Sept. 4, 1956 A. LATOUR 2,761,933

DEVICE FOR BREAKING ELECTRIC CIRCUITS

Filed Nov. 20, 1953 2 Sheets-Sheet 1

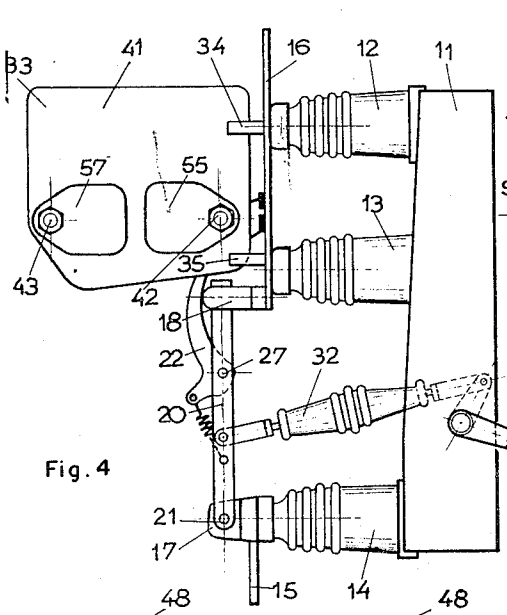

Fig. 4

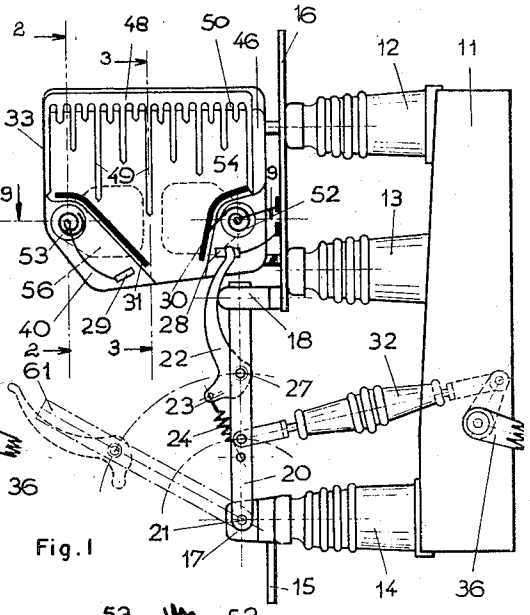

Fig. 1

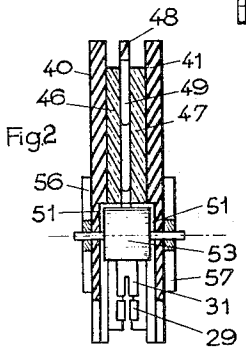

Fig. 2

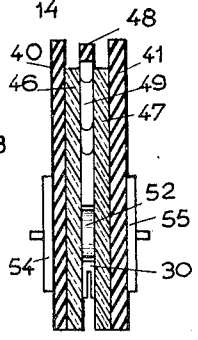

Fig. 3

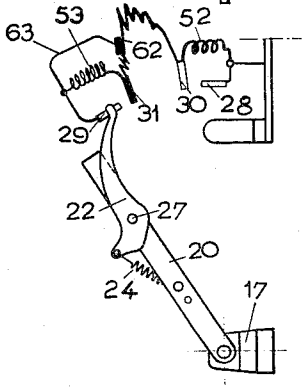

Fig. 8

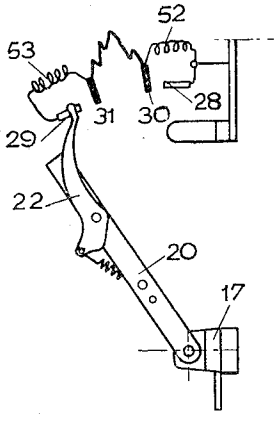

Fig. 7

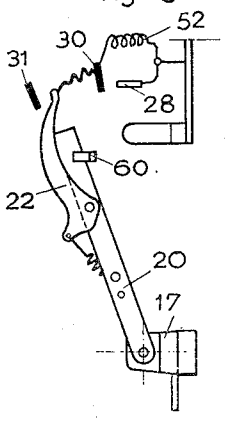

Fig. 6

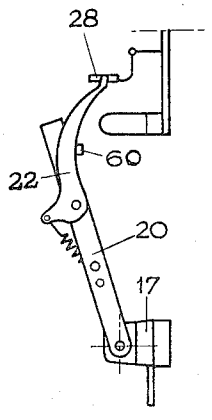

Fig. 5

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DEVICE FOR BREAKING ELECTRIC CIRCUITS

