April 19, 1960 R. E. FRINK 2,933,574

CIRCUIT INTERRUPTERS

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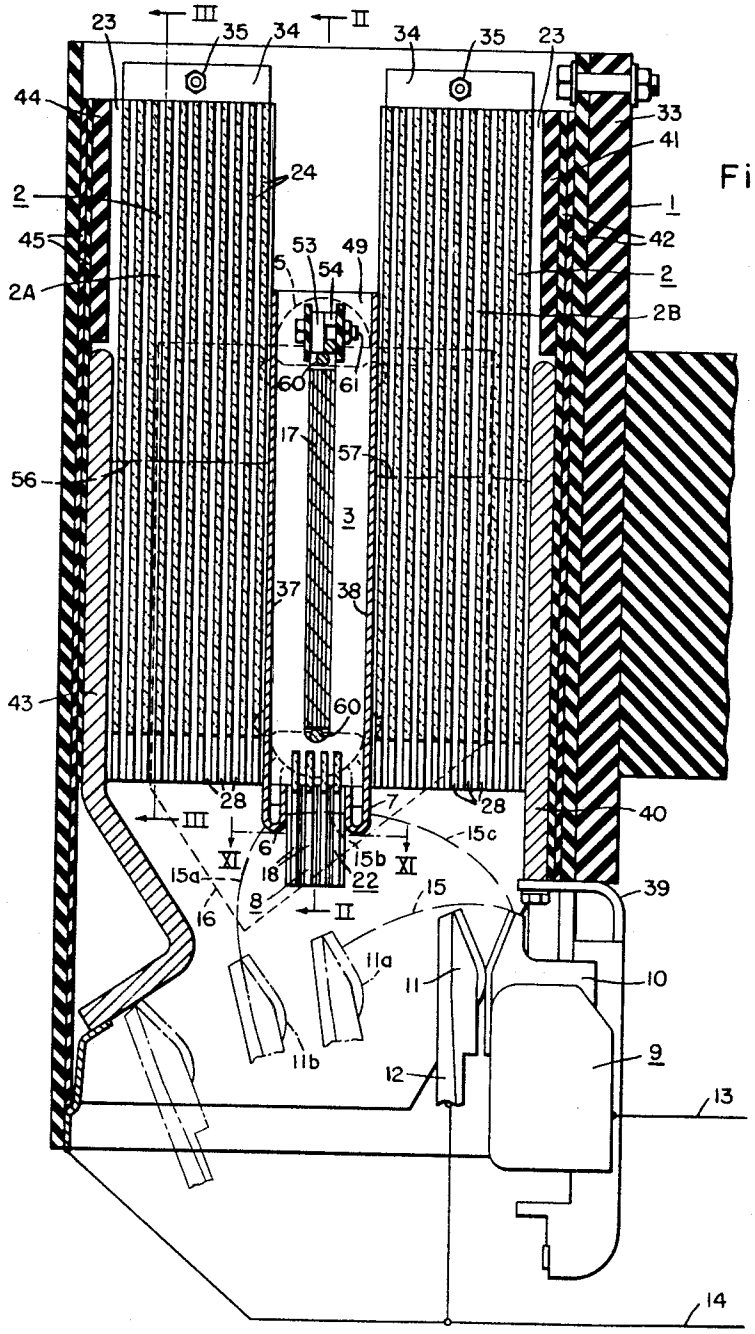



Fig. 1.

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Fig. 4.

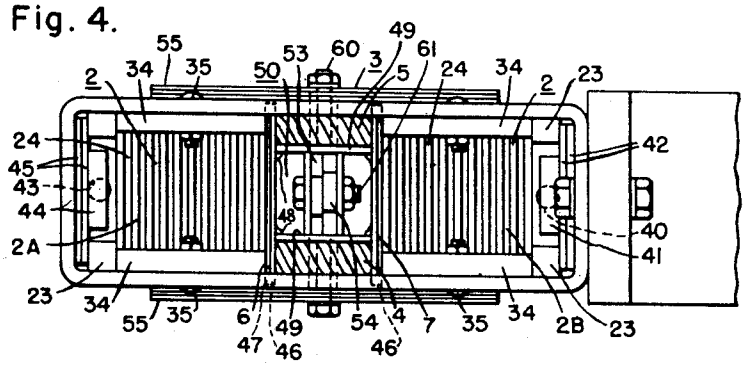



Fig. 2.

