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2,888,539

ARC-EXTINCTION CHAMBERS FOR CIRCUIT-BREAKERS

Filed Aug. 31, 1956

2 Sheets-Sheet 1

Fig. 1A.

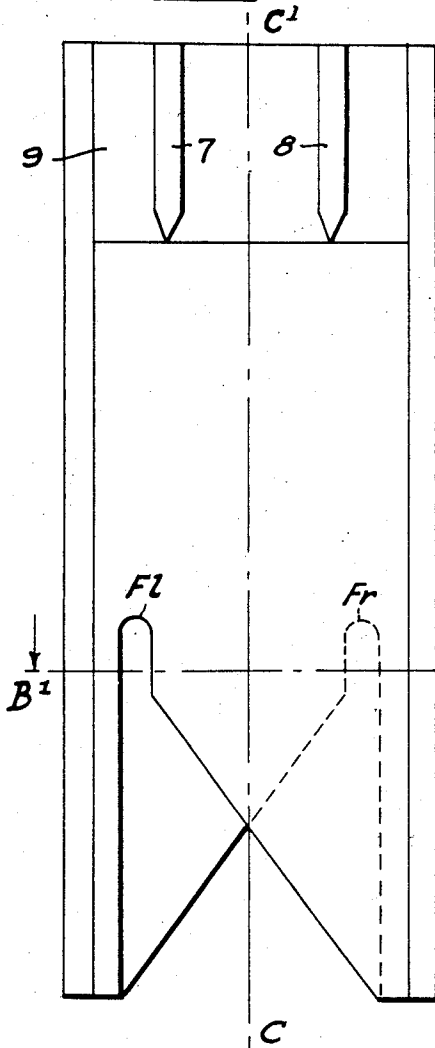


Fig. 1C.

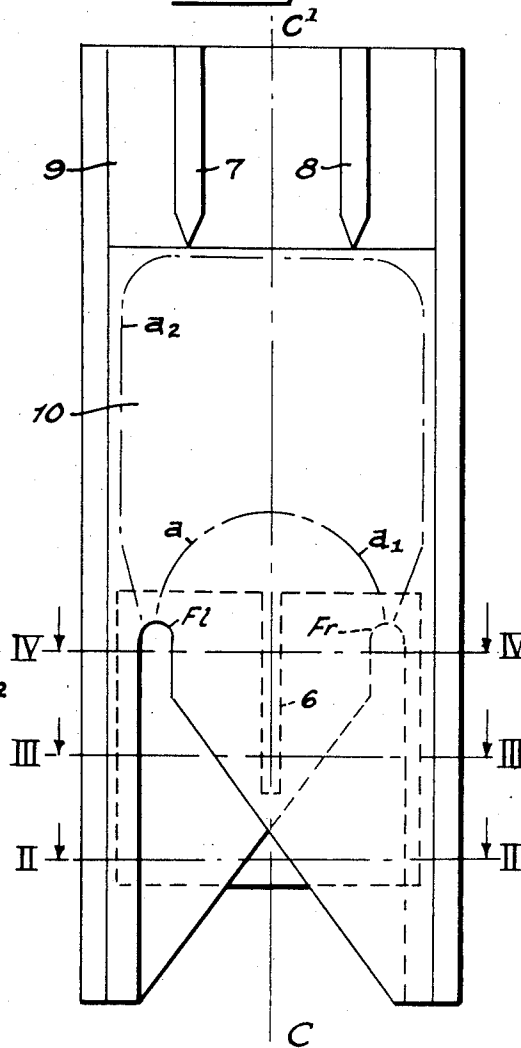
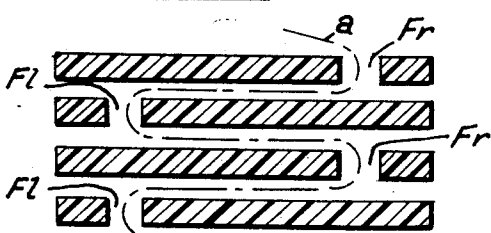


Fig. 1B.



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Fig. 2.

