less contact erosion because an arc moves more quickly from the arc to the arc chute.

The invention will now be described, by way of example, with reference to the accompanying drawings in which:

Figure 1 is a vertical sectional view through a multi-pole current limiting circuit breaker showing the contacts in the closed position; and

Figure 2 and 3 are fragmentary sectional views showing another embodiment of the invention.

A three-pole circuit breaker 3 in Figure 1, illustrates an insulating housing 5 including a base 7 and a cover 9 which is secured to the base in a conventional manner such as by screws (not shown). Although the principal of this invention is applicable to a single pole circuit breaker, it is usually applicable to a multi-pole unit for which reason the housing 3 comprises insulating barriers separating the housing into three adjacent side-by-side pole unit compartments in a manner well known in the art.

Within the housing a circuit breaker mechanism 11 is mounted within the center pole unit of the housing and comprises a single operating mechanism and a single latch mechanism 15. The circuit breaker mechanism 11 also comprises, in each of the three pole units, a separate thermal device 17 and a high speed electromagnetic trip device 18. A typical high speed electromagnetic trip device is more completely described in the specification of U.S. Patent No. 4,220,935.

Each pole of the circuit breaker is provided with a pair of separable contacts 19 and 21, attached to upper

and lower contact arms 20 and 22, respectively. An arc extinguishing unit or arc chute 23 is also provided in each pole unit. The upper contact 19 is electrically connected, through the upper contact arm 20 (constructed of conducting material), to a shunt 24 which is connected through a conducting strip 25 and the thermal and magnetic trip devices 17, 18 to a terminal 26.

The lower contact 21 is connected through the lower contact arm 22 and a conducting strip 27 to a terminal 29. With the circuit breaker 3 in the closed position, an electrical circuit thus exists from the terminal 29 through the several items 27, 22, 21, 19, 20, 24, 25, to the terminal 26.

The contact arm 20 is pivotally connected at pivot 33 to a rotatable carriage 34 which is fixedly secured to an insulating rotatable tie bar 35. The carriage 34 includes a slot or pocket 37 in which an end portion 39 of the arm 20 is rotatably mounted on the pivot 33. The arm 20 and the carriage 34 rotate as a unit with the tie bar 35 during normal current conditions through the circuit breaker.

The single operating mechanism 11 is positioned in the center pole unit of the three-pole circuit breaker and is supported on a pair of rigid support plates 41 (one of which is shown) that are fixedly secured in the base 7 in the center pole unit of the breaker. An inverted U-shaped operating lever 43 is pivotally supported on the spaced plates 41 with the ends of the legs of the lever positioned in U-shaped notches 45 of the plates. The operating lever 43 includes a handle 47 of molded electrically insulating material.

The contact arm 20 for the center pole unit is operatively connected by means of a toggle comprising an upper toggle link 47 and lower toggle link 47 to a releasable cradle member 51. The toggle links are pivotally interconnected by means of a knee pivot pin 53. The lower toggle link 49 is pivotally connected to the carriage 34 of

the center pole unit by the pin 33 and the upper toggle link is pivotally connected to the releasable cradle member 51 by a pivot pin 55. Overcenter operating springs 57 are connected under tension between the pivot knee pin 53 and the bight portion of the operating lever 43.

The contacts 19, 21 are manually opened by movement of the handle 47 from the ON position (Figure 1) to an OFF position to the right of that shown in Figure 1. Movement of the handle 47 to the right (to the OFF position) carries the line of action of the overcenter operating springs 57 to the right, causing collapse of the toggle links 47, 49 and to rotate the cross bar 35 in a clockwise direction to simultaneously move the contact arm 20 of the three pole units to the open position and thereby opening the contacts of the three pole units. The contact arm 20 is then in the broken line position (Figure 1).

The contacts are manually closed by reverse movement of the handle to the left which movement moves the line of action of the overcenter springs 57 to the left to move the toggle links 47, 49 to the position shown in Figure 1. This movement rotates the cross bar 35 in a counterclockwise direction to move the contact arms 20 of the three pole units to the closed position.

The releasable cradle member 51 is latched in the position shown in Figure 1 by means of the latch mechanism 15 which is a lever actuated by the trip device 17 that is an electronic or thermal-magnetic trip mechanism (not shown in detail). The trip mechanism 17 is capable of detecting both low level short circuit or overload current conditions and high level short circuit or fault current conditions. Upon the detection of any such condition the trip device 17 rotates the latch mechanism or lever 15 clockwise to initiate the trip operation of the operating mechanism 13.

In accordance with this invention a bottom arc plate 24 of the arc chute 23 is physically and electrically connected to the line conductor 27 by a connector 59 such as a screw or bolt. When the circuit is closed, the fault

current flows through the reverse loop formed by the lower and upper contact arms 22, 20 in a direction shown by an arrow 61 which follows the circuit path set forth above from the line terminal 29 to the load terminal 26.

