Sept. 6, 1955 C. J. BALENTINE 2,717,294

ELECTRIC CIRCUIT INTERRUPTER

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Fig. 1.

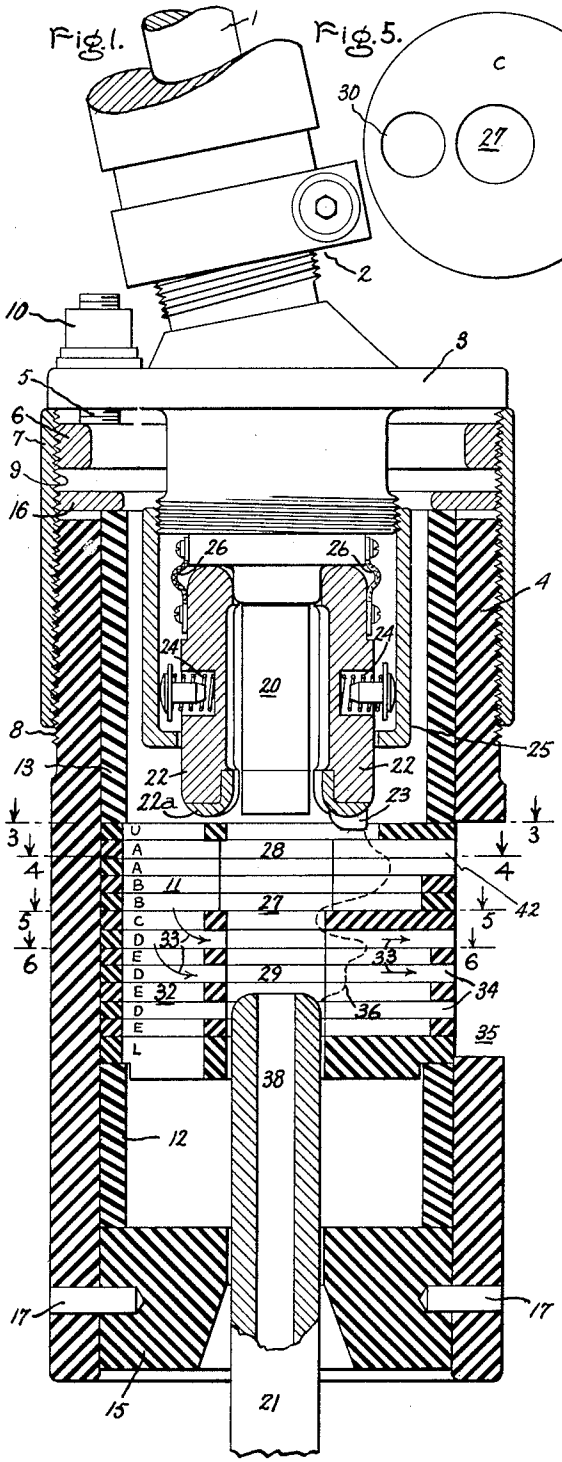


Fig. 5.

Fig. 2.

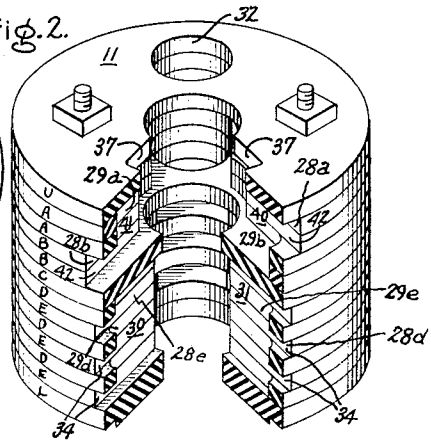


Fig. 3.

