Aug. 18, 1942. P. BARTLETT 2,293,487

ELECTRIC CIRCUIT BREAKER

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Fig. 1.

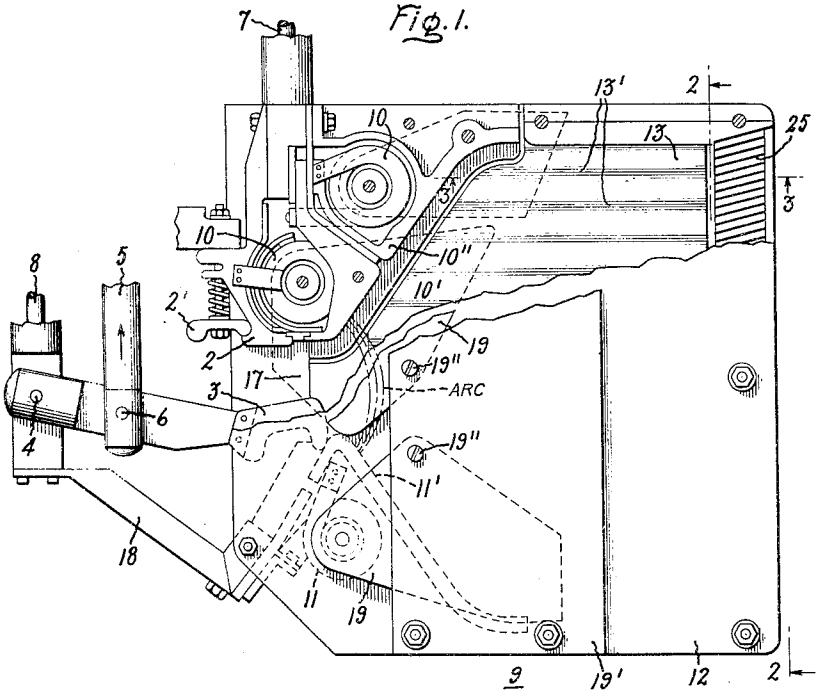


Fig. 2.

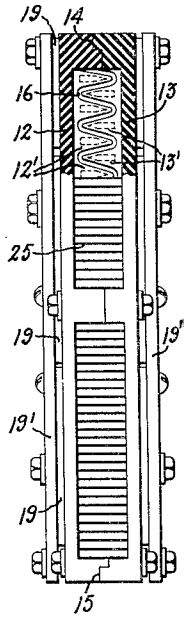


Fig. 3.

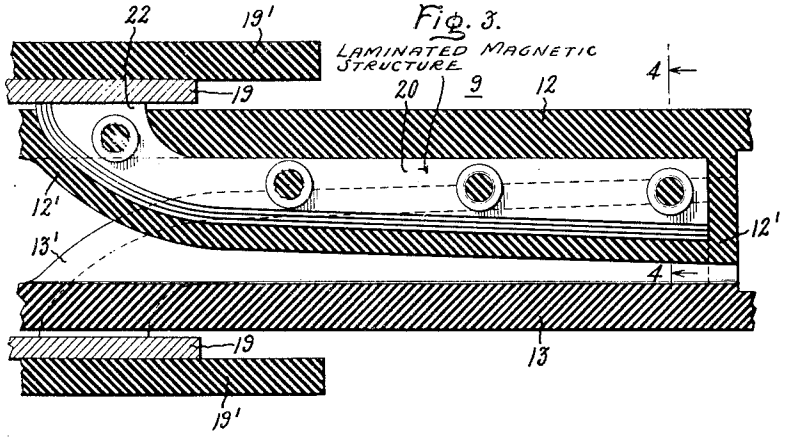
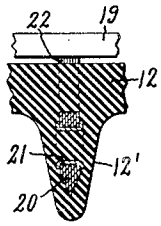


Fig. 4.



Inventor:
Percy Bartlett,
by Harry E. Dunham
His Attorney.

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Fig. 5.

