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CIRCUIT INTERRUPTER

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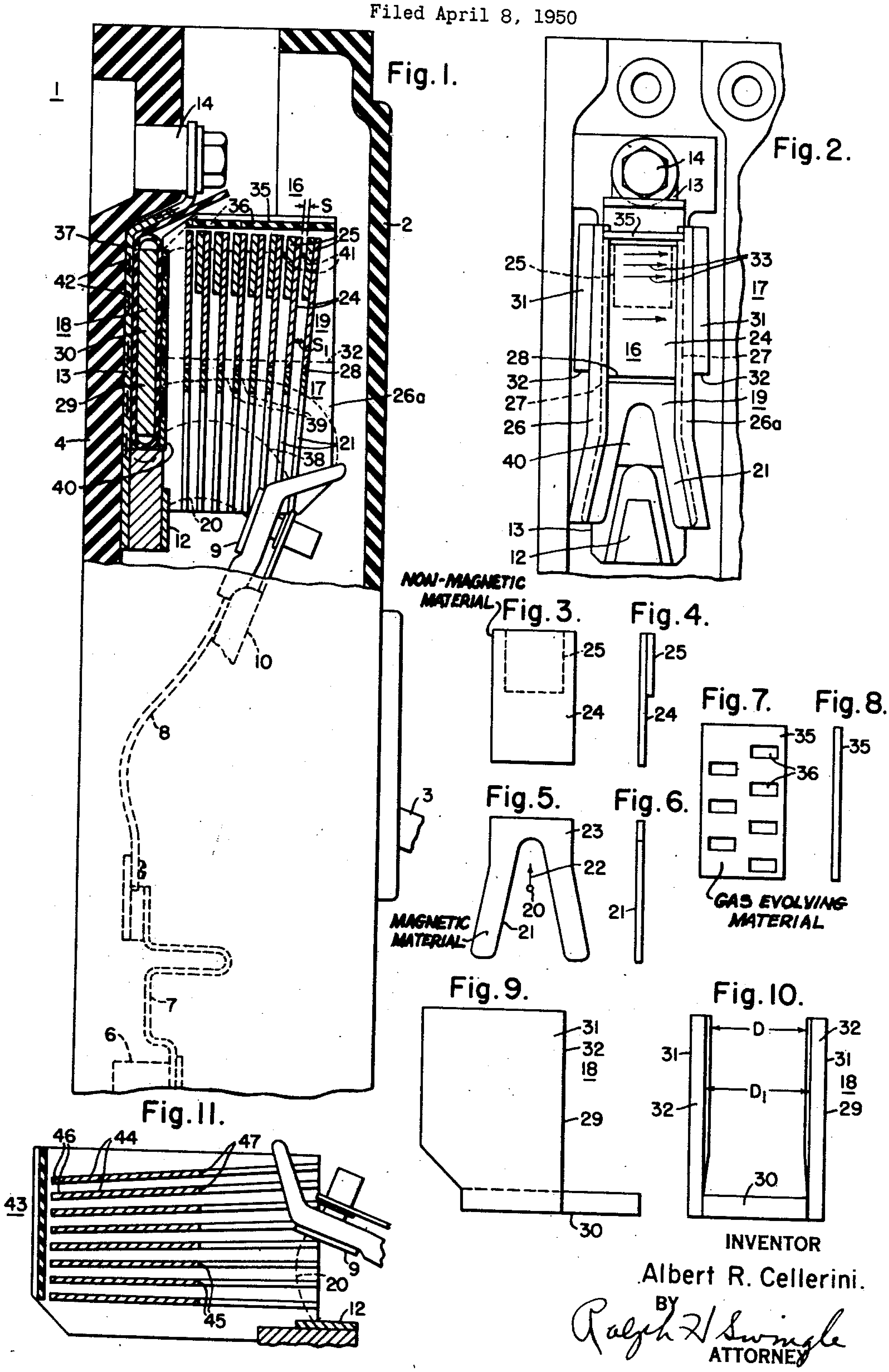

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CIRCUIT INTERRUPTER

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8 Claims. (Cl. 200—147)

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

The general object of my invention is to provide an improved spaced metallic plate type of arc chute, in which the established arc is more effectively cooled and extinguished than has been obtained heretofore.

