Aug. 14, 1956 J. D. WOOD 2,759,073

HIGH VOLTAGE MAGNETIC ARC EXTINGUISHING MEANS

Filed Nov. 22, 1952 3 Sheets-Sheet 1

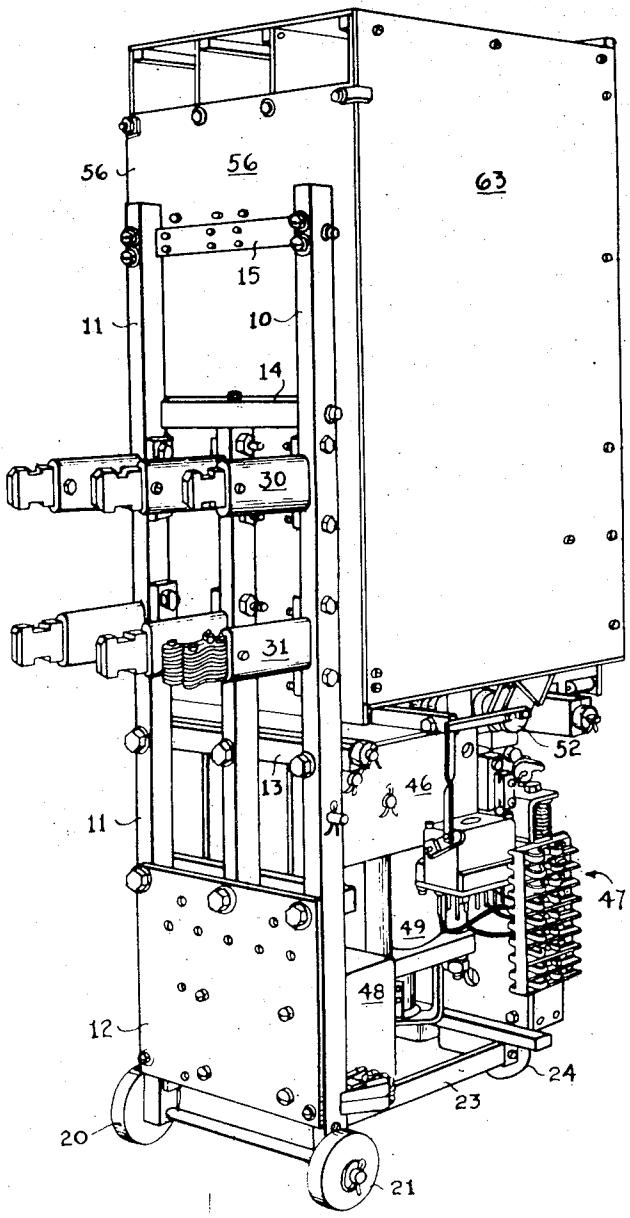


Fig. 1.

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HIGH VOLTAGE MAGNETIC ARC EXTINGUISHING MEANS

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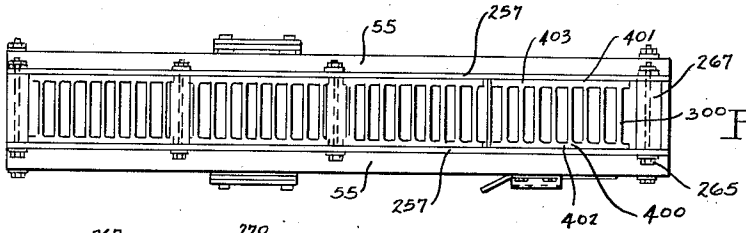


FIG. 4b

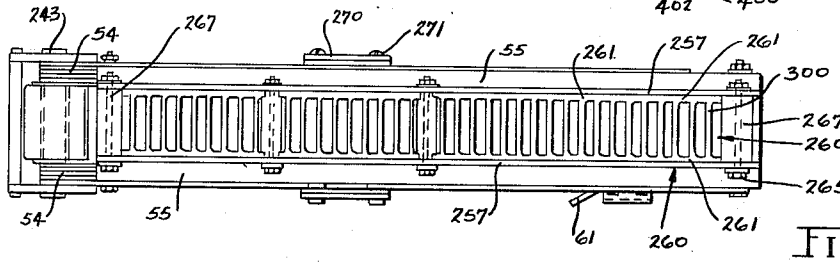


FIG. 4a

FIG. 3.