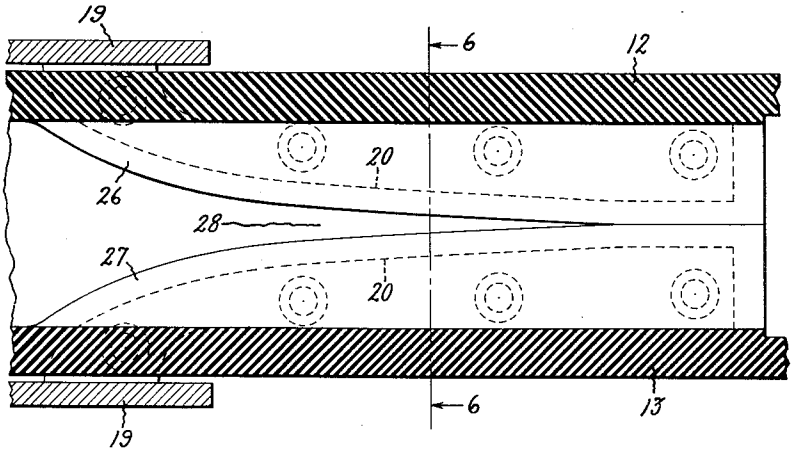
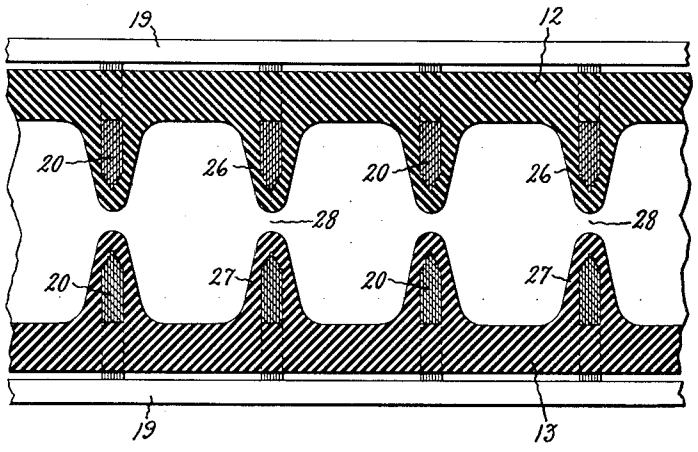


Fig. 6.



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2,293,487

UNITED STATES PATENT OFFICE

2,293,487

ELECTRIC CIRCUIT BREAKER

Percy Bartlett, Springfield, Pa., assignor to General Electric Company, a corporation of New York

Application July 25, 1941, Serial No. 403,988

7 Claims. (Cl. 200—147)

My invention relates to electric circuit breakers, more particularly to air circuit breakers of the magnetic blowout type wherein the arc to be interrupted is blown into arc extinguishing structure, such as an arc chute, by magnetic forces established by the arc current, and has for its principal object the provision of an improved arc extinguishing structure that is effective to apply the magnetic blowout force to the arc more efficiently as the arc is driven into and through the extinguishing structure.

A further and more specific object of my invention is the provision, in an arc chute of the interference barrier type, such as for example the interleaving or staggered fin type, of magnetic structure so disposed or embedded in the chute walls that the arc is continuously acted upon during its travel through the chute structure by a more intimate and effective magnetic blowout field.

My invention will be more fully set forth in the following description referring to the accompanying drawings, and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

Referring to the drawings, Fig. 1 is an elevational view, partly in section, of a magnetic blowout type air circuit breaker embodying the present invention; Fig. 2 is an end view, partly in section, taken along the line 2—2 of Fig. 1; Fig. 3 is an enlarged sectional view of the arc chute structure taken along the line 3—3 of Fig. 1; Fig. 4 is a detail sectional view of an arc chute fin structure taken along the line 4—4 of Fig. 3; Fig. 5 is a view generally similar to that of Fig. 3 showing a modified form of my invention and Fig. 6 is a view taken along the line 6—6 of Fig. 5.

The air circuit breaker illustrated by way of example in Fig. 1 is of the magnetic blowout type that is particularly adaptable for central stations and sub-stations. The arrangement comprises relatively movable contact structure which includes a fixed contact 2 and a movable contact 3 that is pivotally mounted at 4 on one of the circuit breaker studs. The contact 3 is operated by means of a reciprocally movable rod 5 connected to the contact arm at 6. The contacts 2 and 3 are electrically connected to the lower ends of the conductor studs 7 and 8, respectively, which serve as the terminals of the breaker unit. Accordingly, when the terminals are connected in a power circuit and the contacts 2 and 3 are separated, an arc may form across the gap indicated.

For the purpose of interrupting this power arc, an arc extinguishing structure generally indicated at 9 is mounted with respect to the separable contacts so as directly to receive the power arc which is under the influence of a magnetic blowout force, such as produced by blowout coils 10 and 11. In the arrangement so far described, the arc extinguishing structure is similar to a conventional arc chute wherein the arc is formed at the entrance of the chute and is rapidly extended in the form of a loop through the chute toward the exhaust opening at the opposite end thereof.