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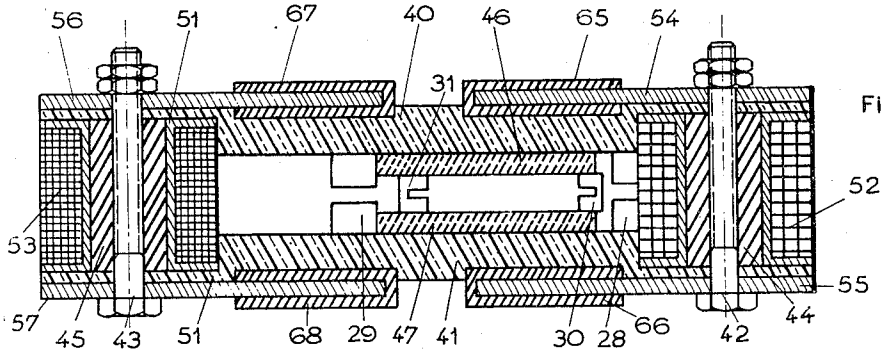

Fig:9

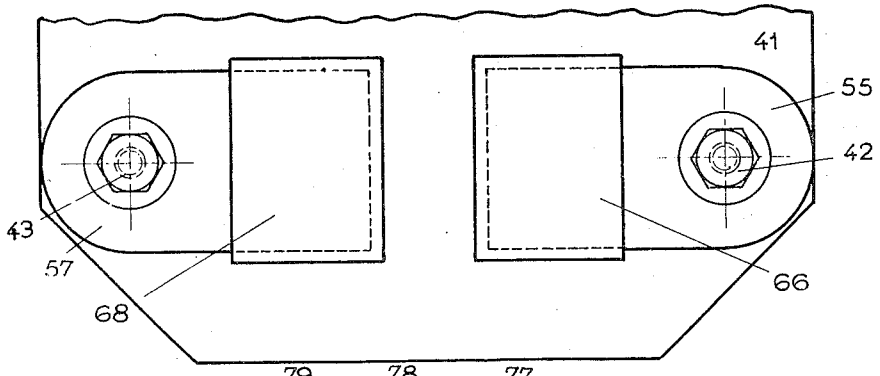

Fig:10

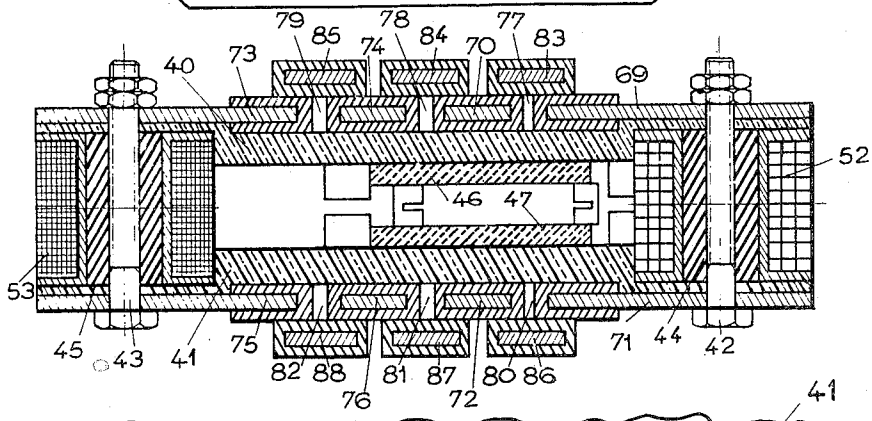

Fig:11

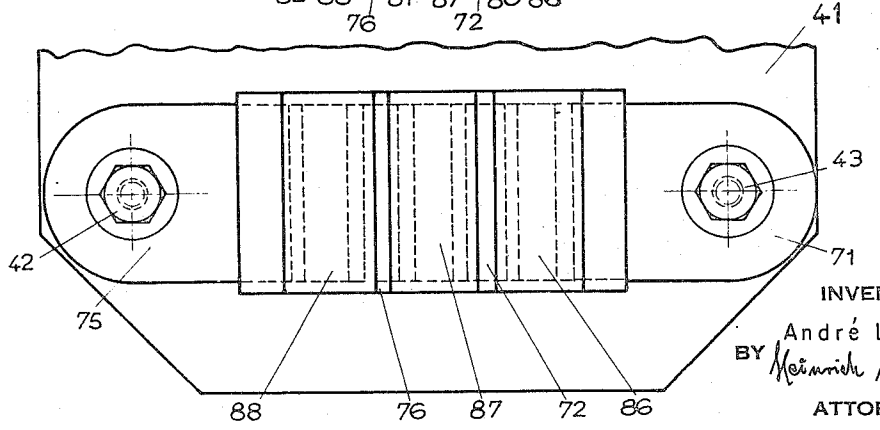

Fig:12

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United States Patent Office

2,761,933

Patented Sept. 4, 1956

2,761,933

DEVICE FOR BREAKING ELECTRIC CIRCUITS

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Application November 20, 1953, Serial No. 393,463

Claims priority, application Belgium December 22, 1952

8 Claims. (Cl. 200—147)

The invention refers to devices for breaking electric circuits under load and generally to devices of the type in which the arc is drawn between at least one stationary contact and at least one movable contact, such as by means of an auxiliary or arcing blade which, when the movable main contact blade leaves the fixed or stationary contact, breaks the current and draws the arc.

More particularly, the invention refers to developments of those arc chambers or arc chutes which comprise a pair of plates of insulating, refractory material which, close together, confine the space within which the arc drawing contact moves and the arc develops and expands, and it is an object of the invention to develop these chambers so as to increase their current breaking power and the rapidity with which arcs of high intensity as well as those of low intensity are extinguished.

For achieving this object, the invention contemplates a formation of this chamber such that the arc, within the plane of its development, is attenuated to an extremely thin lamina and at the same time is elongated in the plane of its development into zig-zag form, the considerable advantage of a substantial elongation of the arc with an intensive cooling effect is obtained.

To this purpose, in accordance with a first development of the invention, the plates which form the arc chute, are disposed extremely close to each other, thus leaving between themselves a space of a width of the order of about one millimeter or less or slightly more up to a few millimeters. Within this narrow space there is provided a comb-like structure constituted by a base body and teeth. The teeth project from the base body