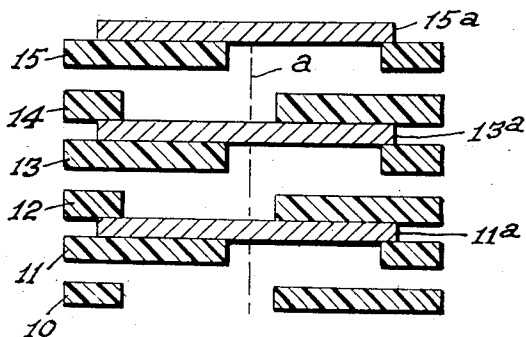


Fig. 3.

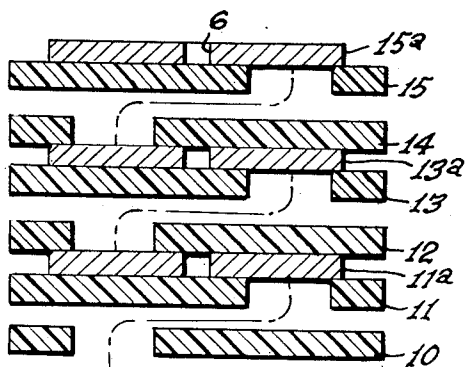


Fig. 4.

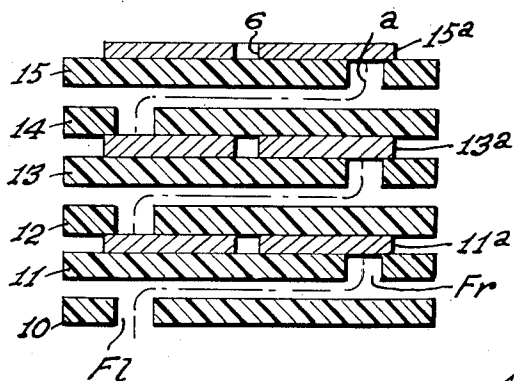
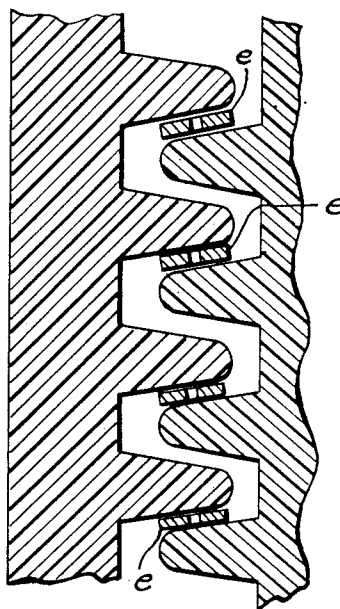


Fig. 5.



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ARC-EXTINCTION CHAMBERS FOR CIRCUIT-BREAKERS

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Application August 31, 1956, Serial No. 607,356

Claims priority, application France September 22, 1955

11 Claims. (Cl. 200—144)

This invention relates to arc-extinction chambers for electrical circuit breakers, more particularly of the kind of circuit breakers comprising a stack of insulating plates or slabs which are parallel to each other and between which the arc extinction is achieved.

For the sake of an easier understanding, it will be assumed that all the plates or slabs are parallel to a vertical plane.

In the circuit breakers of the aforesaid kind, which are well-known and have been manufactured extensively, particularly in the United States, the arc, by means of slots provided in the said plates or slabs, is deflected in the arc-extinction chamber in an almost horizontal plane so as to obtain a zig-zag shape or the shape of a more or less flat sinusoidal curve. Thus, if the width of the slabs is L and their number n , the length of the arc is at the outside nearly equal to $L \times n$. These circuit breakers will be called hereinafter, for brevity, American type circuit-breakers.

On the other hand, circuit-breakers are known which include arc-extinction chambers of the same kind, that is, built up of a stack of parallel insulating plates or slabs in which, when the number of slabs of each chamber is n , the arc is subdivided into $n-1$ subsidiary arcs, each subsidiary arc being turned between the slabs to which it belongs, without being lengthened, by an angle of 90° with respect to its initial direction, so as to come to a position parallel to the slabs, whereupon the subsidiary arc expands, taking the shape of a loop of considerable length amounting to a multiple of the initial length of the subsidiary arc, this considerable lengthening being achieved by the electro-dynamic forces produced by the subsidiary arc and reinforced by the electrodynamic forces produced by the adjacent subsidiary arcs, the shape of a loop being obtained by preventing appreciable movement of the roots of the arc.

