Dec. 12, 1950 H. E. SCHLEICHER 2,534,069

ARC EXTINGUISHING MEANS FOR ALTERNATING CURRENT ELECTRIC SWITCHES

Filed April 9, 1947 2 Sheets-Sheet 1

Fig. 1.

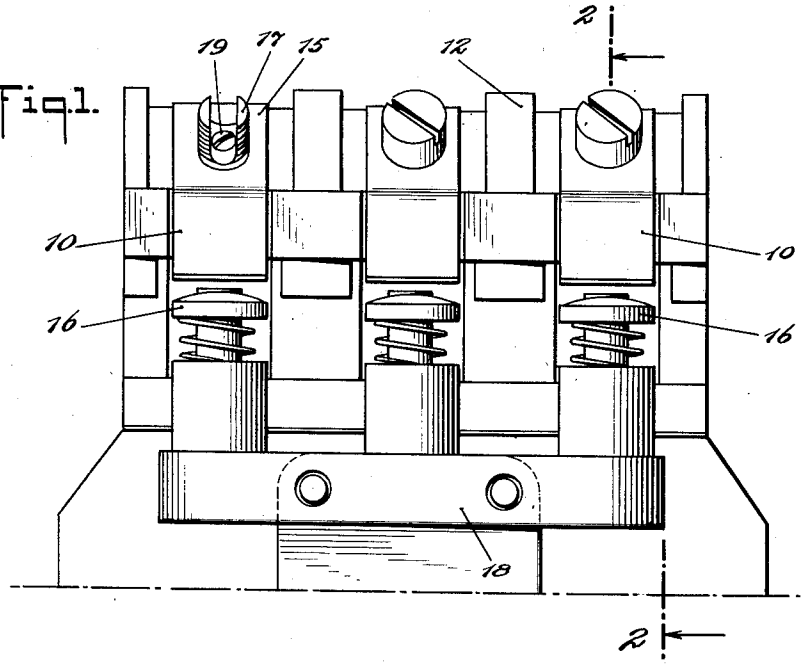


Fig. 4.

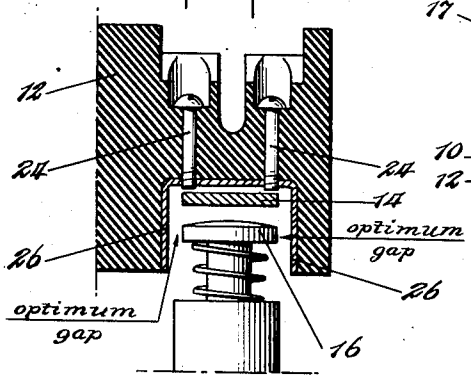
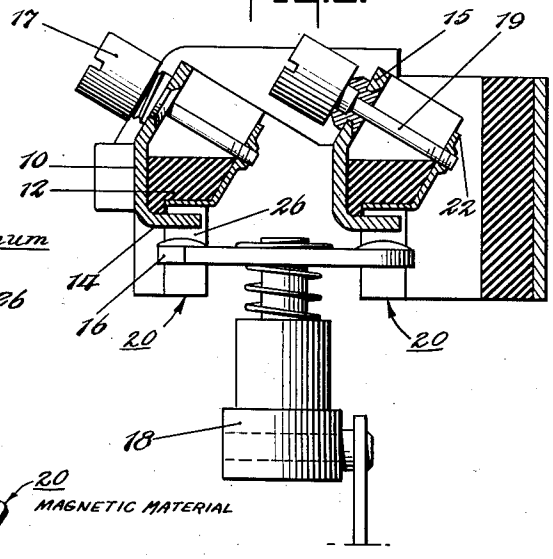


Fig. 2.



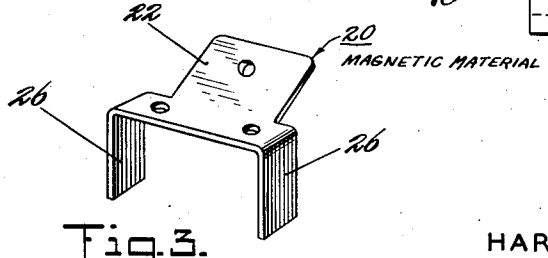


Fig. 3.