and the exit end of the chute into the space of the chute and into the path of the arc development and expansion. The teeth are extended transversely of the chute space from plate to plate thus are of a height so as to adjoin over their lengths, closely without gap, the side walls of the chute space. The teeth are spaced apart from one another by interspaces of a width so as to allow the attenuated arc to penetrate into the interspaces and thus to be deflected and elongated within a plane parallel to the side walls or plates. At the exit or upper end of the arc chute, the comb-like structure is so disposed that the interspaces communicate at the roots of the teeth with the outside of the arc chute.

A further object of the invention is an arrangement of the arcing contacts for the control of the magnetic arc blowing means, an arrangement which within the same device makes possible to blow out with equal efficiency arcs of high current intensity and arcs of low current intensity.

In this arrangement, two blow coils are provided of which one, by being wound with wire of larger diameter and fewer turns is essentially designed to develop a strong blow field under heavy current, whereas the other coil wound with wire of smaller diameter but with a greater number of turns is designed for the blowing out of arcs of lower intensity.

It is particularly an object of the invention to make

the duration of the insertion of these coils into the circuit independent of the velocity with which the circuit breaker is operated. To this purpose, the principal coil, or, in the arrangement of the invention, the coil for blowing the arc of heavy currents will be connected between the stationary contact which the arcing blade engages in the closed position and a supplementary auxiliary contact or electrode provided in the vicinity thereto on the path of the arcing blade. Thus, however slow the opening command of the switch may be executed, the principal coil is switched in series into the circuit at a precise moment and after the arcing blade or lever had overcome the frictional resistance resulting of its engagement with the stationary contact of its closed position, and had reached the succeeding auxiliary contact to which the second end of this coil is connected.

