Jan. 27, 1959 R. E. FRINK 2,871,318

CIRCUIT INTERRUPTER

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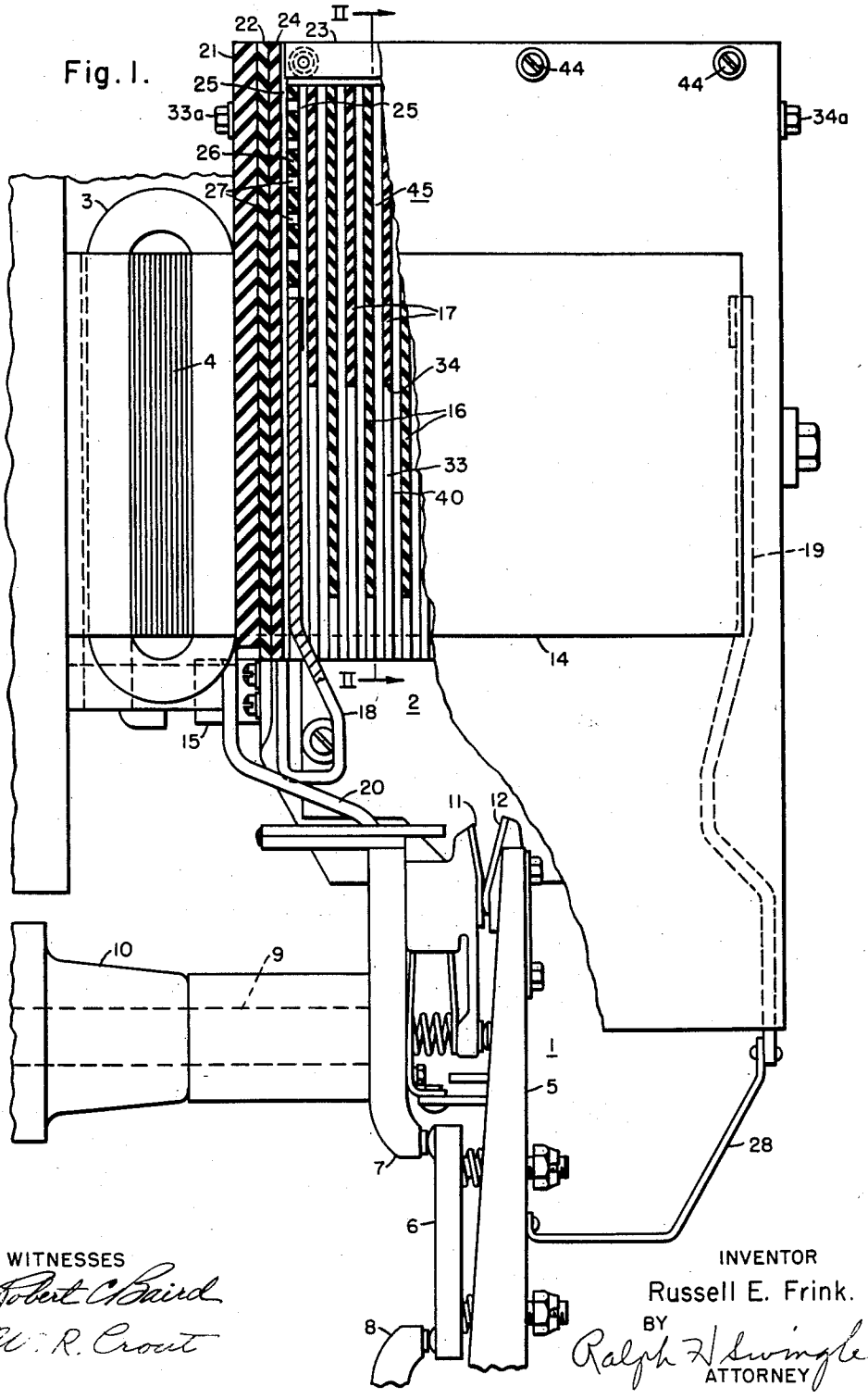
Fig. 1.