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ARC EXTINGUISHING MEANS FOR ALTERNATING CURRENT ELECTRIC SWITCHES

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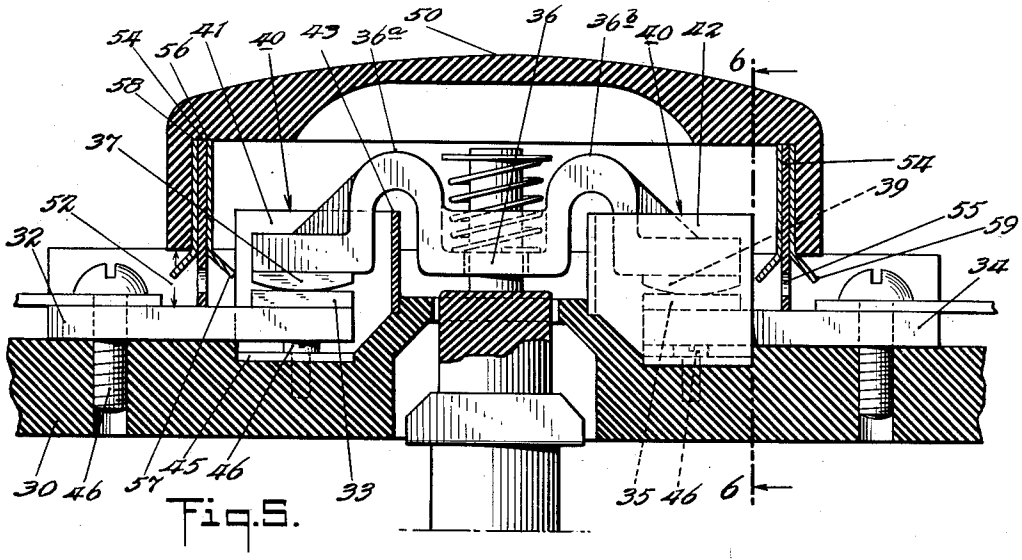


Fig. 5.

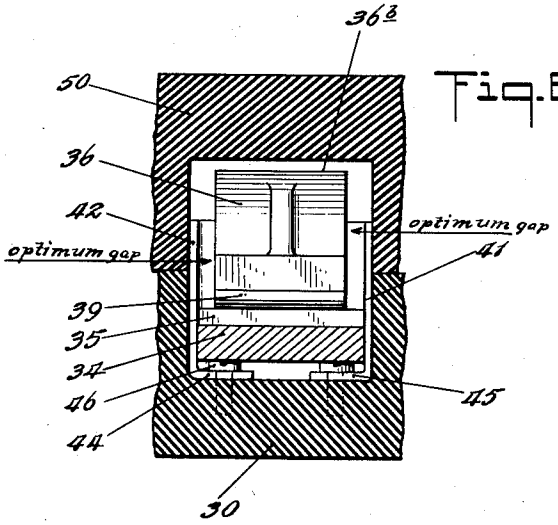
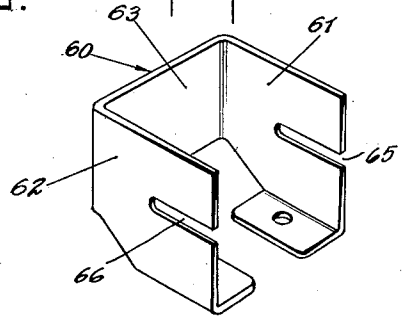


Fig. 6.

Fig. 7.



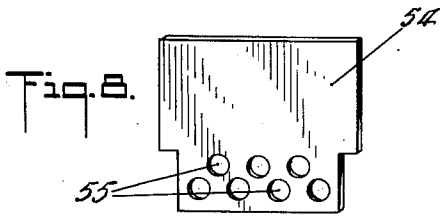


Fig. 8.

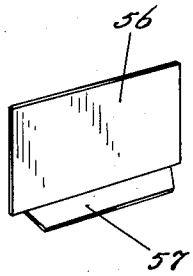


Fig. 9.

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ARC EXTINGUISHING MEANS FOR ALTERNATING CURRENT ELECTRIC SWITCHES

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Application April 9, 1947, Serial No. 740,406

11 Claims. (Cl. 200—147)

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This invention relates to arc extinguishing means associated with the contacts of alternating current electric switches for extinguishing the arc that is incident to switch opening. More particularly the invention relates to means associated with the fixed contact of an electric switch to provide for the joint electromagnetic blowout action by magneto motive effect and arc suppressing action by separation of the contacts the optimum distance for quickest arc suppression.

