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ARC CHUTE FOR ELECTRIC CIRCUIT BREAKERS

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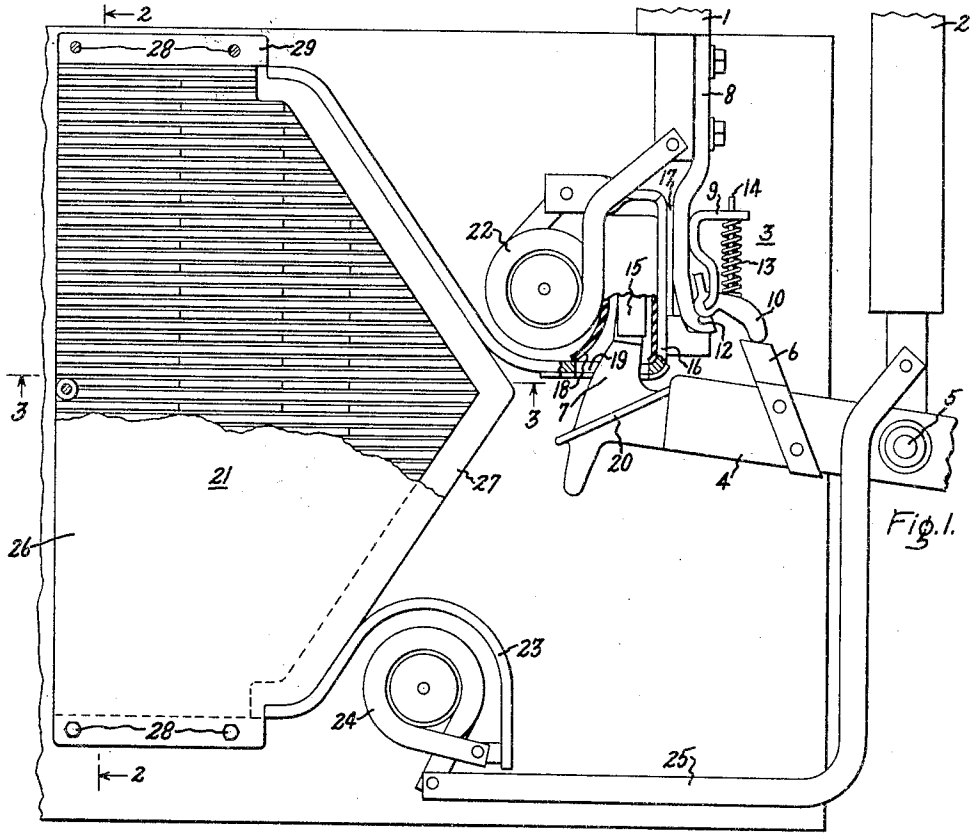


Fig. 1.

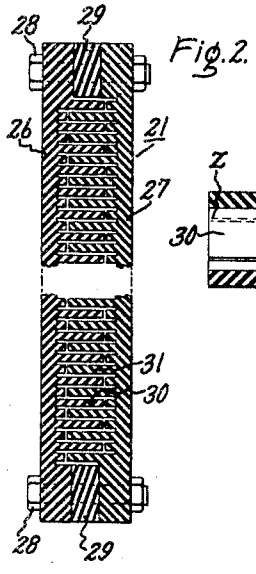
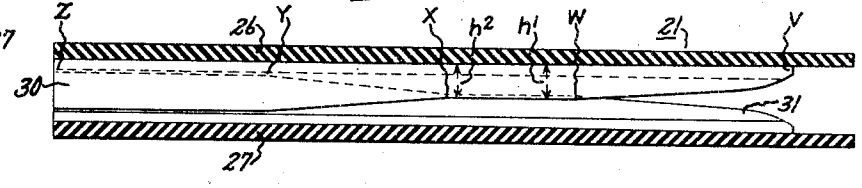


Fig. 2.

Fig. 3.



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ARC CHUTE FOR ELECTRIC CIRCUIT BREAKERS

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8 Claims. (Cl. 200—144)

This invention relates to arc chutes for electric circuit breakers and more particularly to arc chutes which are adapted for interrupting electric currents of large magnitudes.