Another object is to provide an improved composite plate structure for a circuit interrupter of the spaced metallic plate type in which special provision is incorporated for the interruption of both low and high currents.

A further object is to provide an improved spaced metallic plate type of arc-extinguishing structure in which novel means are utilized to accelerate movement of the arc into the spaced plate structure and thereacross to become subdivided thereby.

A further object is to provide an improved magnetic structure for such a type of circuit interrupter in which the transverse magnetic field is intensified at the rear or exhaust end of the arc chute to facilitate the interruption of the higher magnitude currents.

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

Figure 1 is a side elevational view, partially in vertical section, of an improved spaced plate type of circuit interrupter incorporating my invention, the contact structure being shown in the open circuit position;

Fig. 2 is a fragmentary side elevational view of the arc-extinguishing structure of Fig. 1, with the cover removed from the interrupter;

Figs. 3 and 4 are side elevational and end views of the plate used in the rear portion of the composite plate structure;

Figs. 5 and 6 are side elevational and end views of the plate used in the front or entering portion of the composite plate structure;

Figs. 7 and 8 are side elevational and end views of the gas-evolving barrier plate employed in my improved arc chute;

Figs. 9 and 10 are side elevational and front elevational views of the improved magnetic structure for my improved arc-extinguishing structure; and

Fig. 11 is a fragmentary vertical sectional view of a modified type arc chute with the contact structure in the open circuit position.

Referring to the drawing, and more particularly to Fig. 1 thereof, the reference numeral **1**

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generally designates a circuit interrupter including a molded cover **2** through an aperture of which extends an operating handle **3**. The cover **2** rests upon a molded base **4** which may be mounted either horizontally or vertically as shown. The invention is applicable to either a single-pole circuit interrupter controlling one line of a circuit, or to a multi-pole circuit interrupter controlling all of the lines of the circuit to be protected.

Briefly, the circuit through a single pole of the interrupter includes a terminal stud **6**, a flexible strap **7**, which may be associated with a thermal tripping device, not shown, but which may be utilized to automatically actuate the operating mechanism upon the occurrence of overload conditions. The circuit then extends through a second flexible conducting strap **8** to a movable contact **9**, the latter being actuated by a movable operating lever **10** actuated in turn by any suitable mechanism, not shown. The mechanism is manually operated by operation of the externally projecting handle **3** in a manner well known to those skilled in the art.

In the closed-circuit position of the interrupter, not shown, the circuit extends from the movable contact **9** to a stationary contact **12**, and thence through a strap conductor **13** to the other terminal stud **14** of the interrupter.

Associated with the movable and stationary contacts **9**, **12** is an arc chute, generally designated by the reference numeral **16**, and comprising a composite conducting plate structure **17** and a magnetic circuit **18**. The composite conducting plate structure **17** includes a plurality of composite arcing plates **19** disposed in spaced relationship, as shown in Fig. 1, to receive the established arc **20** and to cause the subdivision and movement of the same.

Referring to Figs. 3–6, it will be observed that each composite plate **19** includes a U-shaped front or entering magnetic arcing plate **21**, the configuration of which is more clearly shown in Figs. 5 and 6. The front plate **21** is made of any suitable magnetic material, such as iron, so that the magnetic field surrounding the established arc **20** will be distorted and will cause the arc **20** to be attracted or biased in the direction **22** of Fig. 5 toward the bight portion **23** of the U-shaped plate **21**. The action of the iron plate **21** is particularly effective during low-current interruption.

The composite plate **19** also includes a rear arcing plate **24**, more clearly shown in Figs. 3 and 4. Preferably the rear plate **24** is made of a suitable non-magnetic material having the desirable characteristics of being able to withstand the heat and high temperature of the arc when it travels across the surfaces of the rear plate 24. I have found an alloy composed of substantially 80% nickel and substantially 20% chromium to be particularly suitable for use in fabricating the rear plate 24. The use of such alloy in such an arc extinguishing plate structure is more particularly described, its characteristics set forth, and is claimed in my copending application filed February 16, 1950, Serial No. 144,461, and assigned to the assignee of the instant application.