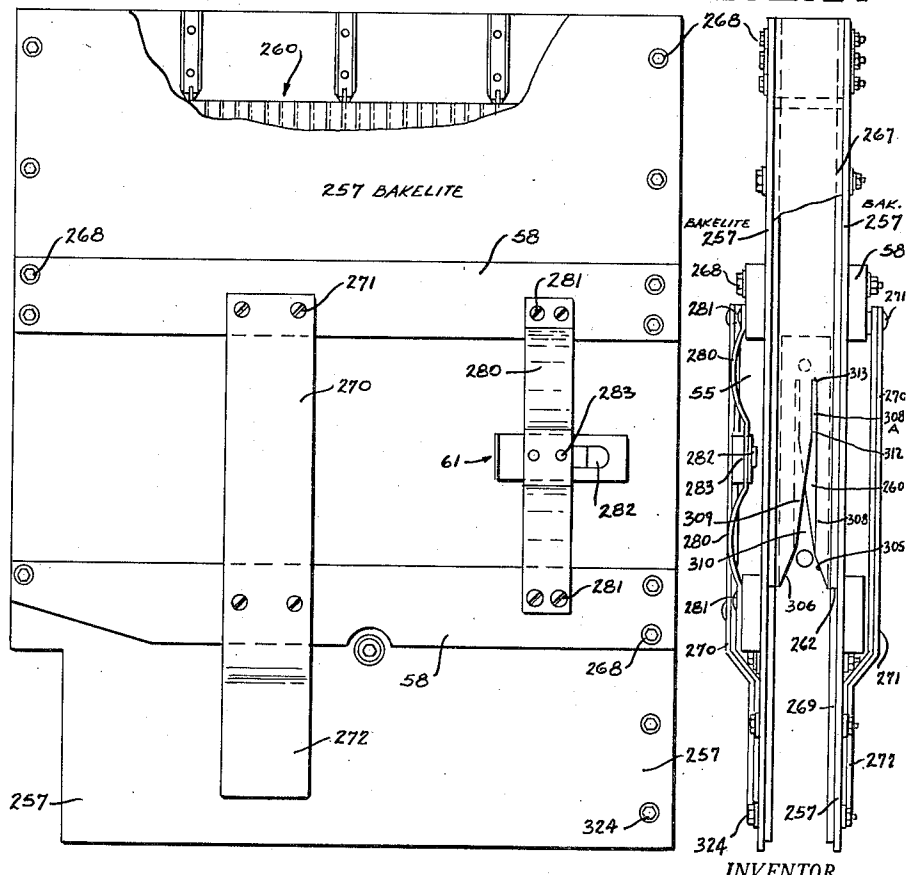


FIG. 2.

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FIG. 5A.

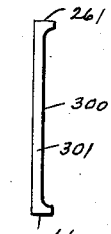


FIG. 6A.

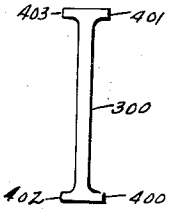


FIG. 5B.

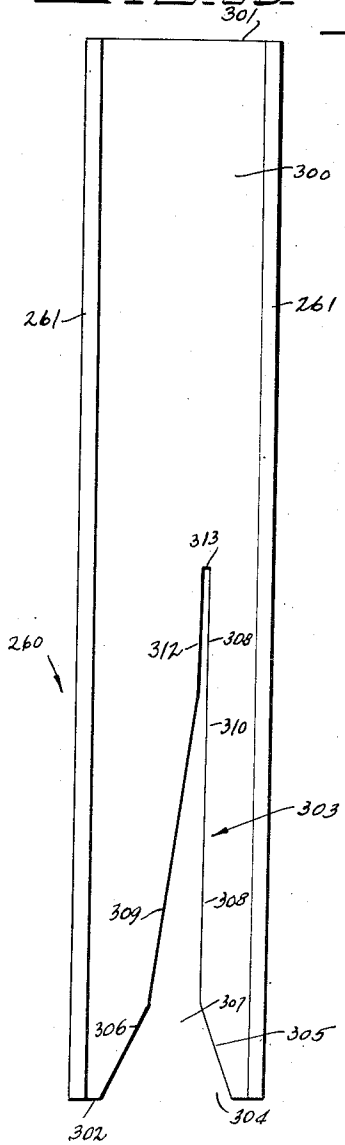


FIG. 5C.