The value of electromagnetic blowout means in connection with electric switches has long been known. It has also been scientifically determined that there is an optimum distance of contact separation in alternating current electric switches. Contacts that are separated a lesser or greater distance than this certain scientifically-determined optimum distance have been found to have shorter life due to pitting and burning resulting from unnecessary prolongation of the arc incident to ordinary operation of the switch under load conditions.

It is an object of my invention to provide improved arc extinguishing means for use in connection with alternating current electric switches which embody the principles of an electromagnetic blowout and also provide for the separation of the contacts or contact-carrying parts the optimum arc extinguishing distance.

Another object of my invention is to provide improved arc extinguishing means of the foregoing type, in which the optimum distance for arc extinguishment will be maintained between the fixed and movable conductive parts of the contact structure, regardless of the separation of the contacting surfaces of the contacts beyond the optimum arc extinguishing distance.

Another object is to provide improved arc cooling and baffling means for use in connection with the structure achieving the previously mentioned objectives.

Other objects and advantages of my invention will become apparent as it is described in connection with the accompanying drawings.

In the drawings—

Fig. 1 illustrates an electric switch contact structure embodying three sets of fixed and movable contacts in which the principles of my invention have been incorporated;

Fig. 2 is a section view of a structure shown in Fig. 1, the section being taken on line 2—2 of Fig. 1;

Fig. 3 is a perspective view of an arc extinguishing member employed in the form of my invention illustrated in Figs. 1 and 2;

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Fig. 4 is a section view taken along line 4—4 of Fig. 2;

Fig. 5 is a transverse section view of another form of the invention;

Fig. 6 is an end section view, partly broken away, taken along line 6—6 of Fig. 5;

Fig. 7 is a perspective view of a modification of the form of arc suppressing member shown in Figs. 5 and 6;

Fig. 8 is a detailed view of the baffle plate used in the form of the invention illustrated in Fig. 5;

Fig. 9 is a detailed view of the arc fending plate used in the form of the invention illustrated in Fig. 5.

Referring to the drawing, a pair of angulated metal bars of highly conductive material form fixed contact members 10 which are mounted upon an insulating base 12 in spaced positions. Each fixed contact has an end portion 14 whose surface is adapted to be contacted by the end portions of a movable bridging contact, preferably in the form of a conductive metallic bar resiliently carried by a movable insulated actuator 18 in any suitable fashion. As the bridging contact 16 disengages the contact portions 14, an arc will be drawn normally under ordinary load conditions of operation of the switch.

To extinguish the arc quickly and effectively, I provide an arc extinguishing member 20. As illustrated in Fig. 3, it is of substantially U-shape and has an oblique lateral extension 22 from its transverse portion. This arc suppressing member 20 is secured to the insulating base 12 behind and spaced from the portion 14 of the fixed contact by means of a pair of bolts 24 passing through the insulating base in a direction substantially parallel to the central portion 10 of the fixed contact.

For securing the fixed contact in position, the longer leg thereof may be bent at an angle to the central portion 10, providing a terminal portion 15 on which is mounted an externally threaded and diametrically slotted stud 17. In the bottom of the slot is an axial aperture to receive a securing bolt 19, which extends through a slot in the insulating base 12 to thread into an aperture in the oblique extension 22 of the arc suppressing member. Preferably the profile of the base 12 adjacent the middle and terminal portions of the contact member 10 and adjacent the central part and the oblique extension of the arc suppressing member 20 will be the same as the surfaces of those parts, so that as the securing bolt 19 is tightened, it will clamp both members to the base in fixed relation to each

other, the arc member also being held by aforementioned bolts 24.

The wing portions 26 of the arc extinguishing member are spaced from and extend past the side edges of the contact portion 14 of the fixed contact in the direction of movement of the movable contact member away from the fixed contact. These wing portions continue and extend beyond the side of the movable contact 16 also, when that contact has moved from the stationary contact the optimum distance for arc extinguishment. The precise extent of the wing portions will depend on and should at least equal the maximum separation which the movable contact can separate from its complementary fixed contact in any particular switch.