The second coil for the breaking of weak currents will be inserted in series with the arc by means of two auxiliary contacts provided on the path of the auxiliary blade. The time period during which this second coil is inserted into the circuit depends solely upon the duration of the arc. However the length of this period may still be further reduced by providing an auxiliary electrode by means of which the arc may short-circuit the secondary coil as soon as the arc will have developed to a proper length, sufficient to cause its extinction.

The arc expansion and extinction chamber or arc chute with its blow coils and contacts may be developed as a unitary structure adapted to be removably mounted as a whole at one of the supply leads or bus bars of the current interrupter so that the interrupter may be employed with the chamber as a circuit breaker and without the chamber as a section switch which holds a line section separated after the circuit had been opened by a circuit breaker associated with the section switch.

Further objects of the invention refer to the development of the magnetic pole plates of the blow coil so as to protect the device against the risk of the flash-over of an arc between these pole plates when they are electrically charged with a high potential difference relatively to each other.

Further objects and features of the invention will become apparent as the specific description of the invention proceeds. In order to point out more clearly these objects and features, reference will now be made to the accompanying drawings which form part of this specification and which by way of example illustrate embodiments of my invention. It will be readily understood however that these drawings are intended to be illustrative of the invention but not limitative of its scope. Other embodiments incorporating the principle underlying my invention are feasible without departing from the spirit and ambit of appended claims.

In the drawings:

Fig. 1 is an elevational side view of a circuit breaker of the invention, with the forward plate of the arc development and expansion chamber removed for showing the interior and rearward part of the chamber;

Figs. 2 and 3 respectively are sections along lines 2—2 and 3—3 of Fig. 1;

Fig. 4 is an elevational veiw of the circuit breaker illustrating the chamber secured to the upper supply lead of the circuit breaker;

Figs. 5 to 7 are diagrammatic views showing schematically the various steps of inserting the coils into the circuit during the opening movement of the switch;

Fig. 8 is a modification of Fig. 7 showing the arrangement of a supplementary auxiliary contact for short-circuiting the low amperage coil through the developing arc;

Figs. 9 and 10 respectively are a section along line 9—9 of Fig. 1 and a side view, both on an enlarged

scale, of a modification of the arc developing and extinguishing chamber;

Figs. 11 and 12 are similar views of another modification.

In the drawings, 11 is the frame of the circuit breaker. Upon this frame there are mounted the supporting insulators 12, 13, 14. The supply leads or conductor bars of the current are designated by 15, 16. They end respectively at the main contacts or terminal posts 17, 18 of the circuit breaker. The main blade 20 of the circuit breaker, which in the closed position of the circuit breaker engages the jaws of contact 18, is pivotally mounted at the terminal post 17 by means of pivot 21. 22 is the arcing auxiliary blade pivotal about pivot 27 upon main blade 20. The arc drawing lever or arcing blade, in its closed position, engages a first stationary, auxiliary contact 28 connected to conductor bar 16. A nose 23 of the arc drawing contact lever 22 is biased by a spring 24 secured to blade 20. The main blade is operated by means of a coupling rod constituted by an insulator 32 which on its part is actuated by the command lever 36. On operation of the main blade and when it leaves contact 18, spring 24 will be sufficiently tensioned to withdraw the contact faces of the arc drawing lever 22 from the clamping jaws of the first stationary, auxiliary contact 28.

Upon the insulators 12, 13 there is mounted, through the intermediary of the conductor bar or supply lead 16, the arc developing and expansion chamber or arc chute, generally designated by 33, conveniently detachable by conventional securing means, schematically indicated at 34, 35, Fig. 4.

The arc chute 33 comprises two outer side walls 40, 41 of insulating material, of any conventional or convenient type, held together by screw bolts 42, 43 and spaced apart from each other by insulating spacing sleeves or cylinders 44, 45, as may best be seen on Figs. 9 to 12.