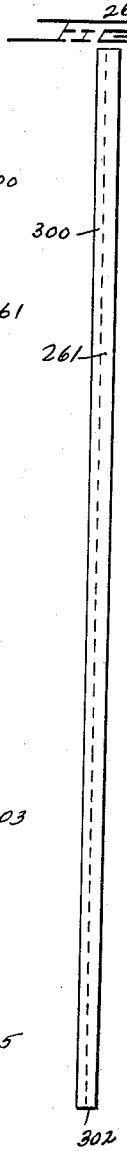


FIG. 6B.

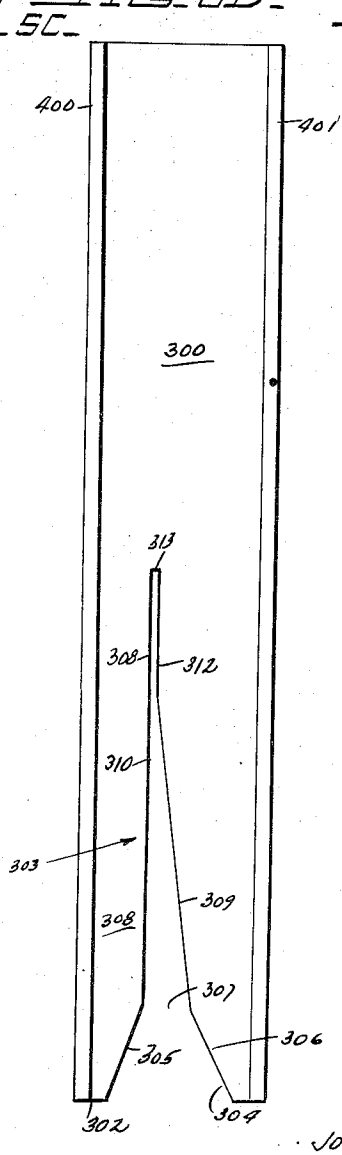
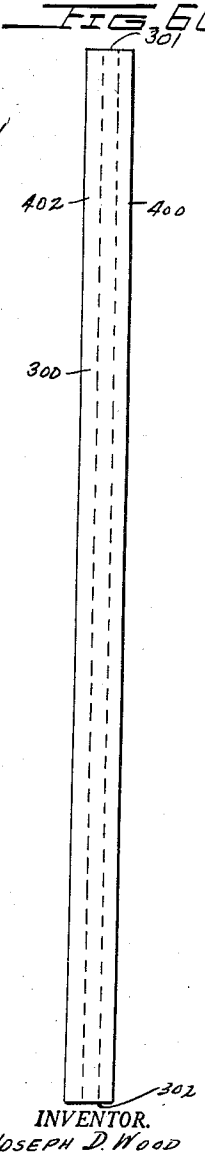


FIG. 6C.



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HIGH VOLTAGE MAGNETIC ARC EXTINGUISHING MEANS

Joseph D. Wood, Wayne, Pa., assignor to I-T-E Circuit Breaker Company, Philadelphia, Pa., a corporation of Pennsylvania

Application November 22, 1952, Serial No. 322,027

7 Claims. (Cl. 200—147)

My present invention is a continuation in part of application Serial No. 746,554, filed May 7, 1947, and is directed primarily to a novel arc chute structure including a novel arrangement and mounting for the arc extinguishing plates in the arc chute.

As pointed out in the above application, the circuit breaker in which my novel arc chute is to be mounted and with which my novel arc chute is to cooperate is a high voltage high capacity air break unit so arranged as to lend itself to mass production techniques by the utilization of individual relatively inexpensive sub-assemblies.

In a high voltage high capacity breaker the first and most important step involved is the construction of the arc chute and of the arc blow-out mechanism so that any arc which is drawn between the contacts as they open may be readily extinguished before damage to the breaker or to the circuit may occur.

My novel circuit breaker includes a simple unitary arc chute structure made as a single unit provided with a disconnect and so arranged that it may readily be mounted on the circuit breaker and connected thereto or removed therefrom as a whole without the necessity for special tools.