When the circuit breaker is tripped, such as by the trip mechanism 15, or by the upper contact arm 20 being "blown open" to the position 20a (Figure 1), any arc commutates from between the contacts 19, 21 to the lower arc plate 24, from where it extends, as shown by arrow 63, to the upper contact arm 20a. Because the arc plate 24 is connected to the line conductor 27, the arc 63 takes the path of least resistance, or commutates to the arc plate 24. The resulting arc current path 63 extends through the connector 59 to the line conductor 27, thereby bypassing the reverse loop 61. Ultimately, the arc chute 23 extinguishes the arc 63 in a conventional manner.

Another embodiment of the invention is shown in Figure 2 in which similar numerals refer to similar parts. In Figure 2 the lower arc plate 24 is connected to the line conductor 27 by a flexible or solid connector 65, such as a strap, cable, or shunt. Like the connector 59 (Figure 1) the connector 65 assists in preventing the arc 63 from migrating towards the lower contact arm 22 after the arc commutates to the lower arc plate 24.

In another embodiment of the invention (Fig. 3), the lower arc plate 24 includes a bent portion 28 that connects the plate 24 to the line conductor 77. Like the connector 59 (Fig. 1) the portion 28 prevents the arc 63 from migrating to the lower contact arm 22 after the arc commutates to the lower arc plate 24.

Inasmuch as lower contact arms normally do not readily commutate an arc to the arc chute under low fault conditions, the connectors 59, 65, 28, transfer the arc from the lower contact arm to the arc chute thereby bypassing the reverse loop 71. As the contacts 19, 21 open the arc 63 is blown into the arc chute 23 because the lower arc

plate 24 serves as an active runner to transfer the arc to the lower plates of the arc chute.

When an ordinary fault occurs, the arc commutates from the lower contact arm to the arc chute where a magnetic field generates. Once the arc touches the plates of the arc chute 23, it senses the lower potential paths of the lower arc plate 24. For higher fault conditions the magnetic reaction blows the arc into the chute 23 where the arc lengthens with increasing arc voltage which is proportional to the length of the arc.

In conclusion, the device of this invention enables transfer of the arc from between the contacts into the arc chute under low fault conditions. The lower contact arm, being in close proximity to the lower arc plates enables the arc to transfer from the contact arm to the plates. A two-folded advantage is derived including extended contact life and more effective arc cooling.

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CLAIMS:

1. A circuit breaker comprising an insulating housing having a line terminal and a load terminal, separable contacts disposed in the housing for opening and closing a circuit between the terminals, an operating mechanism having a pivoting carriage and means adapted for manual operation to pivot the carriage between open and closed positions, contact support means including first and second pivoting contact arms each supporting one of the contacts, the first contact arm being pivotally attached to the carriage, means for restricting relative motion between the carriage and the first contact arm to rotation, a conductor extending between the line terminal and the second contact arm, arc extinguishing means around the path of travel of the first contact arm and the means including spaced arc-absorbing plates, electrical connector means between the conductor and one of the arc-absorbing plates for commutating any arc from the second contact arm to said one arc-absorbing plate.

2. A circuit breaker as claimed in claim 1 in which bias means are provided on the carriage for urging the first contact arm into a first position with respect to the carriage to enable the first contact arm and the carriage to rotate as a unit to open and close the separable contacts.

3. A circuit breaker as claimed in claim 2 in which the arc absorbing plates include a number of plates adjacent and other plates nonadjacent to the second arm

when the contacts are closed, and the electrical connector means extending between the conductor and one of the adjacent plates.

4. A circuit breaker as claimed in claim 3 in which the second arm is disposed within the planes of the adjacent plates.

5. A circuit breaker as claimed in claim 4 in which the conductor is disposed on the side of the second arm opposite the first arm, and the connector extends between the conductor and the nearest plate.

6. A circuit breaker as claimed in claim 5 in which the connector may be a rigid member, or a flexible member.

7. A circuit breaker, constructed and adapted for use, substantially as hereinbefore described and illustrated with reference to the accompanying drawings.