Side walls 40, 41, at their inside faces, are covered with sheets or plates 46, 47 of ceramic or other refractory, electrically insulating material of any convenient or conventional type, sheets which thus line the arcing space proper and protect it against deterioration through dielectric and mechanism strains caused by the arc. These refractory linings are just spaced sufficiently from each other to allow the passage of the moving arcing blade 22 therebetween. The spacing thus is narrow, of a width of the order of about one to a few millimeters, for thus attenuating the developing and expanding arc into a thin lamina.

Simultaneously with this attenuation into a thin lamina, the arc will be elongated and deflected in its plane, a plane parallel to the side walls of the chute, into zig-zag form by the provision, between the refractory linings, of a comb-like structure between the walls of the arc development and expansion chamber. In the embodiment illustrated, this element of comb-like structure is inserted between the plates 46, 47. This element comprises teeth 49 of various lengths adjoining closely, without gap, the side walls or refractory plates 46, 47, as Figs. 2 and 3 illustrate. These teeth project, as Fig. 1 illustrates, from a base body 48 at the upper or exit end of the arc chute towards and into the path of the arc and transversely thereof leaving between themselves interspaces of a lateral width sufficient to allow the attenuated arc to penetrate into the interspaces and thus to be deflected and elongated in zig-zag form in the plane of its development and expansion, a plane parallel to the side walls of the arc chute. The base body of the structure may project above the side walls 40, 41 of the arc chute or above the inner lining 46, 47 so that the interspaces between the ribs, or openings 50 provided between the ribs at their roots or the base of the comb-like structure, may communicate with the outside of the arc chute and thus allow the hot gases generated by the arc to escape from the arc chute to the outside atmosphere.

The comb-like structure, here illustrated as a separate body, may be of any proper insulating material having a certain elasticity, properly inserted between the walls of the chamber so as to leave, at the interspaces between the ribs, uncovered escape openings for the hot gases. Instead of employing a separate comb-like structure, this structure may be obtained by providing correspondingly shaped ribs projecting in relief from the one or from both walls, the ribs being of a height so as to extend across the chamber spaces from wall to wall. These ribs project from the upper part or exit end of the chamber downwards towards and into the path of the arc and transversely thereto. The interspaces between the ribs communicate at their upper ends, or between the roots of the ribs with the outside of the chamber.

At their lateral ends, the plates 40, 41 are shaped with sockets 51 to lodge therein two blow coils 52, 53 whose effect will be enhanced through magnetic pole plates 54, 55 and 56, 57 provided upon the outside faces of the insulating plates 40, 41.

In addition to the first stationary, auxiliary contact 28 which the arcing blade 22 engages in the closed position of the circuit breaker, there are at least three more auxiliary stationary or fixed contacts disposed within the arc chute and distributed along the path of the arc drawing movable contact blade and spaced apart from contact 28 and from one another. The end contact 29, similar to contact 28, is shaped of a pair of contact making clamping jaws between which blade 22 enters or which it engages frictionally, whereas the median contacts 30, 31, Figs. 1 to 3 and 9, are in form of slotted arc horns of conductive sheet material extended between the plates 46, 47 of insulating refractory material. Contact blade 22 passes through these slots and contacts the horns when it moves along its path while the circuit breaker is being opened.

Blow coil 52 is connected to the contacts 28 and 30, those next on the path upon which the arc drawing blade 22 moves when the circuit breaker is opened. This coil is so designed as to develop a strong blow field under heavy currents, thus with fewer turns and a larger diameter of the wire. The second blow coil 53, on the other hand, is designed to develop a strong blow field under weak currents, thus is of a greater number of turns wound of a wire of smaller diameter. This coil is connected to the contacts 29, 31, thus to those most distant from the closed position on the path of the opening arc drawing blade 22.

The device then operates as follows:

As long as the circuit breaker is closed, the current flows from supply lead 15 over terminal post 17, blade 20, contact 18 and supply lead 16. When the circuit breaker is opened, blade 20 leaves the main contact 18. The arcing blade 23, however, remains for a certain length of time inserted between the jaws of contact 28, as indicated in Fig. 5. For this short period of time, the current flows from supply lead 15 over post 17, blades 20, 22, contact 28 to lead 16.