It will be observed that secured, such as by spot welding, to the exhaust end of the rear plate 24 is another plate 25, which is also preferably formed of a nickel-chromium alloy similar to the plate 24, the purpose for which will subsequently be explained. I provide a pair of ceramic plate holders 26, 26a having grooves 27 provided therealong. The composite plates 19 are securely fastened into position by being placed within the grooves 27, in a manner more clearly shown in Figs. 1 and 2. It will be observed that a slight space 28 is present between the two plates 21, 24 of each composite plate 19.

To expedite the movement of high current arcs across the plate structure 17, I provide the magnetic circuit 18 more clearly shown in Figs. 9 and 10. Briefly the magnetic circuit 18 includes a U-shaped magnetic yoke member 29 having a base portion 30 and outwardly extending leg portions 31.

Preferably the distance "D" between the exhaust ends of the legs 31 is less than the distance "D_1," which is the distance between the front edges 32 of the magnetic circuit 18 so that the transverse magnetic field 33 will be more concentrated at the rear portion of the arc chute 16 because of the smaller air gap therebetween, as indicated in Fig. 2.

Disposed at the rear end of the arc chute 16, as shown in Figs. 1 and 2, is a perforated gas evolving barrier plate 35 having staggered apertures 36 provided therethrough, the purpose for which will be subsequently explained. Also a substantially U-shaped bent insulating plate member 37 is provided about the base portion 30 of the magnetic yoke 29 to prevent electrical contact between the yoke 29 and the strap conductor 13.

The operation of my improved arc chute 16 will now be explained. When it is desired to open the contact structure, the handle 3 may be manually operated. Or if overload conditions are present, a suitable thermal or magnetic tripping device will be actuated, as is well known to those skilled in the art, to actuate the operating mechanism (not shown) associated with the interrupter to cause separation of the movable contact 9 away from the stationary contact 12 to establish an arc 20 therebetween. Because of the loop circuit including the operating lever 10, the movable contact 9 and the stationary contact 12, the arc 20 will tend to expand, as shown by the reference character 38.

During the interruption of low amperage currents, the magnetic or iron plates 21 will be particularly effective to bias or force the arc 38 toward the bight portion 23 thereof, so that the arc 38 will become subdivided by the plurality of front plates 21. Such subdivision of the arc 38 into a plurality of arcs 39, as shown in Fig. 1, brings about intensive cooling and deionization of the several short arcs 39 extending between the front iron plates 21. Under normal conditions such arcs will be rapidly extinguished, this all occurring during a time when the magnetic field 33 is relatively weak due to the small amount of current.

During the interruption of heavy currents, the single turn winding, as indicated by the current arrows 42 of Fig. 1, of the magnetic yoke 29 will create an intense transverse magnetic field 33, particularly concentrated at the rear portion of the arc chute 16, as shown in Fig. 2. In such case the high amperage arcs 39, having been previously subdivided by the iron plates 21, will continue their lateral movement into the rear plates 24 as attracted thereinto by the intense magnetic field 33. Moreover, the presence of the plates 25, which cause the spacing S to be less than the spacing "S_1," the distance between the front edges of the plates 24, will attract the heavy current arcs 41 to the rear end of the composite plate structure 19. Because of the greater mass of metal, and because of the intensive magnetic field, such lateral movement of the high current arcs 41 will be rapid. When the high current arcs 41 reach the outer ends of the plates 25, they will cause the evolution of gas from the gas-evolving plate 35, which gas will tend to move the arcs 41 backward toward the front of the arc chute 16. Interruption soon follows.

Because of the provision of the vents 36 in the barrier member 35 being disposed in staggered relation, as shown in Fig. 7, the arcs 41 will not pass out through the barrier 35 to cause flashover at the exhaust end of the arc chute 16.