Thus, in the chambers having plates or slabs of nearly the same dimensions as those of the circuit-breakers of the American type, the total length of the arc is 5 to 6 times the length of the initial arc, so that the circuit-interrupting capacity of the circuit-breaker is considerably increased. These circuit-breakers will be called hereinafter, for brevity, circuit-breakers of the second kind.

Applicant has now found that it is possible starting from the zig-zag form of the arc, to further increase the length of the arc, and consequently to augment considerably the breaking power of the circuit-breakers of the American type by combining the principle on which their functioning is based with the principle of the circuit-breakers of the second kind cited hereinabove, without having to modify the structure of the apparatus, simply by adding to the existing breakers a certain number of parts of very low cost, as will be disclosed hereinafter.

The invention enables the manufacturers who produce the circuit-breakers of the American type to transform these breakers without modifying their dimensions and constructive features, so as to reduce to a notable extent, that is to say, by approximately 50%, the considerable

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difference between the length of the arc as existing at present in their circuit-breakers, and the length of the arc of the circuit-breakers with looped subsidiary arcs (circuit-breakers of the second kind).

According to the invention, and starting from the initial sinusoidal arc whether divided into subsidiary arcs or not which can be obtained with the American circuit-breaker, one branch of each two consecutive branches is alternatively suppressed by short circuiting this branch by means of metallic conductors, alternately placed on the path of each second branch whereby only parallel subsidiary or divisional arcs remain in which the current flows in the same direction.

Thus, the electro-dynamic forces produced by each subsidiary arc no longer eliminate one another but, on the contrary, add *uo.*, i.e., operate to increase, the effect of the electrodynamic forces of the adjacent subsidiary arcs. The remaining subsidiary arcs so obtained develop each into a long loop parallel to the slabs or plates in a manner quite similar to that occurring in the circuit-breakers of the second kind. The loop extends into the part of the chamber which, in the American circuit-breakers, is devoted to the cooling of the ionized gases.

The invention will be better understood by the following description of certain preferred embodiments, it being understood that slight modifications are possible without departing from the scope of the present invention. In the accompanying drawings:

Fig. 1A is an elevational view of an insulating slab or plate used in the circuit-breakers of the American type.

Fig. 1B is a horizontal cross-section of a stack of three slabs along the line B^1-B^2 of Fig. 1A.

Fig. 1C is an elevational view of a slab as in Fig. 1A, but provided with conducting elements according to the present invention.

Fig. 2 is a horizontal cross-section along the line II—II of Fig. 1C.

Fig. 3 is a horizontal cross-section along the line III—III of Fig. 1C.

Fig. 4 is a horizontal cross-section along the line IV—IV of Fig. 1C, and

Fig. 5 is a horizontal cross-section of an embodiment of the invention for a circuit-breaker in which the path of the arc is determined by a pair of imbricated comb-like plates.

It will be remembered that in the circuit-breakers of the American type referred to above, the arc is struck upon the separation of the contacts in a vertical plane CC^1 perpendicular to the plane of Fig. 1A, and then driven by means of a magnetic field from C upwards towards C^1 .

The slabs or plates are provided with slots which are arranged alternatively in such a manner that the slot of the first slab is located, for instance, on the left side of the symmetry plane of the stack or the arc-extinction chamber, while the slot of the second plate is placed on the right side, and so forth. The slots placed at the left are designated by F_1 and those placed at the right by F_2 . As a consequence, the arc, when it has reached the plane $B_1 B_2$ (Fig. 1A), is brought into a sinusoidal shape as shown in Fig. 1B, wherein the arc is represented by a broken line designated "a."

In these circuit-breakers the whole part of the slab situated above the line $B_1 B_2$ serves only for the cooling of the ionized gases produced by the arc.