In one type of presently known circuit breaker, it is the practice to draw an arc at the contacts of the breaker and then to force the arc by suitable means into an arc chute comprising a pair of spaced apart arc-resistant side walls having ribs along the adjacent surfaces thereof, the ribs being arranged in progressively increasing overlapping relation for effecting extinguishment of the arc as set forth in U. S. Patent 2,293,513 to Linde, granted August 18, 1942, and which is assigned to the assignee of this invention. In such a construction, it may be difficult to force the arc of currents of large magnitude deeply into the interleaved overlapping rib portion for effective cooling by heat transfer to the chute sidewalls due to the tendency for such high current arcs to resist being stretched and forced to occupy the passage defined by the interleaved ribs which passage becomes more and more labyrinth-like for the arc as it is moved through the chute. Thus the arc may not be cooled sufficiently for positive extinction and may thus restrike across the opening contacts of the circuit breaker. On the other hand, arcs which are of a low magnitude of current may be forced completely through the chute and may restrike at the exhaust end thereof.

A principal object of this invention is to provide an improved arc chute for electric circuit breakers which facilitates the extinguishment of high current arcs.

Still another object of this invention is to provide an improved arc chute construction for electric circuit breakers which construction facilitates the cooling of an electric arc drawn thereinto.

In accordance with the invention, an arc chute constructed of two spaced plates each having parallel ribs thereon arranged in interleaving relationship and forming an arc extinguishing portion and an arc entrance portion is provided with a rib portion intermediate such entrance and extinguishing portions which is adapted to facilitate movement of the arc deeply into the chute and into the arc extinguishing region so as to effect rapid cooling and extinguishment of the arc. To this end the intermediate portion of each rib is constructed of uniform height, which, alternatively, could be of a progressively decreasing height in the direction of arc movement or of a height which progressively increases at a smaller slope than the slope of the edges of the ribs in the arc entrance portion of the chute.

The invention will be better understood by reference to the following description taken in conjunction with the accompanying drawing in which Fig. 1 is a side view of a circuit breaker embodying the invention; in which Fig. 2 is a view along the line 2—2 of Fig. 1, and in which Fig. 3 is a somewhat enlarged view along the line 3—3 of Fig. 1.

With reference to Fig. 1, the circuit breaker includes a bushing 1 comprising a conductor stud and a corresponding electric bushing 2 both of which are fixed in position with respect to the arc chute interrupter structure and the circuit breaker supporting frame (not shown). The fixed contact structure generally designated at 3 is electrically connected with the electric bushing 1 while the movable contact blade 4 is pivoted and electrically contacted at 5 to the conductor stud of the corresponding electrical bushing 2. Contact blade 4 is rotatable about fixed pivot 5 by a suitable insulated operating rod (not shown) which is connected to the contact blade 4 at the right hand extremity thereof. Fixedly mounted on, but movable with, the contact blade 4 is a broad movable current-carrying contact 6 and a relatively narrow movable arcing contact 7.

Electrically connected with the conductor stud of bushing 1 is a conducting member 8 to which is fastened the curved contact retaining member 9 thereby to form a holding pocket for receiving therein the anchored ends of the main contact fingers 10. Main current-carrying fixed contact fingers 10 are biased for limited rotative wiping movement in the clockwise direction about the pivot comprising the curved portion 12 of conducting member 8 by means of compressional springs 13 whose associated guide pins 14 may slide in corresponding guide holes provided in the retainer member 9. Fixed arcing contact 15 is mechanically and electrically connected to the member 8 by suitable clamping means (not shown) for effectively short-circuiting the main contacts during an opening downward swing of the blade 4.

It sometimes happens that the arc drawn between the arcing contacts may, under certain unfavorable conditions, tend to restrike back across to the current-carrying contacts and thereby hazard a delay or failure to interrupt and cause damage to such main contacts which are unprotected by arc-resistant tips such as are provided for the arcing or secondary contacts. Furthermore the magnetic blowout effect from adjacent coils diminishes toward the main current-carrying contacts so as to become less effective in driving a backwardly wandering arc forwardly into the chute which is a necessary prerequisite to its extinguishment. Thus it is imperative that an arc must be prevented from striking or reforming across the main current-carrying contacts 6 and 10.

In order to prevent such backward striking of the arc between the main current-carrying contacts, a conducting arc runner 16 whose inner extremity is in the form of a barrier or gas-directing means is provided for insertion in the region between the fixed arcing contact 15 and the fixed current-carrying contact fingers 10. Insulation, such as 17 and 18, is provided for electrically isolating the runner 16 from the associated conducting parts or contacts so that runner 16 really constitutes an effective shunt path through the adjacent blow-out coil independent of the contact structure. Thus, when the arc is drawn initially from the fixed contact 15 and as the arcing tip of movable arcing contact 7 is moving through the slot-like opening 19 provided in the arc runner 16, the arc transfers to the rim of the opening 19 from the arcing contact 7 instead of moving backwardly on to the current-carrying contacts. The portion of the runner 16 shielding the arcing contact 15 from the main contact 10 also serves to minimize blow-back of ionized arc products toward the main contacts which would favor breakdown. Furthermore, in order more effectively to prevent the ionized gases formed at the arcing contacts, which due to the barrier effect of the runner 16 explained above, issue as a downward jet through the slot 19, from spreading toward the current-carrying contacts 6 and 10 to hazard a breakdown, a movable deflecting barrier 20 may be provided which constitutes a broad flange and is integral with the arcing contact 7. As is clearly evident from Fig. 1, the flow of gases downwardly through the opening 19 will