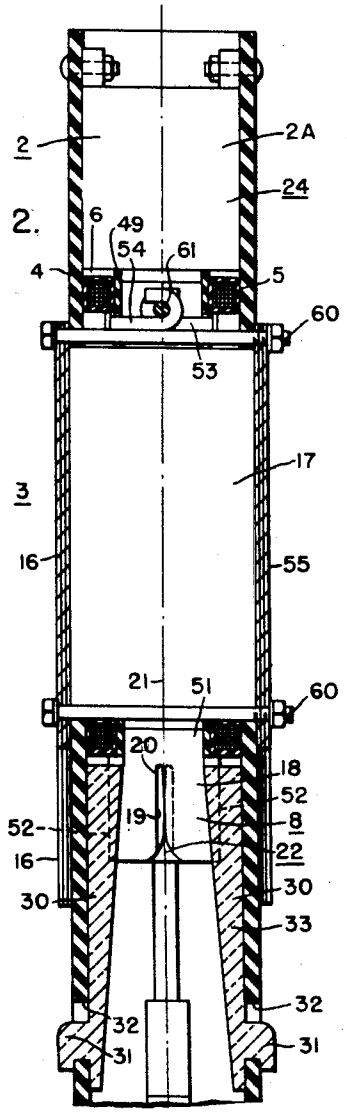
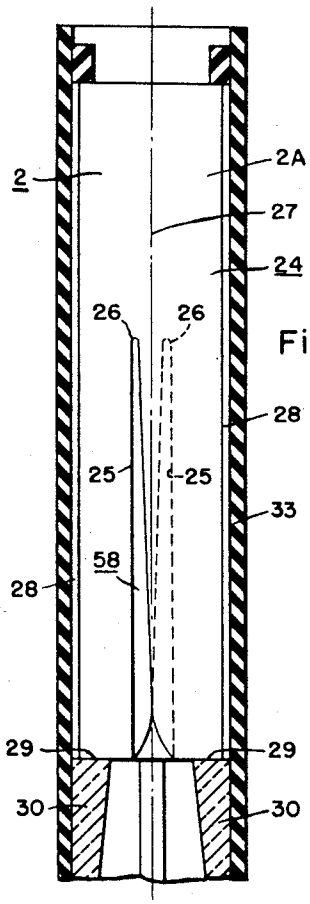



Fig. 3.



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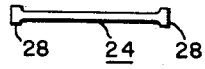
CIRCUIT INTERRUPTERS

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Fig. 5.
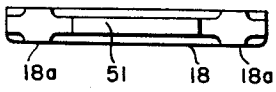



Fig. 8.



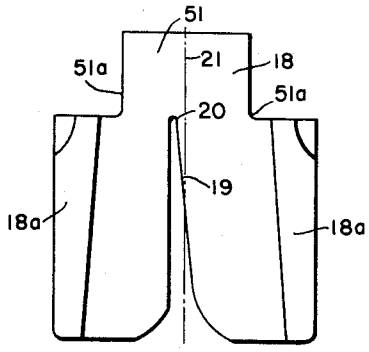




Fig. 6.

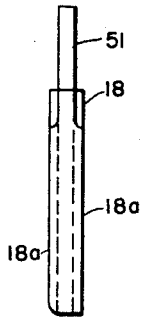



Fig. 7.

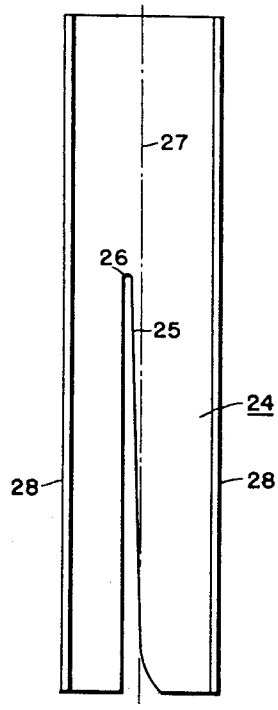



Fig. 9.

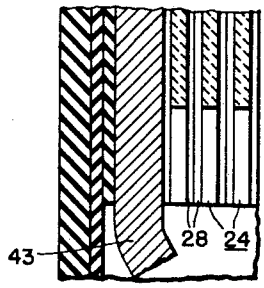



Fig. 10.