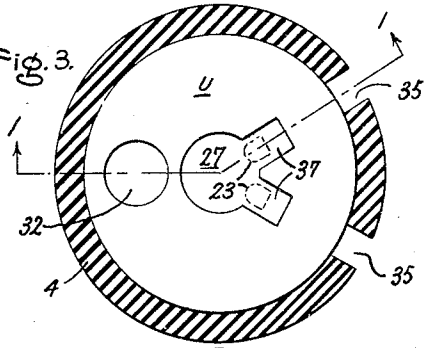


Fig. 4.

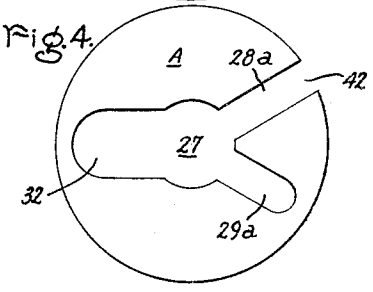
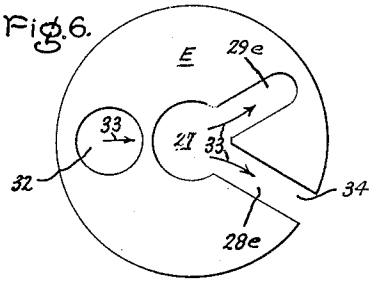


Fig. 6.



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Fig. 8.

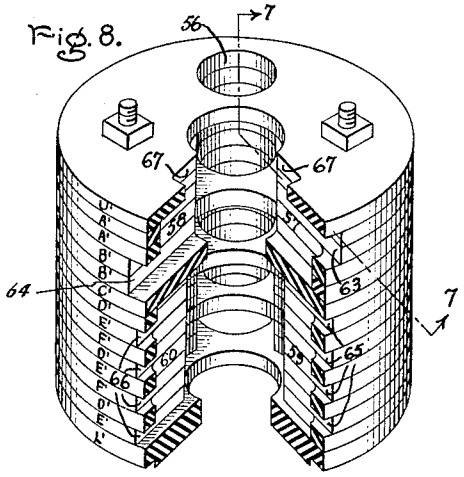


Fig. 7.

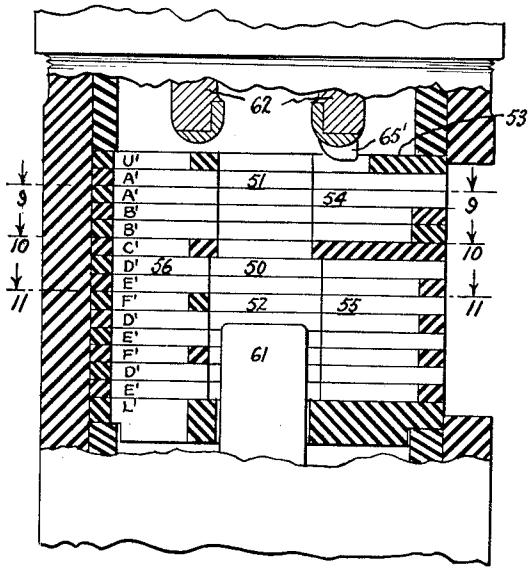


Fig. 9.

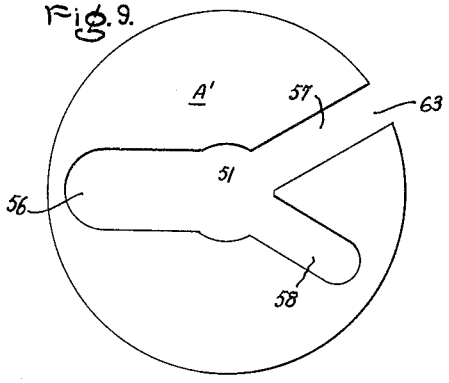


Fig. 10.