In Figure 1C is shown a slab, designated by 10, made of insulating material having the same shape and the same slot as the slab shown in Fig. 1A.

In Figures 2, 3 and 4 are shown cross-sections taken at various levels of a stack of slabs numbered 10, 11, 12, 13, 14, 15 and having slots F_1 and F_2 placed alternatively on the left and right side of the symmetry plane

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of the stack just as applied in the circuit-breakers of the American type. According to the invention, after each odd-numbered slab there is located a conducting plate 11a, 13a, 15a Such a plate is shown in Fig. 1C partly in broken lines, as this plate lies mostly behind the slab.

This conducting plate has a rectangular shape, nearly the same width as the insulating slabs and a height such that its upper edge is located slightly above the top of the slots F_1 and F_r and its lower edge is slightly beneath the point of intersection formed by the inclined edges of the slots as seen in vertical projection. The conducting plate is, moreover, provided with a vertical slit 6.

Each even-numbered slab is provided at its upper part and on the side opposite to the preceding metallic plate with a flame arrester 9 made, for instance, of asbestos and kept at some distance from the insulating plate, as by spacers 7 and 8. These flame arresters are known and conventionally used in the circuit-breakers of the second kind mentioned above. They are intended to prevent the arc loop from extending too far towards the top of the arc extinction chamber and even leaving the chamber, which might produce an external display or even cause a short circuit with the adjacent loops.

Figures 2, 3 and 4 allow one to understand readily the functioning of the new arc-extinction chamber. The arc "a" struck at the parting of the contacts in the symmetry plane CC' of the arc extinction chamber, perpendicular to the plane of Fig. 1C, is driven upwards by the magnetic field and butts against the lower edges of the conducting plates 11a, 13a, etc., and is divided into $m+1$ subsidiary arcs if m is the number of conducting plates (Fig. 2). These subsidiary arcs are in series. Continuing their ascending movement under the action of the magnetic field, the subsidiary arcs attain a point where their roots butt against the inclined edges of the alternating slots F_1 and F_r . From this instant on, while still adhering to the conducting plates, they climb upwards along these inclined edges whereby each subsidiary arc is turned into a position as shown in Fig. 3. Still continuing this movement, each subsidiary arc becomes progressively free from the action of the magnetic field and increasingly subject to the electro-dynamic forces produced by its current, and which forces are reinforced by the effects of the currents of the adjacent subsidiary arcs.

When the roots of the subsidiary arcs attain the apex of the slots F_1 and F_r , the arc follows a path shown in Fig. 4 in a plan view. At this stage, the subsidiary or divisionary arcs are already appreciably bent and have a shape as shown in Fig. 1C, in an elevational view, by the curve a_1 .

From this instant on, the roots of the arc cannot move further; they are arrested, but each divisionary or subsidiary arc continues to expand, taking the shape of a loop which finally butts against the lateral walls of the chamber and the lower edge of the flame arrester. At this stage, the shape of the subsidiary arc is shown by the curve a_2 . In this position, the arc is subject to an intensive cooling which causes its extinction, if it has not already been extinguished before reaching this final position, by the cooling undergone during its expansion as a consequence of its contact with the two slabs between which it moves, and which are spaced at a distance varying, as is known, between 1 and 4 millimeters.

It will readily be appreciated that according to the invention each subsidiary arc can be expanded to a length equal to 2 or 3 times its initial length. Though this result is somewhat inferior to that obtained with the circuit-breakers of the second kind above mentioned, it is nonetheless important for the manufacturers of the circuit-breakers of the American type and for those users who wish to increase the breaking capacity of the circuit-breakers they have already in service.

The invention applies not only to all circuit-breakers

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in which the breaking arc is lengthened and given a zig-zag or sinusoidal shape by means of a stack of insulating plates or slabs, but also to those wherein the lengthening is not obtained by a plurality of slabs, but by only two plates placed at some distance so as to be separated by a small interval or gap and having projections which are imbricated so as to cause a lengthening of the arc path. In such a device, the metallic elements necessary to short circuit, i.e., to suppress the undesirable portions of the arc, are inserted alternatively between two imbricated projections as shown at e in Fig. 5.