While blade 20, when being opened moves along a certain length of its path, the auxiliary blade 22, retained at its contacting end by the clamping effect of the contact jaws 28, will, turned about contact 28 by its moving pivot 27, tension spring 24. Blade 20, after a certain length of its path, will bear with its stop 60, Fig. 5, against the arcing blade 22, and will thus pull it out of contact 28. At this moment, when blade 22 is released from contact 28, the tensioned spring 24 may act upon blade 22 and this blade will then swing rapidly about pivot 27 and during its pivoting motion pass rapidly through the slotted auxiliary contacts 30 and 31, and over auxiliary contact 29, Figs. 6 and 7, for finally reaching

the open end position out of the arc chute 33, indicated in dotted lines at 61, Fig. 1.

With the moment at which blade 22 leaves the stationary contact 28, a breaking arc is developed, its successive phases being shown in Figs. 5 to 7. At the moment when the arcing blade 22 passes the electrode 30, the arc which formed between contact 28 and blade 22 leaves contact 28 and clings to electrode 30, Fig. 6. Coil 52 is now inserted into the circuit and traversed by the current which is to be interrupted.

Continuing this movement, blade 22 passes the auxiliary electrode 31 whilst, under the influence of the blow field produced by coil 52, the arc with its roots on blade 22 and electrode 30 develops and rises towards the comb-like structure 48, 49.

As soon as blade 22 reaches the stationary contact 29, the left hand root of the arc will leave blade 22 and adhere to electrode 31, coil 53 thus being inserted into the circuit in series with the arc and coil 52, Fig. 7.

Both coils are now inserted into the circuit and both contribute to the rapid expansion of the arc towards the upper part of the chamber. The arc will now bear against the ribs 49 of various lengths of the comb-like structure and will thus be considerably elongated and will rapidly extinguish, and this even before blade 22 has left the auxiliary contact 29 in order to reach the open position at 61.

The hot gases produced by the arc will escape through the openings 50 provided in the base 48 of the comb-like structure and above the space of the arc development and expansion chamber.

The extinction of the arc, in the case of heavy currents will generally be accomplished before the auxiliary blade 22 reaches the auxiliary electrode 31, the action of coil 52 alone being sufficient for expanding the arc to the extent necessary for rapid extinction. Coil 53 in such a case will not be inserted into the circuit.

If, contrariwise, weak currents are to be interrupted, coil 52 in view of the small number of its turns will not suffice to produce a blow field strong enough for extinguishing the arc. The arc thus will still subsist when blade 22 reaches the auxiliary contact 29. Coil 53 thus is likewise inserted into the circuit and owing to the great number of its turns will contribute to the immediate extinction of the arc of low current intensity, and, in any case, within a lapse of time much shorter than that necessary for the auxiliary blade to pass contact 29.

In cases where it is desired to shorten still more the length of time during which the second coil is inserted into the circuit a further auxiliary contact such as shown at 62, Fig. 8, may be provided which through line 63 is connected to contact 29 and the end of coil 53 connected therewith. As soon as the arc between contacts 30 and 31 has reached a certain expansion, it will bridge, as indicated in Fig. 8, the contacts 31 and 62 and will thus short-circuit coil 53.

In the position indicated at 61, Fig. 1, both blades 20 and 22 have reached the open end position. The distance between the blades and the chamber then is such that no re-igniting of the arc is possible. In this open end position the chamber is not subjected to any dielectric strain. On the other hand, at the moment when the current is broken, and particularly when the auxiliary blade 22 engages contact 29, the chamber is subjected to a dielectric strain which however is transmitted by means of the pole plates 54, 55, and 56, 57, towards the midst of chamber 33 which does less impede the extinction of the arc than if the strain were transmitted to the region of coil 53.

From these developments of the circuit breaker in accordance with the invention, the following advantages result among others.

In the apparatus of the invention, the breaking of the arc is visible and thus may easily be surveyed.

When the circuit breaker is open, the arc breaking chamber is not subjected to any dielectric strain. This strain, however, during the breaking process is transmitted to the midst of the chamber; the problem of insulating the chamber is simplified and the conditions for the extinction of the arc improved through more favorable distribution of the electric field. The chamber is readily removable from the circuit breaker so that the field of use of the same construction is widely enlarged.