WITNESSES

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Fig. 2.

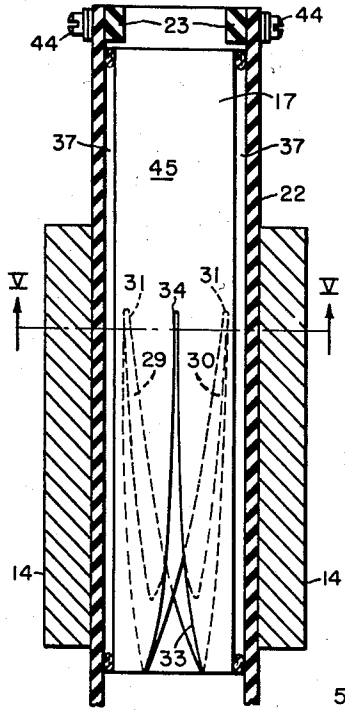


Fig. 3.

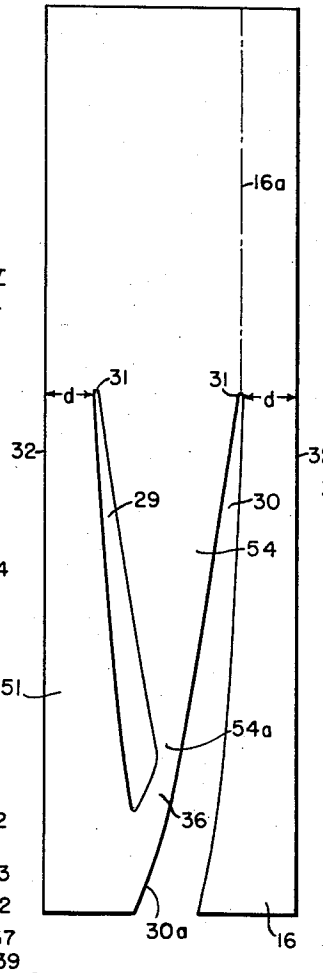


Fig. 4.

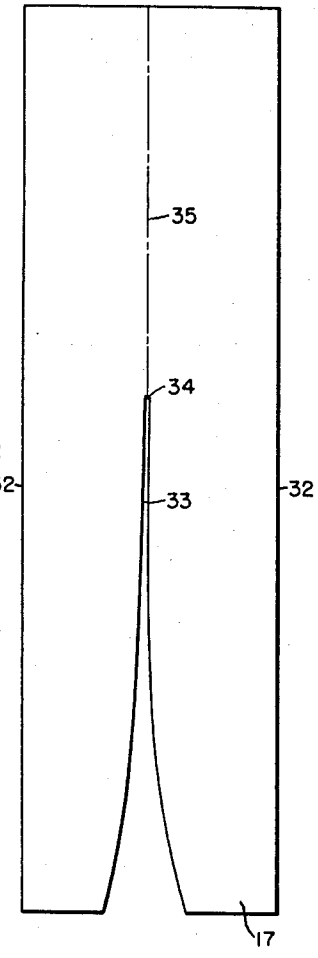


Fig. 5.

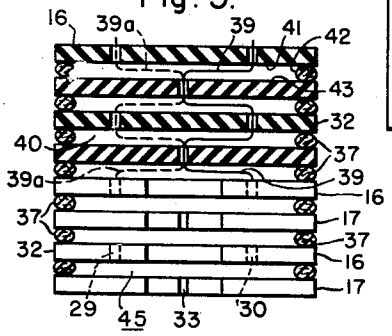
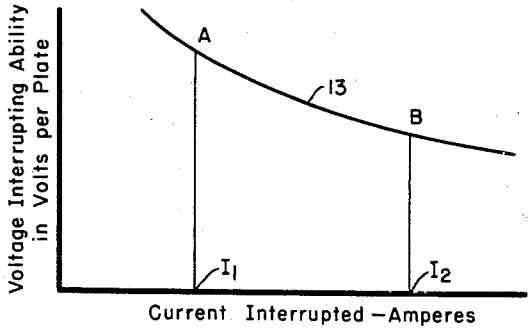


Fig. 6.