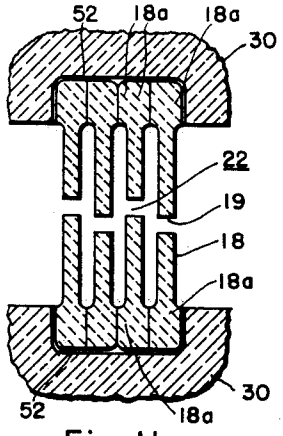



Fig. 11.

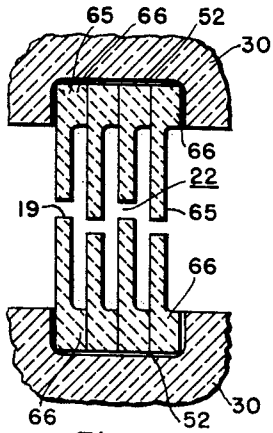



Fig. 12.

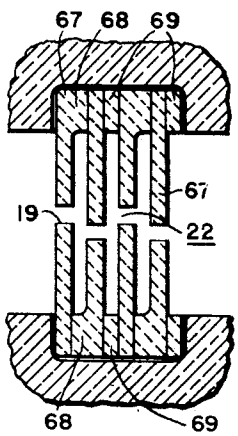



Fig. 13.

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Patented Apr. 19, 1960



2,933,574

# CIRCUIT INTERRUPTERS

Russell E. Frink, Pittsburgh, Pa., assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Application April 26, 1954, Serial No. 425,560

10 Claims. (Cl. 200—144)

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

A general object of my invention is to provide a circuit interrupter of improved and more effective construction.

A more specific object of my invention is to provide an improved circuit interrupter having plate structure which may be inexpensively manufactured and which may be easy for workmen to assemble.

A further object of my invention is to provide improved spacing means for spacing a plurality of plate-like portions of an interrupting structure apart.

An ancillary object of my invention is to cheapen the manufacturing processes and to cut down the assembly time for construction of circuit interrupters, generally of the spaced-plate type.

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

Fig. 1 is a vertical sectional view through a circuit interrupter embodynig my invention, the contact structure being shown in the closed-circuit position;

Fig. 2 is a vertical sectional view taken substantially along the line II—II of Fig. 1;

Fig. 3 is a vertical sectional view taken substantially along the line III—III of Fig. 1;

Fig. 4 is a top plan view of my improved circuit interrupter;

Figs. 5–7 illustrate details of the improved transfer stack plates of my interrupter;

Figs. 8 and 9 illustrate the constructional details of the main interrupting plates utilized in the circuit interrupter of Fig. 1;

Fig. 10 is a fragmentary enlarged vertical sectional view of a portion of the main interrupting stack;

Fig. 11 is a fragmentary enlarged view taken substantially along the line XI—XI of Fig. 1, looking in the direction of the arrows;

Fig. 12 illustrates a modified type of plate structure which may be used in place of that employed in Fig. 11; and

Fig. 13 illustrates still a further modified construction which may be substituted for that shown in Figs. 11 and 12.

Referring to the drawings, and more particularly to Fig. 1 thereof, the reference numeral **1** generally designates an arc chute comprising a pair of serially related stacks of arc-extinguishing plates **2**, separated by a generally H-shaped magnet **3** disposed at a floating potential. A pair of serially related energizing coils **4**, **5** serve, when energized, to set up a magnetic field within the magnet **3**. Associated with the energizing coils **4**, **5** are a pair of transfer arc horns **6**, **7**, the transfer arc between which is extinguished within a transfer interrupting stack, generally designated by the reference numeral **8**, and more fully described hereinafter.

Contact structure **9** is provided to close the circuit through the interrupter. The contact structure **9** includes a relatively stationary contact **10**, which may have a slight lateral motion to provide contact pressure, and a cooperating moving contact **11** positioned at the outer extremity of a rotatable contact arm **12**, operated by any suitable mechanism, which forms no part of my invention. A line connection **13** may be made to the stationary contact structure **10**, and the other line connection **14** may be made to the rotatable contact arm **12** in the manner indicated in Fig. 1.