impinge on the inclined deflecting surface of baffle 20 so that the gases are directed toward the left into the arc chute structure generally designated by the numeral 21 rather than backwardly toward the main contact 6 and 10. The cooperating structure comprising barrier 20 and arc runner 16 forms no part of this invention and is claimed in application Serial Number 189,026, by E. J. Frank and V. E. Phillips filed October 7, 1950, now matured into Patent No. 2,639,354, issued May 19, 1953, and assigned to the assignee of this invention. Thus, as the arcing contact 7 moves downwardly during an opening stroke, the upper arc root will initially transfer from the fixed arcing contact 15 to the arc runner 16 at the aperture 19 thereby introducing in series with the arc the first blowout coil 22 which is series connected between conductor stud of bushing 1 and arc runner 16. At this point, it will be understood that current flowing through the hinged contact arm 4 and the arc has been shunted around the contact structure via the insulatingly shielded arc runner 16 and the coil 22. As is well known, the effect of this blowout coil is to establish a magnetic condition which urges the arc in a direction toward the left and into the arc chute 21. As the contact 7 continues to move downwardly, the lower root of the arc will transfer from the arcing contact 7 to the arc runner 23 thereby introducing the lower blowout coil 24 in series with the arc and the upper blowout coil 22 to thus augment the blowout effect upon the arc toward the left. Because the coil 24 is connected with conductor stud of bushing 2 through the conducting strap 25, the interrupting circuit is now shunted completely around the contact arm 4. In the particular embodiment shown, the blowout effect of these two coils upon the arc whereby it is driven to extinction in the chute 21 will be adequate to insure the interruption of all currents within the rating of the circuit breaker. For higher ratings it is conventional to employ additional blow-out coils.

As will be more clearly understood from Figs. 2 and 3, are arc chute 21 comprises a pair of spaced sidewalls 26 and 27 constructed of appropriate arc-resistant insulating material. These chute walls are secured together and in position by means of the bolts 28 which hold the spacer elements 29 between the projecting clamping flanges of the sidewalls 26 and 27. Formed integrally, by molding or machining, on the adjacent surfaces of the chute sides 26 and 27 are the projecting ribs 30 and 31 arranged for mutual interleaving. Generally speaking, this construction of the arc chute is of the type disclosed in the aforementioned United States Patent 2,293,513 to Linde. As is shown in Fig. 3, each of the ribs 30 and 31 is provided with a primary or arc entrance portion VW of low but ascending height, a secondary or intermediate portion WX having but limited change, if any, in height, and a tertiary or arc extinguishing portion XY of ascending height which is followed by an exhaust portion YZ having little change in height. Thus, initial movement of the arc into the chute structure is effected easily in the converging throat region VW due to the fact that there is but a gradual change in mechanical impedance of the arc chute in this primary wedge like region.

In accordance with the invention, the angle at which the outer edges of the ribs in the secondary region WX are disposed relative to their associated chute sideplates changes more or less abruptly and becomes different from, or less than, the angle at which the outer edges of the ribs in the primary entrance region VW are disposed relative to their sideplates. Thus, once the arc has crossed the threshold of the chute by passing into the secondary zone or portion WX, due to magnetic blowout action, it meets with a moderated mechanical impedance so that it may proceed readily and deeply into the chute interior, such movement facilitating arc extinguishment by accelerating the cooling rate as the arc transfers its heat progressively along the chute ribs and

sidewalls. It will be understood that the edges of the ribs in this secondary region WX are such that the positive slope between the initial height h_1 and the final height h_2 of these ribs relative to their chute sidewalls is less than the corresponding slope in the primary region VW. Of course, by this broad definition, the ribs in this secondary region could have uniform height i. e. with h_1 equal to h_2 or, the ribs could have a negative slope, i. e. with h_2 being less than h_1, without departing from the invention. Furthermore, although we have shown the edges of the interleaving ribs in the secondary portion WX in slightly overlapping relationship, we may choose to make them lie in the same vertical plane, or perhaps, somewhat short of this, i. e. with a small space therebetween, for actual tests show any of these variations to be quite effective. Thus, even through the magnitude of current in the arc may be quite large, the arc may move forwardly through this region of low mechanical impedance so that it is cooled and remains within the confines of the chute whereby the possibility of a restrike back across the contacts is minimized.