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CIRCUIT INTERRUPTER

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Application April 7, 1955, Serial No. 499,970

5 Claims. (Cl. 200—144)

This invention relates to circuit interrupters in general, and, more particularly, to arc-extinguishing structures therefor.

In United States Patent 2,442,199, issued May 25, 1948, to Robert C. Dickinson and Russell E. Frink, and which was assigned to the assignee of the instant application, there is shown and described an arc-extinguishing structure for circuit interrupters of the air break type, in which arc extinction is accomplished by the lateral movement of an established arc toward the closed ends of a series of tapered slots formed in spaced plates of insulating material. Lateral movement of the arc is obtained by a magnetic field produced by a magnetic blowout coil and magnetic field poles. This magnetic field is also relied upon to produce a blast of unionized gas through the arc while the arc is held substantially immovable against the closed ends of the slots in the plates of insulating material. It is a general object of the present invention to improve the plate or insulating barrier construction in a magnetic type of circuit interrupter so as to obtain more effective performance.

Generally speaking, interrupters of the foregoing type display a volt-ampere characteristic such that for a given current value, there is a maximum voltage interrupting ability, which may be stated in volts per plate. If the number of plates is doubled, and proper field strength, venting, etc., maintained, the voltage interrupting ability at the same current is doubled. Conversely, if the current to be interrupted is increased, the maximum voltage interrupting capacity per plate is correspondingly decreased. It is an additional object of the invention to provide an improved arc chute of insulating material in which the established arc may have axial portions thereof subdivided into parallel lengths to decrease the heating effect upon the extinguishing means of insulating material and thereby bring about an increased voltage interrupting ability per unit of insulating means.

Another object of the invention is to provide an improved arc chute for a circuit interrupter, particularly one of the magnetic air-break type, comprising a plurality of spaced plate portions, which may be either separate rectangular plates disposed in suitable slots along the walls of the arc chute, or an interleaving fin construction, in which certain of the plate portions or interleaving fins are provided with a substantially centrally disposed spot portion, and one or more adjacently disposed plate portions or fin members may be provided with pairs of spaced slots.

As indicated in the preceding paragraph, it is to be clearly understood that although the invention is described hereinafter as applied to an arc chute of the type comprising a plurality of rectangularly-shaped, separate plates stacked on top of one another and disposed within an arc-chute housing, nevertheless it will be apparent to those skilled in the art that certain features of the invention may be readily applied to the interleaving fin type of arc chute, in which plate portions are integrally formed with an arc-chute side wall member, and such plate portions are interleaved upon the assembly of the arc chute.

Still a further object of the invention is to provide an improved circuit interrupter of the spaced plate type, in which certain portions of the established arc may be moved into centrally disposed slots provided in one or more spaced plate portions, and adjacent axial lengths of the arc may be subdivided into parallel arc portions by the provision of other plate portions having spaced slots therein.

Further objects and advantages will readily become apparent upon reading the following specification, taken in conjunction with the drawings, in which:

Figure 1 is a side elevational view, partially in vertical section, of an air-break type of circuit interrupter, embodying the invention and shown in the closed circuit position;

Fig. 2 is a vertical sectional view taken substantially along the line II—II of Fig. 1, looking in the direction of the arrows;

Figs. 3 and 4 are enlarged plan views of certain plate portions utilized in the assembly of the arc-chute structure;

Fig. 5 is a fragmentary, enlarged, inverted sectional view taken substantially along the line V—V of Fig. 2, illustrating the manner of arc extinction; and

Fig. 6 is a graph of the volt-ampere characteristics of a typical circuit interrupter of the spaced slotted plate type.