Following operation of the contact opening mechanism the movable contact **11** moves leftwardly away from the stationary contact **10** to establish an arc therebetween. Because of the loop circuit including the substantially horizontal line connections **13**, **14** and the movable contact arm **12**, the established arc **15** drawn therebetween will tend to bow upwardly. Due to the proximity of the depending pole portions **16**, the magnetic flux surrounding the established arc **15** will be distorted thereby. Thus, the flux above the arc **15** will pass through the depending pole portions **16** and through the yoke or centrally disposed core **17** of the magnet **3**. The magnetic flux below the arc **15** will merely pass through the air space. Consequently, since the flux below the arc **15** has a greater flux density than the flux density in the air above the arc **15** (the flux above the arc **15** having passed through the magnet structure **3**), the arc **15** will be magnetically urged upwardly into contacting engagement with the transfer arc horns **6**, **7**.

I provide a plurality of spaced slotted insulating plates **18** associated with the transfer interrupting stack **8**, and more clearly disclosed in Figs. 5–7 of the drawings. With particular reference to these figures, it will be observed that the insulating transfer plate **18** is molded as a unitary structure, having integrally molded therewith side spacing ridges or projections **18***a*. The side ridges **18***a* serve to space the several plates **18** apart into spaced relation, as shown more particularly in Fig. 11 of the drawings.

It will furthermore be observed that each insulating plate **18** has a slot **19** provided therein, the upper closed end **20** of which is laterally displaced to one side of the center line **21** of the plates **18**. The plates **18** are assembled alternately, as shown in Figs. 2 and 11, with the closed ends **20** thereof alternating about the center line **21**, that is, the closed end **20** of one plate **18** being to one side of the center line **21**, and the closed ends **20** of the immediately adjacent plates **18** being disposed to the other side of the center line **21**. The resulting construction provides a zigzag arc passage **22**, as indicated in Figs. 2 and 11 of the drawings.

By molding the plates **18** with the side edge spacing ridges **18***a*, the necessity for utilizing asbestos rope spacers cemented to the outer sides of the plates, which has been the practice heretofore, is eliminated, and consequently, assembly time has been considerably decreased.

In other words, heretofore a workman has painted the opposite side edges of each plate with a suitable adhesive cement, placed an asbestos rope upon the painted edges, placed another plate upon the aforesaid plate and repeated the process until the desired number of plates were in position. It was necessary to individually treat each plate with the cement and to separately place the asbestos rope spacers into position. With the construction illustrated in Figs. 5–7, the plates **18** are molded as a unitary structure and the provision of the ridges **18***a* eliminates the necessity for utilizing the asbestos rope spacers which were employed heretofore.

Preferably, the plates **18** are molded from an asbestos cement composition. In a particular instance, they were cold-molded, and the molds were steam heated to speed

up the setting process. It is readily apparent that materials, other than asbestos cement, may be employed.

When the moving contact 11 has arrived at the position 11*b* in Fig. 1, the arc extending between it and the stationary contact 10 may consist of three portions, namely, 15*a*, 15*b* and 15*c*. The transfer arc portion 15*b* extends between the transfer arc horns 6, 7 and is extinguished within the transfer interrupting stack 8. This causes an energization of the two serially related blow-out coils 4, 5 surrounding the yoke or central core 17 of the H-shaped magnet 3, as shown more clearly in Fig. 2 of the drawings.

It will be observed that the depending pole portions 16 extend downwardly below the left-hand interrupting stack or arc-extinguishing section 2A, whereas there is no, or relatively little, pole plate portion below the right-hand extinguishing stack or section 2B. Thus, the transverse magnetic field just below the interrupting stack 2A is more intensified than the transverse magnetic field just below the interrupting stack 2B. The reason for this is that normally the arc portion 15*c*, which is closer to the interrupting stack 2B, tends to rise up within the stack 2B faster than the arc portion 15*a*, which is initially drawn farther away from the interrupting stack 2A. However, for most effective operation of the interrupter as a whole, it is desirable to have both arc portions 15*a*, 15*c* move upwardly at the same rate of speed within the extinguishing stacks 2A, 2B.

By the particular configuration of the depending pole plate portion 16, as shown in Fig. 1, the magnetic field is intensified just below the extinguishing stack 2A and thereby accelerates the upward travel of the arc portion 15*a* within the stack 2A so that its position and speed upwardly within the extinguishing stack 2A approximates that of the portion 15*c* upwardly within the extinguishing stack 2B.

Each extinguishing stack 2A, 2B includes a plurality of spaced ceramic or refractory plates 24, which more clearly are shown in Figs. 3, 8 and 9. Each plate 24 has a closed slot 25 extending upwardly therein, the upper closed end 26 thereof being laterally displaced to one side of the center line 27 of the plates 24.