When the circuit breaker of the invention or other circuit breakers with a plurality of blow coils is applied to the breaking of currents in high voltage networks or in other cases where the magnetic pole plates may be susceptible, on drawing the arc, to be charged electrically with considerable potential differences relatively to each other, a flashover of an arc between pole plates of the adjacent coils may occur. The inventor has discovered that this flash-over may be prevented when in accordance with a further development of the invention the pole plates 54 and 56 as well as 55 and 57, Figs. 9 and 10, of the adjacent coils 52, 53, are provided over their surfaces, or at least at their juxtaposed parts, as the figures show, with a cover or hood, or sheet, or layer 65, 66, 67, 68, respectively, of insulating material, insulating material such as is conventional for high tension insulation, e. g. the polythenes $(CH_2CH_2)_x$, vinylchloride C_2H_3Cl or polyvinylchlorides $(CH_2{:}CHCl)_x$, or others.

The inventor has further discovered that the steep change, increase or decrease, of the potential gradient between juxtaposed pole plates may be avoided when in accordance with a further development of this feature the potential gradient over the length of the pole plates is subdivided into steps by subdividing the juxtaposed parts of the pole plates into segments such as illustrated at 69, 70; 71, 72; and 73, 74; 75, 76 in Figs. 11, 12, each segment being covered or coated or enveloped with insulating material and separated by air gaps 77, 78, 79, 80, or gaps filled with other non-conductive non-magnetic material.

For further equalizing and rendering gradual the transition from the high potential to the lower one, the non-conductive gaps, as Figs. 11 and 12 likewise illustrate, may be magnetically but not conductively bridged by counter segments 83, 84, 85, and 86, 87, 88 likewise individually covered or enveloped by insulating material as just described.

I claim:

1. In a device for extinguishing an electric arc at least one stationary contact, a main contact blade, and an arc drawing contact lever resiliently disposed at said main contact blade for movement therewith and movement relatively thereto, an arc chute constitutes by a pair of plates of insulating, refractory material leaving between themselves a space of a width of the order of about one millimeter to a few millimeters, thereby to attenuate the arc; a comb-like structure constituted by a base body and teeth, said teeth projecting from the base body and the exit end of the chute into the space thereof and into the path of the arc development and expansion and extending transversely of said space from plate to plate; said teeth being spaced apart from one another by interspaces of a lateral width so as to allow the attenuated arc to penetrate into said interspaces, the arc thus to be deflected and elongated within a plane parallel to said plates.

2. In a device for extinguishing an electric arc at least one stationary contact, a main contact blade, and an arc drawing contact lever resiliently disposed at said main contact blade for movement therewith and movement relatively thereto, an arc chute constituted by a pair of plates of insulating, refractory material leaving between themselves a space of a width of the order of about one millimeter to a few millimeters, thereby to attenuate the arc; a comb-like structure constituted by a base body and teeth, said teeth projecting from the base body and the exit end of the chute into the space thereof and into the path of the arc edevelopment and expansion and extending transversely of said space from plate to plate; said

teeth being spaced apart from one another by interspaces of a lateral width so as to allow the attenuated arc to penetrate into said interspaces and thus to be deflected and elongated within a plane parallel to said plates; said comb-like structure being disposed in spatial relationship to the exit of said chute so as for said interspaces to communicate at the roots of the teeth with the outside of the chute.

3. In a device for extinguishing an electric arc, at least one stationary main contact, a main contact blade, and an arc drawing contact lever resiliently disposed at said main contact blade for movement therewith and movement relatively thereto, an arc chute constituted by a pair of plates of insulating refractory material leaving a narrow space between themselves; two blow coils disposed at said arc chute for blowing out said arc within said space, one of said coils being designed so as to develop a strong blow field under heavy currents, the other to develop a strong blow field under weak currents; said arc drawing lever having a contact disposed for movement through said arc chute; at least four stationary, auxiliary contacts being disposed within said chute and distributed along the path of said arc drawing contact and spaced apart from one another; the first of said auxiliary contacts being connected to a terminal of said device, said first auxiliary contact and said movable arc drawing contact being mutually disposed for frictional engagement; the first of said coils being connected between the first and the second of said auxiliary contacts, the second of said coils being connected between the last two of said auxiliary contacts; thereby, when the main blade is opened and is moved on its path, to snap said arc drawing movable contact from the first of said auxiliary contacts and move it over the other auxiliary contacts and thus, in rapid succession, while drawing the arc and causing it to develop and expand, first to insert in series with the arc the first named coil, designed for blowing out arcs of high current intensity, and thereafter to insert, in series with the arc and the first named coil, the second named coil, designed for blowing out arcs of low current intensity.