When and if the arc moves from the secondary or intermediate region WX into the tertiary or arc extinguishing region XY, the arc thereupon is stretched thereby increasing its resistance and is further cooled so that invariably it is extinguished in this region of the chute. Thereafter, dissipation of the ionized products of arcing is effected through the exhaust portion of the chute YZ. Since the final portion YZ of the chute is arc-resistant heat-absorbing insulating material, such ionized products become de-ionized to the extent that there is little likelihood that the arc will restrike exteriorly of the chute at the exhaust end.

While we have shown and described a particular construction embodying our invention, we do not wish to be limited thereto and intend in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. An arc chute having an arc entrance portion, an intermediate cooling portion, and an arc extinguishing portion and comprising a pair of spaced sides of insulating material, the space between said sides constituting a passage through which an arc is impelled to move from said entrance portion to said extinguishing portion, a plurality of spaced ribs disposed on adjacent surfaces of said sides and extending in the general direction of movement of the arc, said ribs being of progressively increasing height in the direction of movement of the arc in said arc extinguishing portion and in said entrance portion with the edges of said ribs in said intermediate portion being disposed relative to the associated side at a different average slope than the average slope of the edges of said ribs in at least a part of said entrance portion for facilitating cooling and movement of the arc toward said extinguishing portion of the chute.

2. An arc chute having an arc entrance portion, an intermediate cooling portion, and an arc extinguishing portion and comprising a pair of spaced sides of insulating material, the space between said sides constituting a passage through which an arc is impelled to move from said entrance portion to said extinguishing portion, a plurality of spaced ribs disposed on adjacent surfaces of said sides and extending in the general direction of movement of the arc, said ribs being of progressively increasing height in the direction of movement of the arc in said arc extinguishing portion and in said entrance portion with the edges of said ribs in said intermediate portion being disposed relative to the associated side at a lesser average slope than the average slope of the edges of said ribs in said entrance portion for facilitating cooling and movement of the arc toward said extinguishing portion of the chute.

3. An arc chute having an arc entrance portion, an arc extinguishing portion, and an intermediate cooling portion located between said arc entrance portion and said arc extinguishing portion, said arc chute comprising a pair of spaced sides of insulating material, the space between said sides constituting a passage through which an arc is impelled to move from said entrance portion to said extinguishing portion, a plurality of spaced ribs disposed on adjacent surfaces of said sides and extending in the general direction of movement of the arc, said ribs being of progressively increasing height in the direction of movement of the arc in said arc extinguishing portion and being of substantially uniform height in said intermediate portion.

4. An arc chute comprising a pair of spaced sides of insulating material, the space between said sides constituting a passage through which an arc is impelled to move, a plurality of spaced ribs disposed on adjacent surfaces of said sides and extending in the general direction of movement of the arc, the ribs of one of said parts being disposed in progressively increasing overlapping relation to the ribs of the other of said parts from a point on said ribs intermediate the ends thereof to a point nearer the extremities of said ribs toward which the arc is moved for lengthening and extinguishing the arc, and a preliminary cooling zone defined by said ribs by reason of their being of substantially uniform height to facilitate movement of the arc into said chute.

5. An arc chute comprising a pair of spaced parts of insulating material, the space between said parts constituting a passage through which an arc is impelled to move, a plurality of spaced ribs disposed on adjacent

surfaces of said parts and extending in the general direction of movement of the arc, the ribs of one of said parts being disposed in progressively increasing overlapping relation to the ribs of the other of said parts from a point on said ribs intermediate the ends thereof to a point nearer the extremities of said ribs toward which the arc is moved to lengthen and extinguish the arc, and a preliminary cooling zone defined by said ribs by reason of their being of substantially uniform height with the inner edges of the rib portions of uniform height lying generally in the same common place to facilitate movement of the arc into said chute.

6. The arc chute of claim 1 in which said side walls are fixed relative to each other, and said passage has an open end disposed adjacent said arc extinguishing portion.

7. The arc chute of claim 2 in which said side walls are fixed relative to each other, and said passage has an open end disposed adjacent said arc extinguishing portion.

8. The arc chute of claim 3 in which said side walls are fixed relative to each other, and said passage has an open end disposed adjacent said arc extinguishing portion.

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