My novel arc chute thus combines the essential ideas of simplified construction for greater economy and simplified arrangement in the form of a single unit assembly which may readily be mounted on any circuit breaker of the class to which the arc chute is to be applied. The arc chute may readily be removed for inspection of the contacts of the circuit breaker or for replacement or repair of any part that may require such replacement or repair.

My novel arc chute is supported and carried entirely by my novel blow-out mechanism which in turn is secured to the main panel of the circuit breaker in a readily movable manner hereinafter described. The blow-out mechanism thus constitutes a unit sub-assembly by itself.

The blow-out mechanism comprises essentially a U-shaped iron structure, the base of which is surrounded by the blow-out coil and the legs of which extend out perpendicularly to the panel on which the circuit breaker is mounted. These legs of the U-shaped iron structure carry the arc chute; and the arc chute may be slid on to or off these legs for placement or removal.

As above pointed out, the blow-out iron circuit is made up of a core around which the blow-out coil is wound; to the ends of the core are attached the side plates which project forward nearly the entire depth of the arc chute. These plates also act as slides or runners and supports for the arc chute and the complete assembly is thus supported directly on the back panel support.

Heretofore in the construction of blow-out mechanisms, it has been found that a concentration of flux at the coil end occurs with solid side plates so that only the coil end of the arc chute is used.

In addition, and in order to enhance the blow-out effect, auxiliary blow-out iron plates are attached to the runner strip on each side of the arc chute and divert part of the main blow-out field down into the vicinity of the contact.

By this novel construction the blow-out structure and the arc chute structure are mechanically separated and independent of each other so that the arc chute is much lighter and easier to remove for inspection and so that the blow-out construction acts as a support for the arc chute.

The blow-out mechanism is so arranged that it may move an arc at low interrupting current as well as an arc at high interrupting current properly into the arc chute so that the same may be extinguished—the said blow-out mechanism operating for this purpose over the entire range of interrupting capacity of the circuit breaker without the necessity for additional aid or other expedients. This we achieve in part by passing only a portion of the arcing current through the blow-out coils, the percentage of such current decreasing as the fault current increases.

An important and primary object of my present invention is the provision in the structure and organization above described of a novel arc extinguishing plate, said plate being of insulating material and arranged to extend transversely of the path of the arc. A plurality of such plates are used in order to make up a parallel spaced plate arc chute. These plates are arranged vertically in an arc chute wherein the arc is drawn by substantial horizontal movement of the movable contact.

Each of the plates is provided with a vertical notch communicating with the lower part of the plate, the notch being arranged to one side of the vertical center line of the plate. By reversing successive plates with respect to each other the successive notches are arranged to force the arc drawn through the plates into a sinusoidal path, thereby lengthening the arc. Since the notches do not extend to the top of the plates the blow-out action, when the arc is driven toward the top of the arc chute, also produces a sinusoidal effect in a vertical plane.

The combination of the sinusoidal effect in the horizontal plane during the initial arc extinguishing action with the addition of the sinusoidal effect imposed on the arc in a vertical plane toward the top of the arc chute produces an effect of lengthening and cooling of the arc, which results in rapid and efficient extinguishment thereof.

The plates themselves are preferably made of a glass bonded mica composition which is for all practical purposes completely inert without emitting any gases or other material which may interfere with the required dielectric properties of the arc chute. The plates, of course, may be made of any suitable material which is sufficiently inert and of a sufficiently high dielectric to withstand the arc currents and temperatures.

The vertical notch is preferably a compound notch having a relatively wide bottom opening tapering at a relatively large angle to a smaller opening, thereby providing free access or entry of the arc into the plates.

Thereafter the notch tapers for a substantially greater distance at a smaller angle, providing for a gradual squeezing of the arc and the arc gases generated thereby. This second section of the notch then communicates with a relatively very narrow notch with substantially parallel sides which tends to squeeze the arc still further.

My invention further contemplates that the arc extinguishing plates have marginal flanges, preferably integral therewith, and serving as appropriate spacing elements for the arc extinguishing plates.

The foregoing and many other objects of my invention

will become apparent from the following description of the drawings in which:

Figure 1 is a side, back view in perspective, showing the type of circuit breaker which could use my novel arc chute.