Referring more particularly to Fig. 2, the arc extinguishing structure comprises spaced side walls 12 and 13 composed of arc resisting material, such as an asbestos compound, each side wall having on the side facing the other wall a plurality of parallel ridges or fins 12' and 13', respectively. The fins 12' and 13' extend longitudinally from the chute entrance to the chute exhaust and are preferably integral with the side walls which are joined and suitably clamped together at the ends 14 and 15 so as to form an arc chute. The length and spacing of the fins 12' and 13' are preferably such that when the side walls 12 and 13 are clamped together, the fins of one wall are staggered or interleaved with respect to those of the other, so as to form a restricted sinuous or tortuous passage 16 into which the arc is driven at the entrance 17 of the arc chute structure 9. As shown by Fig. 1, which illustrates in partial detail but half the extinguishing structure, namely the inner side wall 13, the fins project inwardly in a direction transverse to the direction of the movement of the arc as it passes from the entrance 17 into and through the chute.

As the arc is driven by the magnetic blowout field into the entrance passage 17 of the arc extinguishing structure, there is comparatively little transverse deflection of the arc stream during this initial movement due to the fact that the fins 12' and 13' are tapered toward the arc entrance as best illustrated at the left side of Fig. 3. As the arc is driven into the zigzag space defined by the interleaving fins, the cross-section of the arc is reduced as the arc assumes a serpentine form. If the arc is not interrupted in this region, the blowout field continues to move the arc outward through the arc passage, thereby progressively lengthening the path of the arc as the amplitude of the zigzag path becomes greater. The arc is thereby greatly lengthened and attenuated concurrent with great cooling effect due to the large cooling surface of the fins engaged by the

arc during its approach to the exhaust part of the extinguishing structure.

In the arrangement specifically illustrated, referring to Fig. 1, the magnetic blowout coils 10 are electrically connected to the conductor stud 7 and to the arc runners 10' and 10'' so that the arc current serially traverses the blowout coils after separation of the contacts in a manner well known in the art. Normally the current is carried in the closed circuit position of the breaker by the spring biased contact 2', the current being shunted to the arcing contact 2 upon opening of the breaker. After the arc is drawn by the movable contact 3, its lower root transfers to the arc runner 11', so that when it reaches the position indicated by Fig. 1 the blowout coil 11, which is electrically connected through 18 to the conductor stud 8 and also to the arc runner 11', also connects in series in the interrupting circuit. Accordingly, as the arc proceeds into the chute, all the blowout coils become energized by the arc current to establish a magnetic blowout field which, passing transversely across the chute between the side pole plates 19 (which are connected to the coil cores), drives the arc towards the chute exhaust according to well-known principles.

In high voltage circuit interrupters of this type, it is preferable to provide a pair of iron side plates 19 for each blowout coil, each pair being electrically separated from the other as shown, so that a high insulation value is maintained with the contacts in the open position. The strength, and hence effectiveness, of the transverse magnetic blowout field across a given pair of plates 19 is inversely proportional to the reluctance of the magnetic circuit provided, the flux path comprising the low reluctance section through the cylindrical coil cores and the core plates, together with the high reluctance region across the "air gap" formed by the chute body (through which the arc passes) between the plates 19.

In accordance with my invention, I materially decrease the reluctance of this magnetic circuit and also extend its field by providing the additional magnetic structure 20 which, in contact with plates 19 and embedded within and insulated by the fins, is in much closer proximity to the arc passage than were the prior conventional side plates. Accordingly, the "air gap" is greatly reduced, the field made correspondingly stronger and the arc thereby is more effectively influenced by the blowout magnetic action.

Such additional structure therefore is used to advantage in fin type chutes, for light-current arcs are urged more effectively into the chute body for extinction; also the arc passage way or slots may be made of appreciably narrower cross-section than heretofore, so that large heavy current arcs may be compressed into these narrower spaces for maximum cooling effect due to the squeezed and flattened arc engaging a greater area of the fin surfaces. Thus, more rapid cooling of the arc occurs, thereby increasing the arc resistance which is highly desirable in this type of breaker since the increasing arc resistance is utilized both to improve the power factor during the interrupting operation as well as to reduce the arc current and thereby make final interruption much easier.