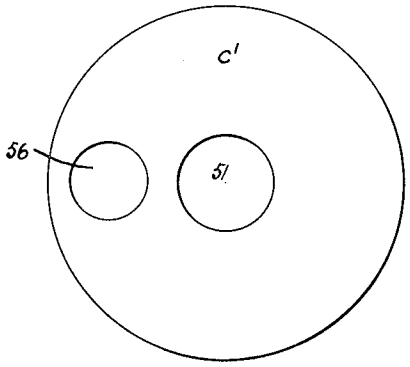
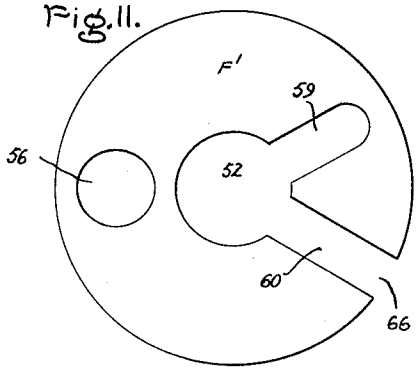


Fig. 11.



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United States Patent Office

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ELECTRIC CIRCUIT INTERRUPTER

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Application February 20, 1953, Serial No. 337,997

2 Claims. (Cl. 200—150)

My invention relates to electric circuit interrupters and more particularly to high speed circuit breakers of the fluid-blast type for opening alternating current power circuits within a few half cycles.

More specifically, my invention constitutes a further development, improvement, and simplification of the general type of circuit interrupter disclosed in my U. S. Patent 2,545,334, which is assigned to the assignee of the present application.

It is a continuing objective in oil-blast power circuit breaker design to reduce arcing times so as to obtain, among other advantages, a reduction in contact erosion and in oil deterioration. This desired objective has been attained in my invention by designing the interrupter in such a manner that a high degree of control over the arc and the pressure generated by the arc is obtained.

In accordance with my invention this desired degree of control has been achieved, in part, by constructing the baffle stack, usually associated with this type of fluid-blast interrupter, of a novel form whereby it is sectionalized into an upper and lower chamber by a division baffle. The upper and lower chambers, through which a single arc may be drawn, have features which cooperate with the division baffle in such a manner that there are provided upper and lower arc-extinguishing agencies arranged closely in series, the upper agency being especially adapted to promote rapid interruption of extreme large and extreme small current arcs and the lower agency being especially adapted to promote the rapid interruption of medium current arcs.

It is a principal object of my invention to provide a new, simplified, and improved circuit interrupter which effects more rapid arc extinction by a closer control of the arc and the arc-generated pressure within the interrupter.

It is another object of my invention to insure that the single arc is initiated and maintained in the precise location within the interrupter where it is most vulnerable to extinction by the fluid blast.

It is still another object of my invention to form the exhaust vents of the interrupter unit of such relative sizes that those difficulties usually associated with the interruption of the extreme high and low currents of the interrupting range are avoided to a large degree.

Further objects and advantages of my invention will become apparent as the following description proceeds, and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

In the drawings, Fig. 1 represents a sectional view taken along the line 1—1 of Fig. 3;

Fig. 2 is a perspective view partly in section of the baffle stack of Fig. 1;

Fig. 3 is a sectional view taken across the top of the baffle stack along the line 3—3 of Fig. 1;

Fig. 4 is a plan view of one of the venting baffles as seen from line 4—4 of Fig. 1;

Fig. 5 is a plan view of another of the baffles, the division baffle, as seen from line 5—5 of Fig. 1;

Fig. 6 is a plan view of still another of the venting baffles as seen from line 6—6 of Fig. 1;

Fig. 7 represents a second embodiment of my invention as seen in an elevation view partly in section taken along the line 7—7 of Fig. 8;

Fig. 8 is a perspective view partly in section of the baffle stack used in Fig. 7;

Fig. 9 is a plan view of one of the venting baffles as seen from line 9—9 of Fig. 7;

Fig. 10 is a plan view of another of the baffles, the division baffle, as seen from line 10—10 of Fig. 7;

Fig. 11 is a plan view of still another of the venting baffles as seen from line 11—11 of Fig. 7.