From the foregoing description it will be apparent that I have provided an improved arc chute in combination with a suitably designed and located magnetic coil to obtain a more effective movement of the arc towards the back of the arc chute 16. The front part of the arc chute 16 is especially suitable for the interruption of small currents, the magnetic field being too weak at this time to be effective. On large currents, such as short-circuit currents, however, the magnetic coil takes up the arc at the throat of the arc chute 16 and moves it back towards the rear of the arc chute 16. By having the rear part of the plates made of an arc-resisting alloy such as nickel-chromium, the material is hence non-magnetic and at the same time a good conductor. In this way the arc meets little resistance in being split up into small arcs and forced towards the back of the arc chute 16.

The magnet 18 is placed back far enough in the arc chute 16 from the iron part of the plates 21 so that little or no magnetic flux is shunted through the iron. In other words, the flux from the magnet is located back far enough to be back out of the influence of the iron part of the plates 19 so that all magnetic forces are effective in drawing the arc towards the back of the arc chute 16. It will furthermore be noted that the U-shaped magnet 29 by being slightly wider at the front end than at the rear end causes a greater air gap at the front end with a corresponding narrower air gap at the rear end. This tends to keep the magnetic flux towards the rear of the arc chute 16 and away from the iron end of the arcing plates 19. The presence of iron at the front end of the plates can be neutralized somewhat by the narrower air gap at the rear of the arc chute 16. It is apparent that the coil energizing the magnetic circuit 18 is formed by the conductor 13 on the one side of the base portion 30 of the magnetic circuit 18 and by the arc runner 40 on the top of the base portion 30. When the arc has travelled to the rear of the arc chute 16, there will be, in effect, almost one complete turn about the core 30.

From the foregoing description it will be apparent that with my improved arc chute 16, when the contacts part, the arc immediately comes under the drawing influence of the front or iron part of the plates. When it has travelled back far enough to come under the influence of the magnetic field of the magnet, it is drawn back by this field towards the rear of the arc chute 16. In this way the arc is stretched to a greater length, thus increasing its resistance. It is cooled more effectively by the sides of the plate holders 26, 26a and by the composite plates 19. It is deionized more effectively as it is forced to move back to the comparatively cooler part of the arc chute 16. The wear on the plates 19 is consequently diminished because the arc is in motion.

By having the rear gaps between the plates 24 slightly smaller than the front gaps between the plates 24, the arc, in seeking the easiest path, will travel to the rear of the arc chute 16 where this path is located. Thus, since the gaps are arranged so that the total sum of the gap spaces in the rear is a little less than the sum of the gap spaces at the front ends of the alloy plates 24, the arc travels to the back of the plates 24 seeking the shortest path. Thus the lateral movement of the arc over the plates 24 is expedited.

My improved arc chute 16 has the following advantages:

1. There is more effective cooling because the arc travels to the rear of the arc chute and thereby comes into contact with the cooler parts of the plates.

2. Burning at one spot is minimized since the arc is in motion.

3. If the arc should hang on longer, it will be at the rear of the plates 24, 25 where damage to the plates 24, 25 will be less than if the arc played at the throat; this result is caused by the fact that the rear of the plate 24 is thicker than the front of said plate.

4. Deionization will be more rapid due to the more efficient cooling of the arc, and consequently higher voltage ratings can be given to the interrupter.

5. There will be increased arc resistance as a result of more stretching of the arc and a compressing of the arc by the narrow rear end of the arc chute.

6. Low currents can be quenched by the front end of the arc chute alone.

7. There is less deterioration of the plates because the arc is in motion most of the time.

8. The evolution of gas from the gas evolving barrier plate 35 intensifies the deionizing action brought to bear upon the arc.

Fig. 11 illustrates a modification of my invention utilizing a modified type arc chute generally designated by the reference character 43. The arc chute 43 includes a plurality of spaced metallic plates 44 which are preferably slotted, as were the plates 21 of Figs. 5 and 6. Again the stationary contact 12 and the movable contact 9 may be utilized to establish an arc 20 which enters the slots 45 of the several plates 44. If the plates 44 are formed of a nonmagnetic material, it is desirable to utilize a transverse magnetic field to force the arc 20 into the plate structure to become subdivided thereby. However, if the plates 44 are formed of a magnetic material, such as iron, such transverse magnetic field is not necessary, and the magnetic plates 44 themselves will suffice to attract the arc 20 into the slots 45 and onto the plates 44 to become subdivided thereby.