The spacing of the wings 26 from the side edges of the movable bridging member will be the distance determined as the most desirable distance for optimum results in arc extinguishment, this distance being known by those skilled in the art for given voltages and frequencies of current. Because the edges of the movable contact are spaced the optimum distance for most effective arc extinguishment from the wing of the arc extinguishing member 20, variations in distance that the fixed and movable contact separate, become of lesser importance since movement of the movable contact away from the fixed contact beyond the optimum distance will not carry the movable contact beyond the optimum distance from the arc extinguishing member. In other words, the points on the periphery of the movable contact 16 nearest the wing portions 26 will remain a fixed distance, i. e. the "optimum" distance from the wing portions whether the contact 16 moves from the stationary contact 14 a distance less than, equal to, or greater than said optimum distance. Thus, any arc drawn between the contacting surfaces will transfer to the arc member if those surfaces get farther apart than the optimum distance. In Fig. 4 the contacts are illustrated as separated approximately the optimum distance. This may or may not be the fully "open" position, depending on the manufacturer's design and the accuracy of fabrication.

Desirably, the arc extinguishing member may be made from magnetic material, so that the flow of current in the fixed contact member 10 will create a magnetic flux between the wings of the arc extinguishing member 20, and the flux lines will be perpendicular to the path of the arc drawn between the fixed and movable contact to exert an extenuating effect on the arc. Thus, my invention provides for the utilization of a combination of arc extinguishing features in a manner not heretofore contemplated by the art and results in an effective arc extinguishing structure to prolong the life of the contacts of electric switches.

In Figs. 5 and 6 there is illustrated a form of the invention adapted for use with the type of switch illustrated in my Patent 2,399,575 dated April 30, 1946. In this type of switch an insulating slab or base member 30 supports one or more sets of fixed contact members 32 and 34 in position to be bridged by a movable bridging contact member 36. The bridging contact member preferably is mounted resiliently upon an insulating carrier and operating member which is, or may be, moved by electromagnetic operating means as illustrated in my Patent 2,399,575 but not illustrated herein; or the bridging contact may be operated by any other suitable reciprocating means.

The fixed contacts 32 and 34 are preferably rectangular metallic blocks of highly conductive material extending, in alignment, inwardly from opposite sides of the insulating base 30. Welded or otherwise suitably secured to the inner upper ends of the contact members 32 and 34 are substantially square pieces of metal forming contact surfaces 33 and 35 respectively, made preferably of silver or other good contact material. The bridging contact 36 is or may be formed from highly conductive material as a bar deformed by a pair of parallel cylindrical arches or ribs between its central portion and its ends, as best illustrated in Fig. 5. Engageable with the contact surfaces 33 and 35 are movable contact surfaces 37 and 39 which are similar to contact surfaces 33 and 35 and mounted upon inner or under surfaces of the end portions of the bridging contact member 36.

Arc extniguishing members 40, similar to the arc extinguishing member 20 of the previously described form of this invention, are associated with each of the pairs of contacts 33, 37 and 35, 39. These arc extinguishing members are identical. Each comprises parallel side plates 41, 42 joined at one edge by an end plate 43 of less height than the side plates. At the bottom or lower edges (see Figs. 5 and 6) of the side plates, plate like feet portions 44 and 45 are inwardly bent in alignment with each other and at right angles to the side plates 41, 42. Passing through the feet portions 44 and 45 are screw bolts 46 which serve to secure the arc extinguishing member to the insulating base 30. The heads of these securing screws 46 are engaged with and therefore electrically connect with the bottom surfaces of the contact members 32 and 34 with the result that each arc extinguishing member is electrically connected with the fixed contact with which it is associated.

The location of the arc extinguishing members is such that the back plate 43 lies centrally within the cavity formed beneath an arcuate portion, i. e. 36*a* and 36*b*, of the bridging contact member. At the same time the side plates 41 and 42 are spaced from the side edges of the bridging contact 36 and its contact surfaces 37 and 39, the most effective distance for optimum results in arc extinguishment. Also the distance between the end plate 43 of the arc extinguishing member and the adjacent surface of the bridging contact 36 will be the optimum distance for arc extinguishment or, in other words, the same distance that the side edges of the bridging contact is spaced from the side plates 41 and 42. Preferably when the movable contact surfaces separate from the fixed contact surfaces, the separation will be said optimum distance. However, should the movable contacts move further from the fixed contact surfaces than said optimum distance, the portions of the movable contact member 36 which are adjacent or nearest to the side and end plates 41, 42 and 43 of the arc extinguishing members, will maintain said optimum spacing of the bridging contact member from the arc extinguishing member. Hence any arc transferring from the contact surfaces to the sides of the contact member and the plates of the arc extinguishing member will play between conductive surfaces spaced at the optimum distance for most effective arc extinguishment.