As more specifically illustrated by Figs. 3 and 4, my invention is carried out by embedding or inserting in the chute ridges 12' and 13' laminated magnetic structure 20 which is in direct contact with the pole pieces 19 so that the structure 20 is in effect an extension of the pole piece 19. As indicated by Fig. 4, the laminated magnetic structure 20 can conveniently comprise a plurality of laminations shaped to the contour of the chute ridges and clamped together by grommets or the like 21 so that the magnetic structure can be placed in the arc chute mold as a unit. In the molding process, which in itself forms no part of the present invention, the magnetic structure 20 is completely embedded in the insulation material of the ridges as indicated by Fig. 4 with the exception of the extensions 22 which engage in abutting relation the pole pieces 19. The pole pieces are suitably clamped in position so that a good magnetic joint is provided as for example, by the rectangular insulating clamping members 19' as shown. The clamping plates 19' and the magnetic side plates or pole pieces 19 may, if desired, be preassembled as a unit by means of the bolts 19'' so as to insure proper positioning.

With this arrangement, it will be noted that the magnetic blowout field is distributed not only throughout the entire length of the arc chute, but also throughout the entire length of the tortuous arc passage as viewed in Fig. 2. That is, each loop or bend of the arc passage is subjected to a transverse magnetic field which acts on all parts of the arc throughout its length. The arc is thereby positively driven through the chute from the time it reaches the entrance of the chute immediately after separation of the contacts.

Although the arc extinguishing structure above described is very effective for interrupting both overload and short circuit currents, the arc, along with the ignited gases, may in certain instances be expelled from the exhaust end of the interrupter. Since this is generally objectionable in practice even though the arc may be ultimately extinguished, a combined muffler and arc suppressing structure generally in the form of a grill as indicated at 25 is provided at the chute exhaust. The muffler and arc extinguishing structure functions without creating excessive back pressure which would decrease the interrupting capacity of the breaker.

The interleaving arc chute particularly with respect to its arc-entrance portion and the combined muffler and arc suppressor unit 25 are more specifically disclosed and are claimed in an application, Serial No. 298,946 (D–63,579), filed October 11, 1939 by L. J. Linde for "Electric air circuit breaker," and assigned to the same assignee as the present invention. Also the design of the zigzag arc passage as shown in Fig. 2 is specifically disclosed and is claimed in an application, Serial No. 359,363, filed October 2, 1940, by E. W. Boehne for "Electric arc extinguishing apparatus," and assigned to the same assignee as the present invention.

It shall be understood that other methods and arrangements for incorporating the magnetic structure in the fin-like structure or chute ridges so as to be closely adjacent to the arc path may be employed without departing from the spirit of the present invention. For example, the magnetic structure in certain cases may be composed of a precipitation-hardened permanent magnet alloy, rather than iron extensions of the blowout coil pole pieces.

In the modification of my invention shown by Figs. 5 and 6, the chute side walls 12 and 13

form, as before, an arc extinguishing space containing insulating barrier structure for restricting the arc stream and for presenting a cooling surface to the arc. In this case, the barriers or fins constitute ridges **26** and **27** positioned on the inner side walls of the chute directly opposite each other, as shown by Fig. 6. The ridges, as contrasted with the previous arrangement, are tapered from the chute entrance so as to engage each other at the exhaust end of the chute thereby to form V-shaped slots **28** as clearly shown by Fig. 5. Accordingly, as the arc moves through the chute it will be progressively squeezed and attenuated in a plurality of passages formed by the V-shaped slots, the barriers **12** and **13** presenting a solid barrier to the arc at a plurality of points at the chute exhaust.

For the purpose of increasing the effectiveness of the blowout field on the arc as it is moved into the V-shaped slots, the ridges or fins **26** and **27** are provided, as in the previous case, with laminated iron structure **20** forming with the side pole plates **19** pole piece extensions for the magnetic blowout field. In this design, by reason of the short arc gap across the oppositely located laminated extensions **20** the strong localized magnetic field serves to drive the arc into the V slot where the arc severing action is greatly augmented. The laminated extensions **20** can be embedded in the ridges by a molding process or the insulating barrier structure and laminations can be fabricated and assembled with respect to the arc chute.

It will be apparent that it is within the scope of my invention to graduate the magnetic blowout field so that the arc is subject to varying control as it passes through the chute. For example, by shortening the magnetic inserts in the central chute area, or even by omitting them entirely, the arc portions toward the "runners," i. e., the arc extremities, would be forced more positively into the chute. This operation is desirable in certain interleaving chute types.

It should be understood that my invention is not limited to specific details of construction and arrangement thereof herein illustrated, and that changes and modifications may occur to one skilled in the art without departing from the spirit of my invention.