This second arrangement is disclosed merely as an example. It is of course less effective than the previously mentioned construction because for a given initial length of a subsidiary arc it does not allow the same easy provision of large spaces for the development of the subsidiary arcs into loops as in the case of the circuit-breakers wherein the initial lengthening of the arc into a zig-zag shape is obtained by means of a stack of insulating slabs.

What is claimed is:

1. In an electric circuit-breaker of the type comprising an arc extinction chamber and means for giving the breaking arc a zig-zag shape between insulating elements with a view to lengthening the same, the improvement comprising conducting means arranged on the path of the arc to replace by a conducting path one of each two consecutive sections of the zig-zag shaped arc whereby the same is divided into subsidiary arcs constituted by the remaining portions of the original arc, these portions being parallel to each other and traversed in series by the arc current having in each portion the same direction.

2. In an electric circuit-breaker comprising an arc extinction chamber built up of a stack of parallel non-conducting slabs designed so as to give to the breaking arc a sinusoidal shape in a plane perpendicular to the plane in which the initial arc is developed, the improvement comprising the provision in the space between the two slabs of alternate pairs of conducting means arranged on the path of the arc to suppress the portion of the arc existing in that space whereby portions of the arc are left only in the spaces not provided with said conducting means, said remaining portions of the arc being parallel to each other and traversed by a current having in all portions the same direction.

3. In an electric circuit-breaker comprising an arc extinction chamber constituted by two parallel non-conducting plates providing a baffle to deflect the breaking arc and to give it a zig-zag shape, the provision of conducting means arranged on the path of the arc to suppress one of two consecutive portions of the arc and to produce thus subsidiary arcs constituted by the remaining portions of the initial arc, said remaining portions being parallel to each other and in use being traversed by a current having in all portions the same direction.

4. In an electric circuit-breaker according to claim 1, the provision between the insulating elements, and in the direction in which the subsidiary arcs tend to develop under the action of the electro-dynamic forces, of spaces of sufficient dimensions so as to allow each subsidiary arc to expand to a length equal to several times its initial length.

5. In an electric circuit-breaker according to claim 2, the provision of insulating plates of such dimensions as to provide, between said plates and in the direction in which the subsidiary arcs tend to expand under the action of the electro-dynamic forces, spaces allowing each subsidiary arc to expand to a length equal to several times its initial length.

6. In an electric circuit-breaker according to claim 3, the provision between the insulating parts and in the direction in which the subsidiary arcs tend to expand under the action of the electro-dynamic forces, of spaces having sufficient dimensions as to allow each subsidiary arc to develop to a length equal to several times its initial length.

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breakers, comprising a plurality of spaced-apart parallel plates of insulating material, alternate plates being slotted adjacent and parallel to their respective right and left lengthwise edges to define a tortuous path for an arc passing between said plates, and conductive plates substantially filling alternate ones of the spaces between said insulating plates, said conductive plates operating to eliminate alternately succeeding portions of the total arc in which the direction of current flow would otherwise be oppositely directed from the current flow of the remaining portions.

8. In a circuit breaker having structure for establishing an arc and an arc extinction chamber, the combination comprising a plurality of pairs of spaced insulating slabs in said chamber, the slabs of each pair having elongated slots formed therein and respectively positioned on alternate sides of the axis of symmetry of the chamber thereby forming with the inter slab spacing a sinusoidal arc passage normal to the direction of motion of the arc through the chamber, a conducting plate positioned in sandwiched relationship between each slab pair and closing the arc passage between slab pairs to short circuit

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each alternate arc portion and divide the sinusoidal arc into a series of mutually parallel subsidiary arcs.

9. The invention as set forth in claim 8 wherein each said conducting plate is symmetrical about the vertical center line of the slab stack and extends from slightly above the upper end of the slab slots to slightly beneath the point of intersection formed by the slot edges as seen in vertical projection.

10. The invention as set forth in claim 9 wherein each said conducting plate has a vertical slit formed therein.

11. The invention as set forth in claim 10 wherein the said elongated slots are formed to be outwardly flaring in a downward direction.

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