Figure 2 is a side view of the arc chute assembly.

Figure 3 is a front view of the arc chute assembly.

Figure 4*a* is a top view of the arc chute assembly of Figure 3 having U-cross-section arc plates.

Figure 4*b* is a top view of the arc chute assembly of Figure 3 similar to Figure 4*a* but having I-cross-section arc plates.

Figure 5*a* shows a cross sectional view of an arc plate constructed in accordance with my invention.

Figure 5*b* shows a front view of the arc plate of Figure 5*a*.

Figure 5*c* shows a side view of the arc plates of Figures 5*a* and 5*b*.

Figure 6*a* shows a cross-sectional view of an arc plate having a different embodiment from that of Figure 5*a* and constructed in accordance with my invention.

Figure 6*b* shows a front view of the arc plate of Figure 6*a*.

Figure 6*c* shows a side view of the arc plate of Figures 6*a* and 6*b*.

Figure 1 shows a high speed, high capacity circuit breaker which could utilize the arc plates of my invention. A detailed description of the construction and operation of the circuit breaker of Figure 1 is given in copending application Serial No. 746,554 filed May 7, 1947, now Patent No. 2,646,481, dated July 21, 1953.

In general, a supporting structure comprising support members **10**, **11**, **12**, **13**, **14**, **15**, **20**, **21**, **23** and **24** support sub-assemblies such as the control panel assembly **47**, trip unit assembly **48** and the operating mechanism assembly **46**.

As specifically described in the above mentioned application, contact operating arms **52** project up from the operating mechanism assembly **46** are so constructed as to cause contact engagement to electrically connect the electric terminals **30** and **31**.

The contacts are positioned within the housing formed by the plates **56** and **63** as are the blow out assembly and the arc chute assembly to which my invention is directed.

Arc chute

The blow-out assembly serves as support for the arc chute described in Figures 2, 3, 4*a* and 4*b*. The arc chute assembly mounted above the contact assembly provides for a positive and efficient arc interruption. It consists of insulation side walls 275, front and back arc runners **291** and **290** respectively and a series of arc extinguishing plates **260** mounted in spaced relation transverse of the arc path and a strong magnetic blow-out field to force the arc into the arc chute.

The sides **257** (Figures 2, 4*a* and 4*b*) have fastened at their lower portion, adjacent the arcing area, inner arc resisting insulating plates **269**—**269** of special composition hereinafter described. The arc resisting plates **269** are chamfered along their upper edges at **262**—**262** to provide a straight locking edge for the cross plates **260** and the spacers **261**. The lower ends of the cross plates **260** and the spacers **261** are appropriately shaped to fit the chamfered edge **262**.

As the arc is driven into the chute by the magnetic field, it passes rapidly through the arc extinguishing plates **260**.

These plates as shown particularly in Figures 5*a*, 5*b*, 5*c*, 6*a*, 6*b* and 6*c* have a main transverse body **300** and vertical flange members **261**, **261** which serve, as shown in Figure 4*a*, to space the plates appropriately from each other. The upper edge **301** of each of the plates is substantially straight and the lower edge **302** of each of the plates is provided with an off-center vertical notch arrangement **303**. The vertical notch arrangement **303** has a wide opening **304** at the lower end tapering rapidly, as defined by the angle of the edges **305**, **306**, to a relatively narrow opening **307**. Thereafter, the edge **308** of the notch is substantially vertical while the edge **309** of the notch tapers at a substantially small angle to the vertical edge **310** where the notch edges are relatively very close together.

Thereafter, the two edges **308***a* and **312** defining the notch are parallel.

By way of example and in order to indicate the relative proportions, in an arc extinguishing plate having a height of 16 5/16 inches, the width of the opening at **304** would be 1¾ inches and the opening to the narrower notch at **307** would be 1.5 inches from the bottom of the plate. The opening at **310** to the still narrower parallel side of the notch would be 6.25 inches from the bottom of the plate and the distance from the bottom of the plate to the end **313** of the notch would be 8.25 inches.

The foregoing figures are given not as necessarily critical values, but primarily to indicate the relative proportions of the three parts of the single notch in the plate.

It will be seen that by making the initial opening **304** substantially central of the plate easy access of the arc into the stack of plates is provided. Thereafter, since the slope **306** is greater than the slope **305**, the notch is shifted to one side of the plate (toward the right with respect to Figure 5*b*).