The embodiment of my invention disclosed in Figs. 1–6 for convenience may be identified as the "lower voltage" design, whereas the embodiment disclosed in Figs. 7–11 may be identified as the "higher voltage" design, although tests have shown that both operate almost equally well for the greater part of the interrupting range over which such devices, singly or by compounding, are usually applied, say 15–330 kv.

The interrupting unit shown in Fig. 1 is adapted to be mounted, along with another similar unit (not shown), inside a relatively large oil-filled enclosing tank of a conventional tank-type circuit breaker. These two interrupting units would cooperate with a reciprocating blade contact (not shown) such as is disclosed in U. S. Patent 1,548,799 to Hilliard, which is assigned to the same assignee as the present application.

With reference to Fig. 1, the interrupting unit is supported within the oil-filled tank from a conductor stud 1 of an inclined electric bushing, being secured thereto by suitable clamping means indicated generally at 2. An adapter 3, which forms a part of the interrupting unit, is constructed and arranged in a well-known manner to support the enclosing, pressure-confining casing 4 by means of studs 5, supporting ring 6 and shell 7. More particularly, shell 7 has internal threads 9 which cooperate at 8 with mating threads formed on casing 4. The supporting ring 6 rigidly carries studs 5 passing through suitable apertures in adapter 3 and has external threads meshing with the threads of shell 7. Thus, by tightening clamping nuts 10, which are applied to the ends of the studs 5, the casing 4 may be rigidly secured to and supported from the adapter 3 and conductor stud 1.

A baffle stack 11 is rigidly mounted within casing 4 by means of cylindrical spacer sleeves 12 and 13 held against opposite ends of the baffle stack 11 by a throat member 15 and adjustable clamping ring 16. The throat member 15 may be secured in place within the casing 4 by conventional means such as dowel pins 17. The adjustable clamping ring 16 has a threaded periphery which cooperates with the threads 9 on shell 7 to provide an adjustable means for compressively retaining sleeves 12 and 13 and baffle stack 11 against the fixed throat member 15.

The contact structure disposed within the casing 4 comprises a stationary contact assembly generally indi-

cated at 20 and a rod-type movable contact 21, which is shown in open position in Fig. 1. The stationary contact structure is a tulip-type cluster of contact fingers 22 which are generally conventional except for an arrangement of arcing tips or electrodes 23 which are applied to certain of the contact fingers 22 for a special purpose to be described in greater detail hereinafter. In a conventional manner, the fingers 22, which may be tipped with arc-resistant material as shown at 22*a*, are radially-inwardly biased by suitable spring means 24 interposed between the fingers 22 and a contact retainer 25 so that these fingers resiliently embrace with appropriate pressure the reciprocable contact 21 when the interrupter is in closed position. Suitable flexible connecting braid 26 assures that electrical contact will be maintained between the fingers 22 and the adapter 3.

The baffle structure 11 comprises a plurality of superimposed insulating baffles or plates U, A, B, C, D, E, and L, which may be rigidly bolted together to constitute a sub-assembly as in Fig. 2. These baffles are formed with cooperating central apertures which define a main, axially-extending arc passage 27 for the arc which is drawn when the movable contact 21 is withdrawn at high speed from the fixed contact assembly 20. In addition, the baffles have cooperating apertures which define passages for controlling the arc-generated pressure and for directing a cross-blast of fluid into the path of the arc. More particularly, the baffle stack comprises a top baffle U shown in detail in Figs. 2 and 3; baffles A adjacent thereto and shown in detail in Fig. 4; baffles B, each of which is simply baffle A laid on its reverse face; division baffle or barrier C shown in detail in Fig. 5; baffle D which is identical to baffle A except that the central arc passage opening of baffle D is smaller than that of baffle A; baffle E which is shown in detail in Fig. 6; and a lower baffle L which comprises the ported bottom plate of the stack sub-assembly. Division baffle C divides the baffle stack 11 into what may be termed an upper and a lower pressure chamber. With the baffles arranged in the order described above, the main arc passage 27 in the upper chamber has a bore 28 substantially different from the bore 29 of the lower chamber. In the lower voltage design of Figs. 1–6, the upper bore 28 is substantially larger than the lower bore 29, the latter having a relatively small clearance about the rod contact 21. This feature of different size bores for upper and lower portions of the main arc passage forms a contributory important part of my invention which is explained in greater detail hereinafter.