Referring to the drawings, and more particularly to Fig. 1 thereof, the reference numeral 1 generally designates suitable contact structure which, when separated to the open circuit position, establishes an arc which is moved upwardly into an arc chute, generally designated by the reference numeral 2, as a result of the transverse magnetic field set up by the blowout coil 3 and associated magnetic structure 4. A rotatable contact arm 5 carries a conducting bridge 6 which, in the closed circuit position, as shown in Fig. 1, interconnects stationary main contacts 7, 8.

A contact stud 9 carries the current from the stationary main contact 7, through an insulating bushing 10 to the external circuit. The contact stud for the stationary main contact 8 is not shown, but it may be identical to the contact stud 9.

Consequently, in the closed-circuit position of the interrupter, as shown in Fig. 1, the electrical circuit comprises the contact stud 9, stationary main contact 7, conducting bridge 6, stationary main contact 8, to the contact stud therefor, not shown, to the external circuit.

During the opening operation of the interrupter, the contact arm 5 is rotated in a clockwise direction about a pivot pin, not shown, but which is in electrical contact with the stationary main contact 8, to draw an arc between the arcing contacts 11, 12 after the separation of conducting bridge 6 from the main contacts 7, 8.

When the arcing contacts 11, 12 separate, the arc formed therebetween will expand upwardly because of the loop circuit so that one terminal thereof will be transferred to the arc terminal member 18, and the other arc terminal will be transferred to the other arc terminal member 19.

When this occurs, the blowout coil 3 will be put into series circuit and the transverse magnetic field set up thereby between the field pole members 14 (Fig. 2) will move the established arc upwardly along the arc terminal members 18, 19 into the arc chute 2. The electrical circuit now comprises contact stud 9, conductor 20, blowout coil 3, contact clip 15, arc terminal member 18, the arc itself, arc terminal member 19, flexible

shunt 28, contact arm 5 to the other contact stud, not shown.

The arc chute 2 comprises an insulating rectangularly-shaped housing member 22 positioned adjacent to an insulating plate 21, the latter serving as a base for the blowout coil 3. Within the housing 22 is placed a plate 24 composed of an insulating material. Two insulating spacer strips 25 space a plate 26, composed of an insulating material, away from the plate 24. The plate 26 may have a plurality of apertures 27 formed therein which facilitate the venting of arc gases therethrough, particularly when high currents are to be interrupted. Two more insulating spacer strips 25 space the plate 26 from a plurality of insulating plate portions, hereinafter more fully described, forming a unitary plate assembly 45. More specifically, the plate portions are of two different types, one type being designated by the reference numeral 16 and shown more fully in Fig. 3 of the drawings, whereas the other plate portions, designated by reference numeral 17, are more fully illustrated in Fig. 4 of the drawings.

Referring more specifically to Fig. 3 of the drawings, it will be observed that the insulating plate portion 16 has provided therein a pair of spaced slots 29, 30, which generally diverge outwardly in a direction toward the upper end of the plate portion. However, it will be noted that the upper closed ends 31 of the spaced slots 29, 30 are positioned inwardly from the outer side edges 32 of the plate portion 16 by an amount "*d*," the purpose for which will become more apparent hereinafter. It will be noted that second, generally rectangularly-shaped plate portion 16 has a wedge-shaped intervening plate portion 54 disposed between slots 29, 30 with the narrow end 54*a* facing the contacts.

The first plate portion 17, shown more fully in Fig. 4 of the drawings, has a substantially centrally disposed slot 33 provided therein, the upper end of which is closed, as at 34. Preferably this slot 33 extends along the center line 35 of the first plate 17.