As in the previous form, the arc extinguishing member 40 preferably will be of magnetic mate-

rial. It will be noted that the arches **36***a*, **36***b* loop over and partially around the end plates **43** of the arc extinguishing member **40**. Thus, the current path partially loops around the member **40**. This association of parts creates a magnetic field of which the flux lines tend to concentrate in and flow through the magnetic member **40**, and creates a field between the side plates across the path of any arc drawn between the contacts as they separate. Thus, there is present the same combined effect hereinbefore described, of optimum arc gap maintenance and movement of the arc over the cool surfaces of the arc extinguishing member and bridging contact to facilitate and make more effective the tendency to quickly extinguish the arc.

Preferably a hood or hollow cover **50** of insulating material formed to permit the movement of the bridging contact **36** will be secured over and onto the insulating base **30** to protect the contacts and provide an arcing chamber. Between the upper surfaces of the fixed contact members **32** and **34** and the lower edge (as viewed in Fig. 5) of the hood **50**, there is a gap or spacing **52** for ventilation. Across this gap or spacing there is located a screen comprising a plate **54** of metal or insulating material perforated with a number of holes **55** near its lower edge. Said plate **54** extends from the stationary contact surface to the roof of the hood **50**. This screen, while permitting ventilation, tends to cool the arc gases as they pass through the holes **55** of the screen.

Against both sides of screen **54** lie arc cooling plates of high thermal conducting material. These plates extend down from the roof of the hood **50** to the area of the holes **55** and have their lower edges bent away at an oblique angle with the screen or plate **54**. Thus the inner plate **56** has its lower edge **57** bent inwardly while the outer plate **58** has its lower edge **59** bent outwardly. The inner plate comprises the primary arc cooling, deionizing, and directing means, while the outer plate **58** comprises a secondary arc cooling, thermal radiating, and fending means. The plates **54**, **56**, **58** may be held in place by slotting the hood at the points where the edges of the plates engage the hood, or in any similar manner. If the plate **54** is metallic and the edge **57** of the plate **56** is spaced the optimum gap from the end of the movable contact member, the edge **57** may act as an arc horn to which the arc would be attracted an caused to play against it in a cooling, deionizing and optimum manner. The combination of the primary and secondary arc controlling means with the screen or plate **54** will effectively limit the blowing out from the enclosure of any incandescent arc gases. Thus the escape of gases will take place at a temperature below incandescence or ionizing conditions.

In Fig. 7 there is illustrated a modified form of an arc suppressing member somewhat similar to the form in Figs. 5 and 6. In this form the side plates **61** and **62** of the arc extinguishing member **60** are cut away from their free edges inwardly toward the back plate **63**. The cut-away portions or slots **65**, **66** are adjacent the points of contact of the fixed and movable contact members. In width each slot equals the desired optimum gap. In length the parallel sides of each slot extend in to at least the point or line of contact of the bridging and fixed contact members. This tends to concentrate the magnetic flux at the areas of the arc suppressing member above and below the cut-away portions thereof. Otherwise the action of this form is like that of the previously described forms.

In some cases and under certain conditions the use of a magnetic cross field on high alternating-current arcs has been found disadvantageous. Recent researches have shown that such a field may lower the dielectric space factor in partially ionized atmospheres, thereby increasing the restriking voltage value and causing reignition and prolongation of the arc. To avoid this condition, the aforementioned slots or cut-away portions of the arc suppressing members are provided. Thus I have shaped the field in such a manner as to allow the arc to move out freely in the direction toward the plate **56**. Insofar as the theory and functioning of this feature of the invention are known and may be described, the arc takes place across an area in which the magnetic field is weak and thus the area is comparatively free of direct magnetic influence and is of optimum width. The concentrated cross field surrounding the slots prevents the arc length from becoming other than the desired optimum. As arcing occurs and tends to extend beyond this weak area in the field, there will be a tendency to move the arc out along the slot or gap towards the plate **56** while always maintaining the optimum arc length or distance. Therefore the strong magnetic field is used to prevent the arc being drawn out beyond the optimum distance when the contacts become separated a distance in excess of the optimum gap. I do not limit myself, however, to this theory of operation.