As may be seen in the drawings, all of the above-described baffles are formed with registering hole or slot-type apertures which collectively define the vertical blast duct 32 disposed at one side of the arc passage 27. At a generally opposite side of the arc passage 27 the baffles A and B are respectively formed with opened end slots 28*a* and 28*b* and closed end slots 29*a* and 29*b* associated in V relationship in a manner similar to that shown in my above-mentioned U. S. Patent 2,545,334. These slots 28*a* and 28*b* define divergent supplementary arc-confining passages 40 and 41 terminating in a pair of offset or angularly displaced vents 42 in the upper chamber. In a corresponding manner, baffles D and E of the lower chamber of the baffle stack are formed with opened end slots 28*d* and 28*e* and closed end slots 29*d* and 29*e*. These slots in the lower chamber are associated in V relation in the same manner as the slots of the upper chamber and define divergent supplementary arc-confining passages 30 and 31 terminating in a series of offset vents 34 in the lower chamber. From Fig. 2 it will be seen that the divergent arc-confining passages 40, 41 in the upper chamber are in substantial angular alignment with corresponding arc-confining passages 30, 31 in the lower chamber. Similarly, corresponding exhaust vents 34 and 42 of the two chambers are in substantial angular alignment down the sides of the baffle stack. It should be noted that exhaust vents 42 in the upper chamber are made comparatively large in relation to the exhaust vents in the lower chamber for reasons to be explained in greater details hereinafter. The baffle stack vents 42 and 34 register with vertically extending exhaust ports 35 formed in the casing 4 to provide for immediately discharging the ionized products of arcing into the surrounding cool un-ionized oil.

The operation of the interrupter is as follows. When the circuit breaker is tripped open, the movable contact 21 is rapidly withdrawn from its closed position toward the position of Fig. 1. This downward movement of contact 21 initiates an arc between the fixed and movable contacts. This arc reacts with the immediately surrounding oil to generate within the upper portion of the baffle stack a gaseous bubble, the pressure from which drives fluid down the blast duct 32 and transversely across the path of the arc as said arc is drawn by the moving contact tip into the lower chamber. The flow pattern is generally indicated by the arrows 33 of Figs. 1 and 6. This cross-blast of fluid is effective to rapidly extinguish the arc, since it bows the arc into an arc confining passage 30 or 31, as illustrated at 36 in Fig. 1, in which position the arc is effectively elongated about the division baffle C, which forms a barrier between the upper and lower supplementary arc-confining passages, and is subjected to a highly intensified cross-blasting action. The fluid blast sweeps the arc products out into the surrounding dielectric fluid through the vents 34 and exhaust ports 35. The divergent passages 30 and 31 constitute pockets for holding the arc entrapped therein for blasting by the arc-extinguishing fluids. The closed ends of the slots 29*d* and 29*e* constitute arc retaining barriers which, nevertheless, do not prevent the flow of arc gases from within the arcing passage 27, so that the latter may be immediately filled with fresh dielectric fluid after the arc is extinguished at a current zero.

Since it is apparent from the above description that the arc is most vulnerable when displaced sidewise into a divergent pocket 30 or 31, I encourage the arc from its inception to assume this favorable displaced position by providing an extended arcing tip 23 for each of the two stationary contact fingers 23 which lie in vertical and angular alignment with the two legs of the V pockets. Thus the arc is drawn at least from one or the other of these tips for displacement immediately into a favorable pocketed position either for obtaining instant blasting and pressure relief through the larger upper vents 42 in the case of heavy current arcs; or, in the case of lighter current arcs, of being drawn further into the lower chamber below the division baffle C and displaced by cross-blast action for venting through the smaller lower vents 34. Such a lighter, or medium current arc might be as indicated by the wavy dotted line 36 in Fig. 1. For receiving the arcing tips 23 therein, short slots 37 in registering relationship with the legs of the V pockets are provided in the upper baffle U as seen in Fig. 2.