In the assembly of the arc-chute structure 2, the plate portions 16, 17 are alternated, that is, a first plate 17 is employed, which is followed by a second plate 16, then another first plate 17, to be followed by a second plate 16, etc. The tie plate portion 36 provided integrally in plate 16, purely for mechanical strength only, is preferably alternated, that is, the first plate 16 employed has the tie 36 to the left, whereas the second plate 16 employed has the mechanical tie 36 disposed to the right, etc. The tie-plate portion 36 bridges the narrow end 54*a* of wedge-shaped plate portion 54 with a side portion 51 of the second type of plate portion 16. Preferably asbestos rope spacers 37, more clearly shown in Figs. 2 and 5, are cemented to the outer side edges 32 of the plate portions 16, 17 to space the plate portions 16, 17 apart. Thus, it will be noted that the entire assembly 45, consisting of the cemented spaced plate portions 16, 17, may be pressed downwardly, as a unit, within the arc-chute housing member 22.

Preferably the plates 16, 17 are composed of a refractory insulating material, such as a zircon porcelain, which does not give off gas when contacting an arc. However, some aspects of the invention are not limited to use of non-gas evolving materials for the plate portions 16, 17.

Above the arc terminal member 19 is a second insulating plate 26, which is spaced by spacer strips 25 from the right-hand plate of the plate assembly 45. Two additional spacer strips 25 space the right-hand plate 26 from a refractory plate, not shown, which is, in turn, separated from the right-hand end of the housing 22 by a plurality of strips of fish paper. Bolts 33*a* secure the several strips 25, plate 26 and the housing 22 to the plate 21. Bolts 34*a* secure the right-hand plate 26 and its spacer strips 25 and fish paper strips to the housing 22.

The plates 16, 17 and the spacer strips 37 are cemented together in a preliminary process to form a unitary plate assembly 45, which may be bodily placed into the rectangular housing 22. Insulating holding strips 23 are secured by bolts 44 to the opposed inner sides of the housing 22 to prevent the unitary assembly of plates 16, 17 from being forced upwardly out of the housing 22 by the pressure of gas formed during the interrupting operation.

The opening operation of the interrupter will now be explained. Upon the clockwise rotation of the contact arm 5, an arc is drawn between the arcing contacts 11, 12 which quickly transfers, because of the loop circuit, to the arc terminal members 18, 19, to thereby connect into series circuit the blowout coil 3. The magnetic field set up by the blowout coil 3 between the field pole members 14 sets up a transverse magnetic field through the arc chute 2, to thereby force the established arc upwardly along the arc terminal members 18, 19 until it comes into the region adjacent the slots 29, 30, 33 of the plate portions 16, 17. At this point the interruption takes place in a different manner than that utilized in the aforesaid patent. More specifically, in interrupters of the air-break type, utilizing a plurality of spaced, slotted, non-gas evolving plate portions of the ceramic type, a volt-ampere characteristic is obtained, as shown in Fig. 6 of the drawings. For a given current value, there is a maximum voltage interrupting ability, which may be stated in volts per plate. If the number of plates is doubled, and proper field strength, venting, etc., maintained, the voltage interrupting ability at the same current is doubled. Conversely, referring to curve 13 of Fig. 6, if point "A" represents the maximum voltage interrupting capacity at a given current I_1, and the current is then increased to a higher value, as indicated at I_2, the voltage interrupting capacity, in volts per plate portion, is decreased, as indicated at point "B" on curve 13. This means that, for two breakers having the same voltage rating, the breaker having the higher current rating must have more plate portions, and must, therefore, be larger. However, in developing higher ratings, there is a practical limit to the number of plates that can be used. The magnetic structure becomes ungainly (the quantity of iron going up as the square of the number of plates), and the problem of uniform control of longer and longer arcs becomes more difficult.

In a conventional arc chute involving spaced slotted plates, the arc would be driven up into the stack so that it occupied the path indicated by the solid line 39 in Fig. 5. However, with the construction which is here disclosed, utilizing insulating means 16 having pairs of slots 29, 30, the spaces 40 between the plate portions will be sufficiently ionized so that the voltage gradient across the arc, represented by the solid line 39, will cause current to flow over the path represented by the dotted line 39*a* and there are then two arcs in parallel. Actually what will probably happen will be that the arc will occupy both paths from the instant that it is driven up into the stack. By dividing the arc into parallel paths 39, 39*a* the current density in each arc is reduced, and the heating of the insulating, or ceramic surfaces is diminished, so that the voltage interrupting capacity, in volts per plate or unit of insulating material, is increased in the same manner as it would be by reducing the current in a conventional structure. Hence, the current interrupting ability of the breaker is increased without lowering the voltage interrupting ability.