As shown more clearly in Figs. 8 and 9, each of the main insulating plates 24 is molded as a unitary structure having side ridges 28 integrally molded therewith. As mentioned heretofore, the plates 24 may be molded from any suitable insulating material, one particular example being an asbestos cement composition. Other materials will readily suggest themselves to those skilled in the art. The side integral ridges 28 serve to space adjacent plates 24 apart in a manner more clearly shown in Figs. 1, 4 and 10 of the drawings.

The plates 24 may be assembled loosely in the stacks 2A and 2B, or they may be cemented together to form a unitary structure. Such a unitary structure, or the loose plates 24, preferably rest upon the upper ends 29 of a pair of ceramic arc shields 30. The arc shields 30 provide an entrance portion upwardly into the arc chute 1 and have lug portions 31 integrally formed therewith which extend through openings 32 provided in the insulating rectangularly-shaped arc-chute jacket 33, as more clearly shown in Figs. 2 and 3 of the drawings.

To prevent the gas pressure generated within the extinguishing stacks 2A, 2B from blowing the stacks 2A, 2B completely upwardly out of the arc chute 1, retainer strips 34 are provided within the arc-chute jacket 33 at the upper end thereof, as indicated in Fig. 4 of the drawings. Preferably, bolts 35 are utilized to maintain the retainer strips in position.

Certain features of the construction illustrated herein are described in more detailed manner and claimed in the U.S. patent application filed May 26, 1951, Serial No. 228,446, now United States Patent 2,692,319, issued October 19, 1954 to Robert C. Dickinson and Russell E. Frink, entitled "Circuit Interrupter," and assigned to the assignee of the instant application.

The transfer arc horns 6, 7 have their lower ends curved around to form arc horns for the transfer stack 8. The upper portions 37, 38 of the arc horns 6 and 7, respectively, serve as arc horns for the interrupting stacks 2A, 2B. Cooperating with the stationary contact 10 and connected thereto by a strap connector 39 is an arc horn 40. Disposed above the arc horn 40 is a barrier plate 41 which, as is the case with the arc horn 40, is suitably secured to a pair of insulating plates 42 by suitable means, not shown.

Similarly, disposed at the outer end of the circuit interrupter 1 is an arc horn 43, above which is a barrier plate 44 secured by suitable means, not shown, to a pair of plates 45. Spacer strips 23 space the stacks 2A, 2B away from the arc horns 40, 43.

Each transfer arc horn 6, 7 has a laterally extending lug portion 46 (Fig. 4) which extends through a slot 47 provided in each side wall of the insulating arc chute jacket 33. Also, each transfer arc horn 6, 7 has connected therewith a lug portion 48 which serves, as shown in Fig. 4 to laterally space insulating rectangularly-shaped washers 49 surrounding the yoke or core 17. A washer 49 is disposed immediately adjacent each blow-out coil 4, 5. Thus, it will be evident that there is provided within my improved arc chute 1 a pair of venting passages 50 (Fig. 4), each of which is defined by a pair of the washers 49, the yoke 17 and the inner side of a transfer arc horn 6, 7.

It will be observed that not only are the washers 49 maintained laterally apart against the magnetic forces exerted by energizing the blow-out coils 4, 5 by the lugs 48 associated with the transfer arc horns 6, 7 but also the upper notched ends 51 of the plates 18 of the transfer interrupting stack 8 serve to maintain the washers 49 apart, as more clearly shown in Fig. 2. The plates 18 are inserted into slots 52 provided in the upper ends of the arc shields 30. The two coils 4, 5 are electrically connected together at the upper ends thereof by the terminal leads 53, 54 and a connecting bolt 61. Consequently, both coils 4, 5 are in series electrically between the transfer arc horns 6, 7.

The operation of my improved interrupting device is as follows: The moving contact 11 first moves toward the left, as viewed in Fig. 1, to the position 11*a*. The arc 15 is established between it and the stationary contact 10. The arc 15 is affected by the depending pole plate portions 16 of the magnet 3, and moves upwardly into engagement with the transfer arc horns 6, 7. Meanwhile, the movable contact 11 moves to the position 11*b*. The arc then consists of three portions 15*a*, 15*b* and 15*c* indicated in Fig. 1. The arc portions 15*b* is interrupted within the transfer interrupting stack 8, thereby energizing the serially related blow-out coils 4, 5, and providing a transverse magnetic field across the pole plates 55.