Although the presence of the division barrier in producing the stepped change in the bores of the upper and lower chambers inherently improves the creepage path conditions along the sidewalls of the arc passage, thereby to minimize restriking of the extinguished arc, the chief function of the barrier is to afford two arc-extinguishing agencies arranged closely in series.

Thus, for very heavy current interruptions intense pressure is generated which can relieve itself immediately through the large vents 42 so that the arc explosively can blast itself out while the central opening in the division baffle is yet substantially closed off by the rod contact. Excessive pressures also may find additional relief through the bore 38 of the tubular rod contact 21. During this interruption of heavy currents the division baffle C, through its cooperation with contact 21, substantially closes off the vents 34 of the lower chamber, thereby preventing too rapid dissipation of the arc-generated pressure in the upper chamber.

For medium current arcs, however, lower pressures

are generated and the arc will continue to be drawn downwardly into the lower chamber where it will be subjected to the cross-blast action of the fluid displaced from the upper chamber through the aperture **32** in the division baffle C, and out through the smaller vents **34**, as indicated by the flow arrows **33**. It has been found by tests that the relative sizes of the vents **34** and **42** is most important, so that in conjunction with the stepped change from the upper chamber to the lower chamber afforded by the division baffle, the interrupter of my invention also requires the combination of the suddenly stepped-down exhaust vents from a large area in the upper chamber to a comparatively small venting area in the lower chamber, e. g., where the two larger vents **42** are rectangular apertures approximately ⅝" x ½"; the smaller vents **34** are ⅜" x ¼" or 3/10 the area. Since the large current arcs are interrupted in the upper chamber, as previously explained, the lower chamber is generally required to handle only medium and low current arcs, that is, arcs of lesser diameter than the high current arcs interrupted in the upper chamber. In order to effectively provide for such smaller arcs, the vents **34** of the lower chamber must be relatively small so as to effectively confine the arc within a supplementary arc passage **30** or **31** so that it is prevented from being looped outward through the vents **34** and established exterior to the baffle stack. Thus, these large and small vents may be considered as constituting appropriate venting apertures adapted for large and small currents respectively, where large and small current arcs are thought of as having commensurate physical diameters.

The large initial vents **42** not only are favorable for extreme high current arcs, as previously described, but are also favorable for extreme low current arcs. For example, during such low current interruptions, large initial vent openings like those at **42** will permit the ready influx of oil from the surrounding oil-filled tank, thereby filling up the space induced by the rapidly receding movable contact **21**, which is producing but a comparatively weak arc and a resulting low pressure. Such light current arcs may persist until they are drawn by the moving contact into the sub-chamber provided for this purpose between the baffle stack and the throat member **15** of the interrupter casing. Pressure generated in this sub-chamber may produce fluid flow upward therefrom into the blast duct **32** to aid in the cross-blast represented by the arrows **33**. Invariably the circuit is interrupted before the tip of the rod contact **21** leaves the interrupter.

From this description of the operating features of my interrupter, it should be apparent that I have provided a design which utilizes a plurality of closely cooperating features to obtain a high degree of control over various arcs and their arc-generated pressures.

The "higher voltage" embodiment of my invention shown in Figs. 7–11 is constructed in a manner very much similar to the embodiment of Figs. 1–6. The only practical difference between these two embodiments is that in the device of Figs. 7–11 the main arc passage **50** has its upper portion **51** of a substantially smaller bore than the lower portion **52**, instead of vice versa, as in Figs. 1–6.