Referring to the plates 16 with double slots 29, 30, shown in Fig. 3, it is believed that the tie plate section of the plate, designated by reference numeral 36, may perform another important function besides imparting mechanical strength to the plate 16. The arc, in being driven up into the stack of ceramic plates, will be forced into a serpentine path by the inner edge 30*a* of slot 30 (Fig. 3) and one edge of the slot 33 of plate 17 (Fig. 4)

until it has reached a position adjacent the lower end of slot **29** (Fig. 3). At this position, two parallel arcs, one traversing slot **29**, and one traversing slot **30** will have an appreciably shorter length than the single arc initially drawn. As a result, the two arcs, in parallel, will generate a lower arc voltage and will, of the two possible conditions, represent the stable condition. Accordingly, this tie-plate section **36** has lengthened the initial arc in such a manner as to cause definite and positive paralleling. The two parallel arc portions move upwardly in the slots **29—30**, becoming progressively restricted and also lengthened, until interruption occurs.

An important feature of my invention is the fact that the upper closed ends **31** of the pairs of slots **29, 30** in plate portion **16** are spaced inwardly from the side edges **32** of plate **16**, so that relatively cool surfaces indicated by the reference characters **41—43** in Fig. 5 are provided. This will assist in arc extinction, and will prevent creepage along the length of the arc chute.

Although the invention has been illustrated, using substantially rectangular plates **16, 17** stacked one on the other, it will be readily apparent that the invention could be adapted to an interleaving fin type of arc chute, where by dividing the plate **17** along its center line **35**, each half thereof could be integrally formed with a side-wall member, as well known to those skilled in the art. Also, the plate portion **16** could, for example, be cut along the dotted line **16*a*** so that the larger portion could be integrally formed with a side wall member, whereas the smaller portion could be integrally formed with the opposite side wall member. Such constructions would be obvious to those skilled in the art and endeavoring to apply the teachings of my invention to spaced interleaving fin types of arc chutes. Merely for purposes of illustration is the invention shown as applied to arc chutes having separate plates stacked up in superimposed relation.

Although I have shown and described a specific structure, it is to be clearly understood that the same was merely for the purpose of illustration, and that changes and modifications may readily be made by those skilled in the art without departing from the spirit and scope of the invention.

I claim as my invention:

1. A circuit interrupter including means for establishing an arc, an arc chute for receiving and effecting the extinction of the arc including side walls, said arc chute also including a plurality of spaced plate portions of insulating material extending transversely inwardly between said side walls and generally transversely to the movement of the arc, a plurality of first insulating plate portions spaced at intervals along said arc chute each having a substantially centrally disposed closed slot provided therein extending inwardly from one side edge of the first plate portion with the open side of the slot facing said arc-establishing means, a plurality of second, intervening, plate portions each having a pair of elongated, closed slots therein spaced inwardly from the side walls of the arc chute and wholly provided in the plate material, one of the pair of elongated closed slots in each of the second plate portions opening at the edge of the second plate portion facing the arc-establishing means and having a tie-plate portion separating it from the adjoining closed slot of the pair of slots so that the latter slot is closed on all sides thereof, and the open ends of the closed slots in the said first plate portions substantially aligning with the open ends of said one slot of the second plate portions for accommodating entrance of said arc into the arc chute.