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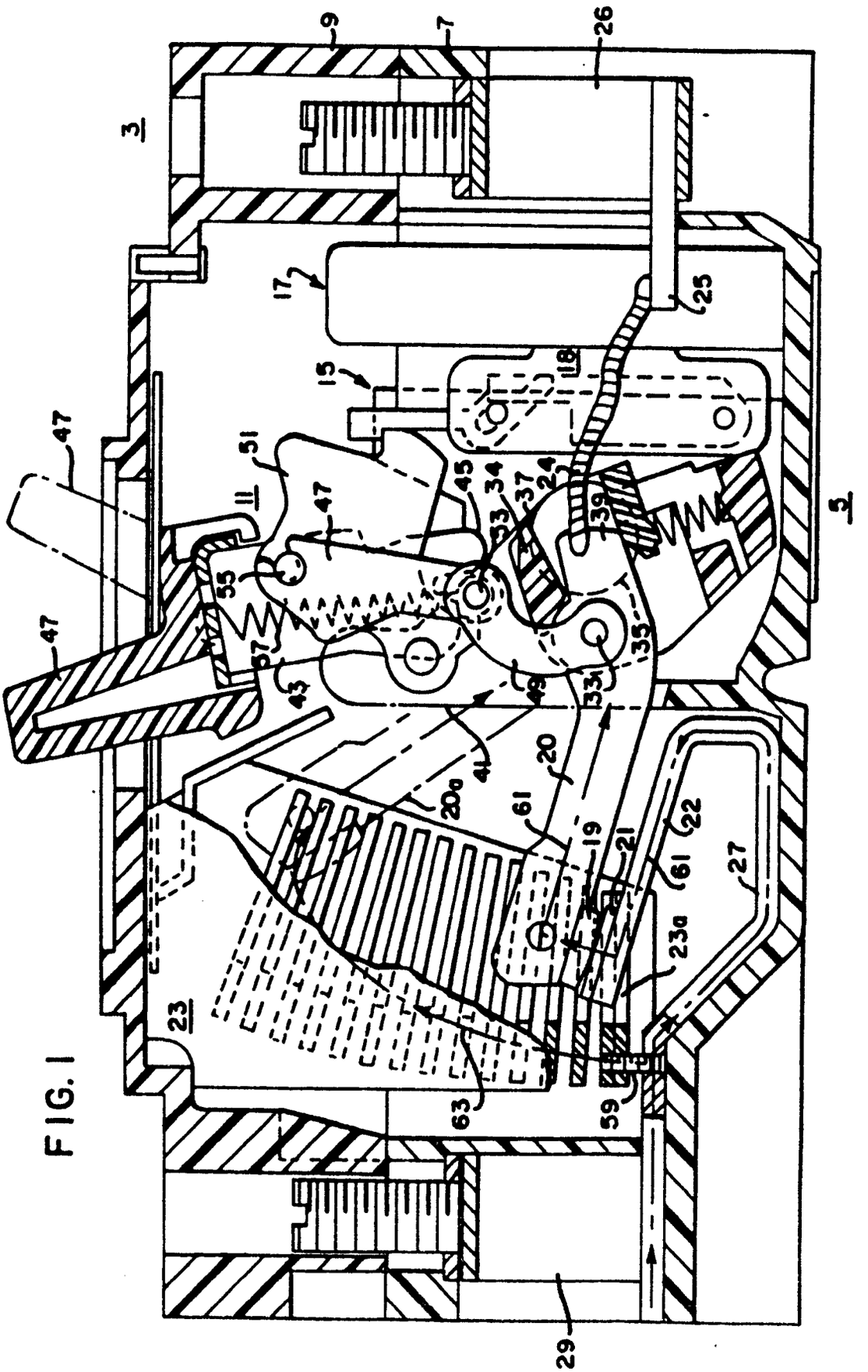

FIG. 1

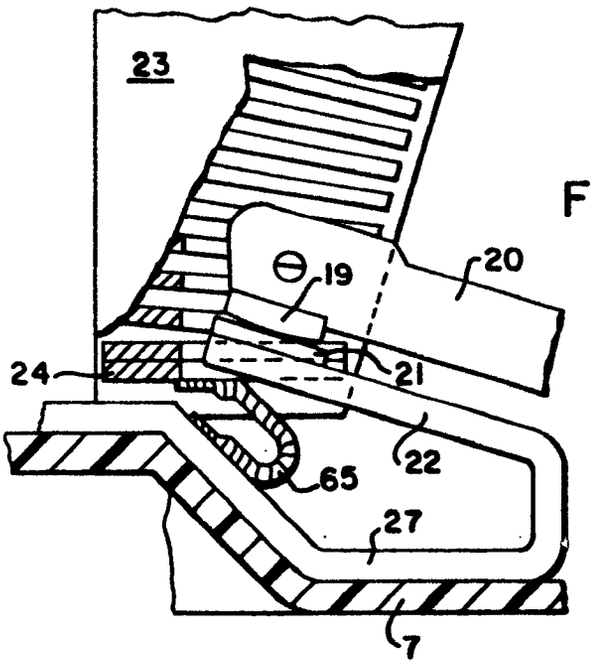

FIG. 2

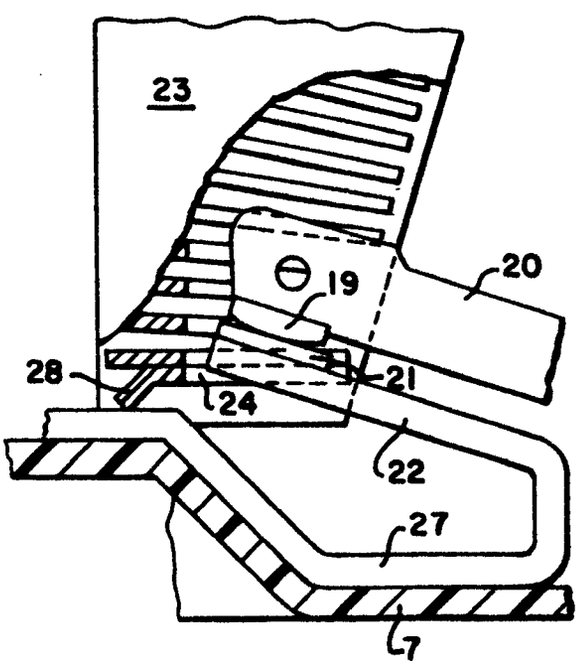

FIG. 3