Thereafter, by making the edge of the notch **308**—**308***a* vertical and continuous the slope **309** causes a further shift of the notch toward the right of the plate. Consequently, the notch is displaced toward one side of the plate and a reversal of successive plates produces a sinusoidal arrangement of the notch openings since the notch openings, particularly at the area of the notch defined by side wall **308**, are displaced laterally with respect to each other in successive plates.

As the arc passes the cross-over point of the plates it is forced into a zig-zag or sinuous path gradually but rapidly increasing its length and bringing it into contact with the larger and larger cool surfaces of the plates. The arc must thus bend around the edges of the plates which are effective in circuit interruption. The positive and efficient arc interruption is affected by the cooling, lengthening and squeezing of the arc at numerous points all along its path.

In addition to this kind of lengthening of the arc, the arc is, of course, further lengthened in a vertical plane by the sinusoidal squeezing thereof which occurs owing to the blow-out action moving the area of the arc above the top **313** of the notch in the plate. While the plates preferably are used with integral flanges **261** forming the spaces between them these provide the most efficient arc resistant spacing method. It will be obvious, of course, that the plates may also be mounted in the manner described in my aforementioned application, where they may be supported in matching grooves in opposite sides of the side walls in the arc extinguishing structure. By means of the flanges **261**, however, full support of the plates with respect to each other over their full length is provided and no part of the plate is loose or unsupported.

Figure 6*a* is an elevation of an I-cross-section arc extinguishing plate similar to that shown in Figure 5*a*. A cross-sectional view of this I-cross-section arc plate when assembled in the arc is shown in Figure 4*b*.

The plate **300** is preferably made of glass bonded mica composition which for all practical purposes is completely inert without emitting any gasses or other material which might interfere with the dielectric properties of the arc chute.

The plates **300** of Figures 6*a*, 6*b* and 6*c* may be thus of the same suitable material used for the plates of Figures 5*a*, 5*b* and 5*c* so that it is sufficiently inert and of sufficient dielectric to withstand the arc temperatures.

The modified arc plate of Figures 6*a*, 6*b* and 6*c* differs

from that shown in Figures 5a, 5b and 5c by providing an I-cross-section. That is, the integral flange 400—402 and the flange 401—403 extend on both sides of the base part of the plate 300.

As heretofore mentioned in connection with Figure 5a, the U-cross-section plates require that a right and left hand plate be manufactured for assembly in the arc chute. However, with the novel modification, as shown in Figures 6a, 6b and 6c, wherein the flanges extend on both sides of the base 300, the so-called right and left hand plates are of identical construction, hence greatly facilitating manufacturing and production thereof.

It will be noted that all portions of the flange serve as spacers for the arc plate 300 in substantially the same manner as set forth in connection with arc plates shown in Figures 4a, 5a, 5b and 5c.

In the foregoing I have described my invention solely in connection with specific illustrative embodiments thereof. Since many variations and modifications of my invention will now be obvious to those skilled in the art, I prefer to be bound not by the specific disclosures herein contained but only by the appended claims.

I claim:

1. In a high voltage circuit breaker comprising a main pair of cooperable contacts and an auxiliary pair of cooperating contacts; arc extinguishing means positioned above said cooperating contacts and comprising a magnetic yoke, a blow-out coil and a plurality of insulator plates; said magnetic yoke comprising a U-shaped member energized by said blow-out coil, said blow-out coil energized by the separation of said cooperating contacts, each of said plurality of insulator plates having a large center opening at the lower end thereof cooperating with an intermediate center slot which in turn cooperates with a vertical center slot, said large center opening being substantially symmetrical with respect to the vertical center line of said insulator plate, said intermediate center slot and said vertical center slot being positioned to one side of said vertical center line of said insulator plate.