The important thing, however, is not the material of which the plates 44 are made, but the fact that the sum of the gap distances at the rear ends 46 of the plates 44 is less than the sum of the gap distances at the front entering edges 47 of the plates 44. The advantage accruing from the use of such a smaller gap distance at the rear ends 46 of the plates 44 has previously been set forth in connection with Fig. 1. Consequently, Fig. 11 merely shows how, instead of utilizing auxiliary plates 25, as in Figs. 3 and 4, one may use a plurality of single plates and have the plates slope in such a direction as to make the sum of the gap distances at the rear ends of the plates smaller than the sum of the gap distances at the arc entering ends of the plates.

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 appended claims.

I claim as my invention:

1. A circuit interrupter including means for establishing an arc, an arc chute including a plurality of spaced composite metallic plates, the arc entering portion of each composite plate being U-shaped and formed of magnetic material, the rear portion of each composite plate being formed solely of non-magnetic material, and means for forcing the established arc into the arc chute to become subdivided thereby into a plurality of serially connected arcs.

2. A circuit interrupter including means for establishing an arc, an arc chute including a plurality of spaced composite metallic plates, the arc entering portion of each composite plate being a slotted plate entirely formed of magnetic material, the rear portion of each composite plate being a plate formed solely of non-magnetic material, and means for setting up a substantially transverse magnetic field across the arc chute especially intensified at the rear portion of the arc chute.

3. A circuit interrupter including means for establishing an arc, an arc chute including a plurality of spaced metallic plates, the established arc moving into the metallic plates to become subdivided thereby into a plurality of arcs, and the sum of the gap spaces at the rear ends of the metallic plates being less than the sum of the gap spaces at the arc-entering ends of the metallic plates.

4. A circuit interrupter including means for establishing an arc, an arc chute including a plurality of spaced metallic arcing plates, the established arc moving into engagement with the arcing plates to become subdivided thereby into a plurality of short arc portions therebetween, and a plurality of relatively small additional metallic arcing plates secured to the rear portions of the first said arcing plates between the same so that the summation of the arcing distances at the rear of the first said arcing plates is less than the summation of the arcing distances at the arc-entering ends of the first said arcing plates and the short arc portions will correspondingly be reduced in length as they move rearwardly across the first said arcing plates.

5. A circuit interrupter including means for

establishing an arc, an arc chute including a plurality of spaced composite metallic plates, the arc entering portion of each composite plate being U-shaped and formed of magnetic material, the rear portion of each composite plate being formed solely of non-magnetic material, and means including a magnetic yoke structure having a greater air gap at the front end thereof than at the rear end thereof for setting up a substantially transverse magnetic field across the arc chute especially intensified at the rear portion of the arc chute.

6. A circuit interrupter including means for establishing an arc, an arc chute including a plurality of spaced composite metallic plates, the arc-entering plate portion of each composite plate being formed of magnetic material, a non-magnetic plate portion positioned beyond the rearmost portion of each of a plurality of the magnetic plates, whereby the established arc is subdivided into a plurality of serially connected arcs.

7. A circuit interrupter including means for establishing an arc, an arc chute including a plurality of spaced composite metallic plates, the arc-entering plate portion of each composite plate being U-shaped and formed of magnetic material, a non-magnetic plate portion positioned beyond the rearmost portion of each of a plurality of the magnetic plates, and means for forcing the established arc into the arc chute and on to the non-magnetic plate portions to play therebetween as a plurality of serially connected arcs.

8. A circuit interrupter including means for establishing an arc, an arc chute including a plurality of spaced composite metallic plates, the arc-entering plate portion of each composite plate being formed of magnetic material, a non-magnetic plate portion positioned beyond the rearmost portion of each of a plurality of the magnetic plates, the surfaces of both the magnetic plates and the non-magnetic plates being exposed to arcing, at least at the central portions thereof, to provide for movement of terminals of short arcs thereon, whereby the established arc is subdivided into a plurality of serially connected arcs whose terminals move across the plates of both types.

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