As may be seen from Figs. 7 and 8, the baffle stack **53** comprises a plurality of baffle plates U', A', B', C', D', E', F', and L', bolted together and sectionalized into an upper chamber **54** and a lower chamber **55** by division baffle C'. Suitably registering apertures in the superimposed baffles define a vertical blast duct **56**, divergent supplementary arc-confining passages **57** and **58** in the upper chamber, and divergent supplementary arc-confining passages **59** and **60** in the lower chamber in the same manner as described in connection with the first embodiment.

To open the circuit, movable contact **61** is rapidly withdrawn from fixed contact assembly **62**, thereby drawing an arc between the two contacts. Depending upon the value of current being interrupted, the arc may be drawn through the successive regions of the interrupter as already explained. Since this blast action is almost identical to that described with respect to Figs. 1–6, no further detailed description is considered to be necessary. The cross-sectional area of the vents **63** and **64** in the upper chamber is substantailly greater than the cross-sectional area of the vents **65** and **66** in the lower chamber. This difference in cross-sectional area of the vents contributes to the same result as described in connection with Figs. 1–6. Similarly, arcing tips **65'** are received in slots **67** in the same manner and for the same reasons as described with respect to arcing tips **23** (Figs. 1 and 3).

The division baffle C' cooperates with the structural features of the upper and lower chambers **54** and **55** to carry out substantially the same functions as attributed to baffle C in Figs. 1–6. Although it might be logical to suppose that the second-described interrupter embodiment of Figs. 7–8 is the more appropriate for the higher voltage application in that the clearance of the lower chamber about the receding rod or tubular contact is greater, tests have shown this to be not a critical factor; the important feature appearing to be that the division baffle C or C', constitutes a step, either up or down, in the bore size of the arcing passage and a dividing means between the upper and lower chambers of the interrupter of my invention.

While there has been shown and described a particular embodiment of the invention, it will be obvious to those skilled in the art that changes and modifications may be made without departing from the invention, and that it is intended by the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

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

1. A fluid-blast type of interrupting unit having means for drawing an arc and establishing a pressure therein comprising a composite assembly of stacked insulating baffle plates, an intermedaite one of said stacked plates constituting a division baffle fixedly positioned in said assembly and sectionalizing said assembly into a first and second chamber, said first chamber being located adjacent the point at which the arc is initiated, openings in said plates defining a main arc passage extending through said chambers and said division baffle, said openings further defining a first supplementary vented arcing passage for said first chamber disposed adjacent said main arc passage on one side of said division baffle and a second supplementary vented arcing passage for said second chamber disposed adjacent said main arcing passage on the opposite side of said division baffle, a blast duct communicating betwen said chambers and adapted to direct a blast of fluid across said arc passage and into one of said supplementary arcing passages, said supplementary arcing passages terminating in vents, the vent from said first supplementary arcing passage being substantially larger than the vents from said second supplementary arcing passage.

2. In a fluid blast interrupting unit having a generally fixed contact and a movable contact separable to draw an arc and establish a pressure within said unit, a composite assembly of stacked baffle plates, an intermediate one of said stacked plates constituting a division baffle sectionalizing said assembly into a first and a second chamber, said first chamber being located between said second chamber and said fixed contact, said plates having openings defining a main arc passage receiving said movable contact and extending through said chambers and said division baffle, the portion of said main arc passage in one of said chambers having a substantially greater clearance with respect to said movable contact than that portion of the main arc passage which extends through said division baffle and the other of said chambers, a first supplementary vented arcing passage for said

first chamber disposed adjacent said main arc passage on one side of said division baffle, a second supplementary vented arcing passage for said second chamber disposed adjacent said main arc passage on the opposite side of said division baffle, a blast duct communicating between said chambers and adapted to direct a blast of fluid into one of said supplementary arcing passages, said supplementary arcing passages terminating in vents, the vent from said first supplementary arcing passage being substantially larger than the vent from said second supplementary arcing passage.

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