The left-hand end of the arc portion 15*a* transfers to the arc horn 43, and the right-hand end of the arc portion 15*c* transfers to the right-hand arc horn 40. The two arc portions within the respective extinguishing stacks 2A, 2B may then be respectively designated by the reference characters 56, 57, as indicated in Fig. 1. Each arc portion 56, 57 rises upwardly within the stacks 2A, 2B at substantially the same rate of speed, and is forced upwardly within the zigzag arc passages 58 provided by the several plates 24 provided in the extinguishing stacks 2A, 2B. These arc portions 56, 57 are quickly extinguished at the upper ends 26 of the slots 25 provided in the plates 24, and the circuit through the interrupter 1 is broken.

To maintain the pole plates 55 rigidly in position, a pair of bolts 60 extend completely through the arc chute 1 immediately inside of the inner bends of the blow-out coils 4, 5, as indicated in Figs. 1 and 2 of the drawings.

To assemble the arc chute, the arc shields 30 are first put into position. Then follows the insertion of the trans-

fer arc plates 18 within the slots 52. Then follows the transfer arc horns 6, 7, the blow-out coils 4, 5 with the side walls of the arc chute jacket 33 pressed outwardly sufficiently far to enable the lug portions 46 of the transfer arc horns 6, 7 to be forced through the slots 47 of the arc-chute jacket 33. It will be noticed that the notches 51*a* of the corners of the plates 18 are held down by the blow-out coils 4, 5 and the washers 49.

The yoke 17 may then be placed in position, and then the extinguishing stacks 2A, 2B, together with the arc horns 40, 43. Then follows the side pole plates 55. The bolts 60 may then be inserted to rigidly hold the assembly in position.

Fig. 12 illustrates a modified type of construction of the plates, which could be used either for the construction of the transfer arc plates 18 or for the main interrupting plates 24. Referring to Fig. 12, it will be observed that the plates 65 have integrally formed therewith side edge portions 66 extending only in one direction. The slots 19 are again provided, and with this construction, two types of plates 65 are provided. One type has the slots 19 asymmetrically located on one side of the center line 21 and the other type having the slot 19 asymmetrically located on the other side of the center line 21. By utilizing alternately one plate of each type, as indicated in Fig. 12, the resulting structure will again provide the zigzag arc passage 22. This construction has a slight disadvantage over that utilized in Fig. 11 in that two types of plates are obviously required. For certain applications, however, its use may be desirable.

Fig. 13 shows a further modification of plate structure which may be employed either for the transfer stack 8 or for the main interrupting stacks 2A or 2B. Here the plates are of L-shaped configuration, each plate 67 having an integrally formed ridge 68 only along one outer side thereof. The longer leg of the L extends transversely across the arc chute. The slots 19 are again formed in the molded plate in an asymmetrical configuration, as employed heretofore. By inverting the plates 67, which may all be of one type, as indicated in Fig. 13, and by utilizing intermediately disposed insulating spacing strips 69 between adjacent sections, each section consisting of two plates 67, a substantially zigzag arc passage 22 may be provided. This construction has a slight disadvantage in that the rectangular spacing strips 69 are required between adjacent sections, the assembling of which requires additional time. However, with this construction of Fig. 13, the plates 67 are all of one type, and so a single mold may be employed.

As will be obvious, the plate structures of Figs. 12 and 13 may be employed in the main interrupting stacks 2A, 2B in the same manner that they may be employed in the transfer stack 8.

From the foregoing description, it will be apparent that I have decreased the assembly time and have cheapened the cost of constructing a circuit interrupter incorporating spaced plate portions. By integrally molding the spacing ridges along one or both sides of the plates, the necessity for using separate spacing strips between each pair of adjacent plates is eliminated. In addition, the plate structure is stronger and has greater heat dissipating characteristics.

Although I have shown and described specific structures, it is to be clearly understood that the same were merely for the purpose of illustration, and that changes and modifications may readily be made therein 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 extinguishing the arc including a plurality of spaced plates of insulating material, said plurality of spaced plates being disposed substantially transversely of the established arc and extending completely across the arc chute, means for moving at least



a portion of said arc transversely directly against the edges of said spaced insulating plates to thereby effect the extinction of the arc, and one or more of the insulating plates having integrally formed spacing ridges along at least a portion of one edge thereof, said spacing ridges extending in opposite directions from the surface planes of the plate.