4. In a device for extinguishing an electric arc, at least one stationary main contact, a main contact blade, and an arc drawing contact lever resiliently disposed at said main contact blade for movement therewith and movement relatively thereto, an arc chute constituted by a pair of plates of insulating, refractory material leaving between themselves a space of a width of the order of about one millimeter to a few millimeters, thereby to attenuate the arc; a comb-like structure constituted by a base body and teeth, said teeth projecting from the base body and the exit end of the chute into the space thereof and into the path of the arc development and expansion and extending transversely of said space from plate to plate; said teeth being spaced apart from one another by interspaces of a lateral width so as to allow the attenuated arc to penetrate into said interspaces and thus to be deflected and elongated within a plane parallel to said plates; said comb-like structure being disposed in spatial relationship to the exit of said chute so as for said interspaces to communicate at the roots of the teeth with the outside of the chute; two blow coils being disposed at said arc chute for blowing out said arc within the space, one of said coils being designed so as to develop a strong blow field under heavy currents, the other to develop a strong blow field under weak currents; said arc drawing lever having a contact disposed for movement through said arc chute; at least four stationary, auxiliary contacts being disposed within said arc chute and distributed therein along the path of said arc drawing contact and spaced apart from one another; the first of said auxiliary contacts being connected to a terminal of said device, said first auxiliary contact and the contact of said arc drawing movable lever being mutually disposed for frictional engagement; the first of said coils being connected between the first and the second of said auxiliary contacts, the second of said coils being connected between the last two of said auxiliary contacts; thereby, when the main blade is opened and is moved on its path, to snap the arc drawing movable contact from the first of said auxiliary contacts and move it over the other auxiliary contacts and thus, in rapid succession, while drawing the arc, expanding and attenuating the same, first to insert in series with the arc the first named coil, designed for blowing out arcs of high current intensity, and thereafter to insert, in series with the arc and the first named coil, the second named coil, designed for blowing out arcs of low current intensity.

5. A device as set forth in claim 3 wherein said arc chute, including plates, stationary contact, auxiliary contacts, and blow coils, is designed as a unitary structure adapted to be removably mounted as a whole at one of the supply leads of a current interrupter, thereby to make possible employment of the interrupter with said arc chute as a circuit breaker and without said arc chute as a section switch.

6. In a device as set forth in claim 3 wherein said blow coils are provided with pole plates of magnetic material, said pole plates having at least at their juxtaposed parts covers of insulating material, thereby, when the arc is drawn and the pole plates might electrically be charged with considerable potential difference relatively to each other, to protect the device against flash-over of an arc between said pole plates.

7. A device as set forth in claim 6 wherein said pole plates in the direction of the potential gradient are subdivided into a plurality of segments with gaps of non-conductive material therebetween, thereby to subdivide the potential gradient into steps.

8. A device as set forth in claim 7 wherein the non-conductive gaps are magnetically but not conductively bridged by counter segments.

References Cited in the file of this patent

UNITED STATES PATENTS

1,623,851	Paul	Apr. 5, 1927
1,914,143	Mason	June 13, 1933
1,933,175	Jansson	Oct. 31, 1933
2,285,643	Beiersdorf et al.	June 9, 1942
2,293,487	Bartlett	Aug. 18, 1942
2,337,949	Walle	Dec. 28, 1943
2,349,681	Slepian	May 23, 1944
2,381,637	Bohn	Aug. 7, 1945
2,393,164	Hobson	Jan. 15, 1946
2,417,683	Harlow	Mar. 18, 1947
2,428,254	Walle	Sept. 30, 1947
2,446,859	Traver et al.	Aug. 10, 1948

FOREIGN PATENTS

590,970	Great Britain	Aug. 1, 1947