2. A circuit interrupter including means for establishing an arc, an arc chute for receiving and effecting the extinction of the arc including side walls, said arc chute also including a plurality of spaced plate portions of insulating material extending transversely inwardly between said side walls and generally transversely to the movement of the arc, a plurality of first insulating plate portions spaced at intervals along said arc chute each having a substantially centrally disposed closed slot provided therein extending inwardly from one side edge of the first plate portion with the open side of the slot facing said arc-establishing means, a plurality of second, intervening, plate portions each having a pair of elongated closed slots therein spaced inwardly from the side walls of the arc chute and wholly provided in the plate material, the pair of elongated closed slots diverging away from each other in the direction of arc motion, one of the pair of elongated closed slots in each of the second plate portions opening at the edge of the second plate portion facing the arc-establishing means and having a tie-plate portion separating it from the adjoining closed slot of the pair of slots so that the latter slot is closed on all sides thereof, and the open ends of the closed slots in the said first plate portions substantially aligning with the open ends of said one slot of the second plate portions for accommodating entrance of said arc into the arc chute.

3. The combination in a magnetic, air-break circuit interrupter of contact means for establishing an arc, a generally rectangularly-shaped arc chute for receiving and extinguishing said arc including spaced side walls and end walls, a multiplicity of insulating spaced plate portions bridging said side walls and extending generally transversely to arc movement, said insulating spaced plate portions being of two types, namely a first type and a second type, the first type of insulating plate portion having a generally centrally located, closed slot therein opening from the edge of the first type of plate portion facing said contact means, the second type of insulating plate portion including two spaced, closed slots, one of the closed slots in the second type of insulating plate portion opening from the edge of the plate portion facing said contact means and having an integral, tie-plate portion separating it from the adjoining slot of the pair so that the latter slot is completely closed on all sides, the first and second types of insulating plate portions being alternately interspersed, and the openings of the slots in the first type of insulating plate portions generally aligning with the said one slots in the second type of insulating plate portions to form an entrance passage for the reception of said arc.

4. The combination in a magnetic, air-break circuit interrupter of contact means for establishing an arc, a generally rectangularly-shaped arc chute for receiving and extinguishing said arc including spaced side walls and end walls, a multiplicity of insulating spaced plate portions bridging said side walls and extending generally transversely to arc movement, said insulating spaced plate portions being of two types, namely a first type and a second type, the first type of insulating plate portion having a generally centrally located, closed slot therein opening from the edge of the first type of plate portion facing said contact means, said closed slot in the first type of insulating plate portion tapering in a more restricted manner in a direction toward the closed end thereof, the second type of insulating plate portion including two spaced closed slots, one of the closed slots in the second type of insulating plate portion opening from the edge of the plate portion facing said contact means and having an integral tie-plate portion separating it from the adjoining slot of the pair so that the latter slot is completely closed on all sides, the two spaced closed slots in the second type of insulating plate portion tapering in a more restricted manner in the direction of arc movement, the first and second types of insulating plate portions being alternately interspersed, and the openings of the slots in the first type of insulating plate portions generally aligning with the said one slots in the second type of insulating plate portions to form an entrance passage for the reception of said arc.

5. A circuit interrupter of the magnetic air-break

type including a movable contact separable from a relatively stationary contact to establish an arc, a generally rectangularly-shaped arc chute including a multiplicity of spaced generally rectangularly-shaped, insulating plate portions for extinguishing said arc, said generally rectangularly-shaped, insulating plate portions being at least of two different configurations, a first type of generally rectangularly-shaped insulating plate portion having a centrally disposed slot opening at one end of the plate portion and tapering to a restricted closed end toward the opposite end of the plate portion in the direction of arc movement, a second type of generally rectangularly-shaped insulating plate portion having a pair of closed-end slots extending generally lengthwise of the plate portion, said pair of slots having a wedge-shaped intervening plate portion therebetween with the narrow end of the wedge-shaped plate portion facing the contacts, a tie-plate portion bridging the narrow end of said wedge-shaped plate portion with a side of the

second type of plate portion so that one of the two closed-end slots opens at the end of the second type plate portion facing the contacts, the first and second types of insulating plate portions being alternately positioned, and said arc moving into the centrally disposed slots of the first type of plate portions and said one slot of the second type of plate portions during the interruption process.

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