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

1. An air circuit breaker comprising separable contacts and arc extinguishing structure having spaced insulating walls forming an arc chute, said chute having an entrance opening at which the arc gap between said separable contacts is formed and an exhaust opening for venting the arc gases incident to circuit interruption, said arc chute having between the inner side walls fin-like structure disposed edgewise to said side walls and extending generally between said chute entrance and exhaust openings, said fin-like structure forming a restricted zig-zag arc passage in said chute, and magnetic structure extending into said fin-like structure so as to be in close proximity to the aforesaid arc passage.

2. An air circuit breaker comprising separable contacts and arc extinguishing structure having spaced insulating walls forming an arc chute, separation of said contacts forming an arc gap at one end of said chute, said arc chute having on inner side walls facing each other a plurality of ridge-like extensions disposed between the ends of said chute, the ridges of one wall being disposed closely adjacent to the ridges of the opposite wall so as to form a restricted arc passage through said chute, and magnetic blowout structure disposed in said ridges so as to be in close proximity to the aforesaid arc passage.

3. An air circuit breaker comprising separable contacts and arc chute insulating structure into which the arc formed upon separation of said contacts is directed, said arc chute having on side walls a plurality of ridge-like projections extending between the ends of said chute, said ridges being disposed closely adjacent to each other so as to form a restricted and tortuous arc passage through said chute, and magnetic structure incorporated in said ridges and substantially surrounded by the insulating material thereof so as to be in close proximity to the aforesaid tortuous arc passage.

4. An air circuit breaker comprising separable contacts and arc extinguishing structure having spaced insulating walls forming an arc chute, said chute having an entrance opening at which the arc gap between said separable contacts is formed and an exhaust opening for venting the arc gases incident to circuit interruption, said arc chute having on the inner side walls facing each other a plurality of ridges extending longitudinally between said chute entrance and exhaust openings, the ridges of one wall being disposed closely adjacent to and interleaved with respect to the ridges of the opposite wall so as to form a restricted and tortuous zigzag arc passage through said chute, magnetic blowout means having pole pieces associated with said arc chute, and magnetic structure forming magnetic extensions of said pole pieces disposed in said ridges so as to be in close proximity to all parts of the aforesaid tortuous arc passage.

5. An air circuit breaker comprising separable contacts and arc extinguishing structure having spaced insulating walls forming an arc chute, a magnetic blowout coil for driving the arc formed upon separation of said contacts into said chute, said arc chute having between the inner side walls facing each other a plurality of insulating barriers extending longitudinally between the ends of said chute, the barriers being shaped and positioned with respect to each other so as to form restricted zig-zag arc passages through said chute, and iron pole pieces magnetically related to said blowout coil extending into said barriers so as to be in close proximity to opposite sides of the aforesaid zig-zag arc passages substantially throughout its length.

6. An air circuit breaker comprising separable contacts and arc extinguishing structure having spaced insulating walls forming an arc chute, said chute having an entrance at which the arc gap between said separable contacts is formed and an exhaust opening for venting the arc gases incident to circuit interruption, magnetic blowout coils arranged to establish a magnetic field for driving the arc into said chute entrance, iron pole pieces for said coils disposed at opposite sides of said chute, said arc chute having on side walls facing each other a plurality of ridges extending longitudinally between said chute entrance and exhaust openings, the ridges of one wall being disposed closely adjacent to and staggered with respect to the ridges of the opposite wall so as to form a restricted and tortuous arc passage through said chute, and magnetic structure comprising iron laminations embedded as a unit in said ridges so as to be in close proximity to opposite sides of the aforesaid tortuous arc passage, said laminations forming magnetic exten-

sions of the aforesaid pole pieces so that the magnetic blowout force is applied evenly and uniformly to the arc substantially throughout its length.

7. An air circuit breaker comprising separable contacts and arc extinguishing structure having spaced insulating walls forming an arc chute, said chute having an entrance opening at which the arc gap between said separable contacts is formed and an exhaust opening for venting the arc gases incident to circuit interruption, said arc chute having on inner side walls facing each other a plurality of ridges extending generally between said chute entrance and exhaust openings, the ridges of one wall being disposed closely adjacent to the ridges of the opposite wall so as to form a restricted and tortuous arc passage extending substantially through said chute, and magnetic structure disposed in said ridges so as to be in close proximity to the aforesaid tortuous arc passage.

PERCY BARTLETT.