2. In a high voltage circuit breaker comprising a main pair of cooperable contacts and an auxiliary pair of cooperating contacts; arc extinguishing means positioned above said cooperating contacts and comprisng a magnetic yoke, a blow-out coil and a plurality of insulator plates; said magnetic yoke comprising a U-shaped member energized by said blow-out coil, said blow-out coil energized by the separating of said cooperating contacts, said plurality of plates positioned in spaced parallel relation to each other and with said magnetic yoke, said insulator plates being made from a non-gas emitting material and having a first, second and third center slot located therein; said first center slot positioned at the bottom of said plate substantially symmetrical with respect to the vertical center line thereof, said second center slot progressively decreasing in width from a first end to a second end of said slot, said first end of said second center slot cooperating with said first center slot, said second end of said second center slot cooperating with said third center slot, said third center slot being of uniform width throughout and positioned on one side of the vertical center line of said plates, alternate plates of said arc extinguishing means having said third slot positioned on the same side of said vertical center line, adjacent plates having said third slot positioned on opposite sides of said vertical center line.

3. A plurality of insulator plates for an arc extinguisher made from a non-gas emitting material and positioned in spaced parallel relation, each of said plates having a first, second and third center slot located therein; said first center slot positioned at the bottom of said plate substantially symmetrical with respect to the vertical center line thereof, said second center slot progressively decreasing in width from a first end to a second end of said slot, said first end of said second center slot cooperating with said first center slot, said second end of said second center slot cooperating with said third center slot, said third center slot being of uniform width throughout and positioned on one side of the vertical center line of said plates, alternate plates of said arc extinguishing means having said third slot positioned on the same side of said vertical center line, adjacent plates having said third slot positioned on opposite sides of said vertical center line.

4. An arc plate for an arc extinguishing device made from an insulating material of glass bonded mica which is non-gas emitting and having a pair of integral flanges, said integral flanges extending on one side of said plates from the edge adjacent the ends thereof, said plates having a center slot having a first, second and third section; said first and second sections progressively decreasing in width from the bottom to the top of said arc plate, said first section decreasing in width at a greater rate than said second section, said third section having a uniform width throughout, said first section positioned substantially symmetrical on either side of the vertical center line of said plate, and said second center section positioned in a non-symmetrical manner with respect to said vertical center line and said third section positioned on one side of said vertical center line of said plate.

5. A circuit breaker comprising a movable contact arm, a contact engaged thereby in the closed position of the arm, an arc chute, a horn element for carrying the arc positioned above said engaged contact at one wall of the arc chute and electrically connected with said engaged contact, a second horn element for carrying the arc electrically disconnected from said first named element and from said contact arm and positioned at the opposite wall of the arc chute, said arc chute comprising a plurality of insulator plates for an arc extinguisher made from a non-gas emitting material and positioned in spaced parallel relation, each of said plates having a first, second and third center slot located therein; said first center slot positioned at the bottom of said plate substantially symmetrical with respect to the vertical center line thereof, said second center slot progressively decreasing in width from a first end to a second end of said slot, said first end of said second center slot cooperating with said first center slot, said second end of said second center slot cooperating with said third center slot, said third center slot being of uniform width throughout and positioned on one side of the vertical center line of said plates, alternate plates of said arc extinguishing means having said third slot positioned on the same side of said vertical center line, adjacent plates having said third slot positioned on opposite sides of said vertical center line.

6. An arc plate for an arc extinguishing device made from an insulating material of glass bonded mica which is non-gas emitting and having a pair of integral flanges, said integral flanges extending on both sides of said plates from the edge adjacent the ends thereof, said plates having a center slot having a first, second and third section; said first and second sections progressively decreasing in width from the bottom to the top of said arc plate, said first section decreasing in width at a greater rate than said second section, said third section having a uniform width throughout, said first section positioned substantially symmetrical on either side of the vertical center line of said plate, and said second center section positioned in a non-symmetrical manner with respect to said vertical center line and said third section positioned on one side of said vertical center line of said plate.

7. A plurality of insulator plates for an arc extinguishing device, each of said plurality of insulator plates made from an insulating material of glass bonded mica which is non-gas emitting and having a pair of integral flanges; said integral flanges being constructed to position said plurality of insulator plates in spaced parallel relation; said plates having a center slot having a first, second and third section; said first and second sections progressively decreasing in width from the bottom to the top of said arc plates, said first section decreasing in width at a

greater rate than said second section, said third section having a uniform width throughout, said first section positioned substantially symmetrical on either side of the vertical center line of said plate, and said second center section positioned in a non-symmetrical manner with respect to said vertical center line and said third section positioned on one side of said vertical center line of said plate.

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