From the foregoing the construction and operation of the invention will be apparent. The invention is particularly useful in switching devices used in industrial conditions where relatively heavy currents must be interrupted frequently as large pieces of machinery are frequently stopped and started. The invention, however, is not limited to such use. Many modifications will occur to those skilled in the art. Therefore I do not limit the invention to the embodiments illustrated in the drawings.

This application is a continuation in part of my prior copending application Serial No. 494,828, filed July 15, 1943, now abandoned.

I claim:

1. In an electric switch for alternating currents, relatively movable contacts which establish, maintain and break the circuit in which they are connected, means to separate said contacts, a single conductive and magnetic means electrically connected with one of said contacts and having portions spaced from the other contact the optimum distance for arc suppression in the circuit in which said switch is used, and said conductive and magnetic means being positioned to create a magnetomotive arc attenuating effect on separation of the contacts, the arc incident to the circuit opening being carried by said contacts until said optimum distance is reached and thereafter playing between said conducting portion and said movable contact, the movement of said movable contact being restricted to the area between said conductive magnetic portions.

2. In an electric switch for alternating currents, relatively movable contacts which establish, maintain and break the circuit in which they are connected, a U-shaped conductive arc-carrying member having arms embracing the contacting surfaces of said contacts and electrically connected with one of said contacts, means to separate said contacts, said conductive member and contacts being positioned to maintain at all times during said separating movement that certain and predetermined distance between said other

contact and said conductive means which gives maximum arc extinguishing effect for the circuit conditions and characteristics in the circuit in which the switch is used, and said conductive member being magnetic, means to create a magnetic field between said arms of said conductive member for attenuating the arc occurring on contact separation, the arc incident to the circuit opening being carried by said contacts until said optimum distance is reached and thereafter playing upon said other contact and said arms.

3. In an electric switch for alternating currents, an insulating base, a fixed contact on said base, a movable contact for engaging said fixed contact, means to separate said fixed and movable contacts, conductive means having a portion spaced from said movable contact a predetermined optimum distance for maximum arc suppressing effect in the circuit in which said switch is used during the entire movement of said movable contact, and a single means to secure both said fixed contact and said conductive means upon said base and to electrically connect them, the arc incident to the circuit opening being carried by said contacts until said optimum distance is reached and thereafter transferring from said fixed contact to said spaced portion.

4. In an electric switch for alternating currents, a fixed contact, a movable contact engaged therewith and separable therefrom a distance at least equal to the optimum distance for most effective arc extinguishment in the circuit in which the contacts are connected, a conductive arc extinguishing and suppressing member associated with said contacts having parallel side plates, an end plate joining said side plates, said side plates extending parallel to and in the direction of separating movement of said movable contact from a point alongside said fixed contact to a point beyond the furthest possible separating movement of said movable contact, the side edges of said movable contact nearest said side plates being spaced from said side plates said optimum distance and maintaining said spacing during the entire separating movement of said movable contact, said fixed contact being electrically connected with said arc extinguishing member.

5. A device as claimed in claim 4 in which the arc extinguishing member is made of magnetic material to concentrate the magnetic flux across the arc path.

6. A device as claimed in claim 4 wherein one of said contacts is located in proximity to said arc extinguishing member to create a magnetic field therein.

7. A device as claimed in claim 4 wherein said movable contact partially loops around said arc extinguishing member to create a magnetic field therein.

8. A device as claimed in claim 4 wherein said movable contact has an arched portion and partially loops around the end plate of said arc extinguishing member, a part of said arched portion being spaced from said end plate said optimum distance, and the edges of said arched portion being spaced from said side plates said optimum distance, said spacings being maintained during the entire separating movement of said movable contact from said fixed contact.

9. A device as claimed in claim 4 in combination with an insulating base supporting said fixed contact and an insulating hollow cover over said base forming an arcing chamber and having an opening adjacent said fixed contact, a perforated insulating screen across said opening.

10. A device as claimed in claim 9 having a metallic non-magnetic arc fending plate between said screen and said contacts against which hot arc gases may move and be cooled, said arc fending plate having an inturned edge adjacent said contacts.

11. A device as claimed in claim 10 having a metallic non-magnetic plate on the opposite side of said screen from said contacts and having an outturned edge to cool and direct the outflow of arc gases.

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