2. A circuit interrupter including means for establishing an arc, an arc chute for extinguishing the arc including a plurality of spaced plates of insulating material, said plurality of spaced plates being disposed substantially transversely of the established arc and extending completely across the arc chute, means for moving at least a portion of said arc transversely directly against the edges of said spaced insulating plates to thereby effect the extinction of the arc, and one or more of the insulating plates having integrally formed spacing ridges along at least a portion of both edges thereof, said spacing ridges extending in opposite directions from the surface planes of the plate.

3. The combination in a circuit interrupter of means for establishing an arc and an arc chute defining a zigzag arc passage including a plurality of insulating spaced slotted plates with the closed ends of the slots alternating on opposite sides of the center line of the arc chute, said plurality of spaced plates extending the full width transversely across the arc chute, means for moving at least a portion of said arc within the slots of the plates to the closed ends thereof so that the arc directly contacts the edges of the plates transversely thereof, and one or more of the insulating plates having at least an integrally formed spacing ridge along at least a portion of an edge of the plate.

4. The combination in a circuit interrupter of means for establishing an arc and an arc chute defining a zigzag arc passage including a plurality of insulating spaced slotted plates with the closed ends of the slots alternating on opposite sides of the center line of the arc chute, the slotted plates extending the full width transversely across the arc chute, means for moving at least a portion of said arc within the slots of the plates to the closed ends thereof so that the arc directly contacts the edges of the plates transversely thereof, and one or more of the insulating plates having integrally formed spacing ridges along opposite side edges of the plate.

5. A circuit interrupter including means for establishing an arc, an arc chute for extinguishing the arc including a plurality of spaced plates of insulating material, at least a plurality of the plates having an L-shaped cross-section with the longer leg of the L extending transversely across the width of the arc chute, adjacent L-shaped plates being inverted and disposed in paired sections, spacing means disposed between adjacent sections, and means for moving at least a portion of said arc transversely against the edges of said spaced plates to effect the extinction thereof.

6. A circuit interrupter including means for establishing an arc, an arc chute for extinguishing the arc including a plurality of spaced plates of insulating material extending transversely completely across the width of the arc chute, and one or more of the plates having substantially an I-shaped cross-section with integrally formed side spacing ridges to space the plates apart, and means for moving at least a portion of said arc transversely against the edges of said spaced plates to effect the extinction thereof.

7. A circuit interrupter including contact means for establishing an arc, an arc chute for extinguishing the arc including a plurality of spaced slotted plates of insulating material into which the arc is moved, the arc directly contacting the edges of said plates transversely thereof, and one or more of the plates having unsymmetrical slots therein with substantially C-shaped cross-section to space the plates apart.

8. A circuit interrupter including means for establish-

ing an arc, an arc chute including a pair of opposed arc shields having recesses therein, one or more blow-out coils, a transfer interrupting stack for assisting in energizing the one or more blow-out coils including a plurality of insulating plates having their edges disposed in said recesses and extending completely transversely across the width between the arc shields, one or more of said plates having an integrally formed spacing ridge along at least a portion of one edge thereof, means for moving at least a portion of said initially established arc transversely directly against the edges of said plates of said transfer interrupting stack to effect the extinction thereof, and extinguishing means for effecting the extinction of one or more remaining arc portions following energization of the one or more blow-out coils.

9. A circuit interrupter including means for establishing an arc, an arc chute including a pair of opposed arc shields having recesses therein, one or more blow-out coils, a transfer interrupting stack for assisting in energizing the one or more blow-out coils including a plurality of plates extending completely transversely across the space between the arc shields and having their edges disposed in said recesses, an H-shaped magnet structure having two arc-extinguishing sections on opposite sides of the yoke portion thereof, at least some of said plates having integrally formed spacing ridges along at least portions of the opposite sides thereof disposed in said recesses, and arc portions being extinguished within said two arc-extinguishing sections following energization of the one or more blow-out coils.

10. The combination in a circuit interrupter of a substantially rectangularly-shaped arc chute, separable contact means separable in a direction lengthwise of the arc chute to establish an arc therein, a stack of closely spaced insulating plates disposed transversely of the arc completely across the width of the arc chute, means for moving at least a portion of said arc transversely directly against the edges of said spaced insulating plates to thereby effect the extinction of the arc, a plurality of said insulating plates having integrally formed spacing ridges along a substantial length of one edge thereof, and the spacing ridges extending in opposite directions from the surface planes of the plates.

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