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[54] **SHOCK-PROOF ARC CHUTE FOR HIGH VOLTAGE CIRCUIT BREAKER WITH METALLIC ARC PLATES HAVING OFF-SET LINES OF OPENINGS**

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[52] **U.S. Cl.**.....**200/144 R,** 200/147 B

[51] **Int. Cl.**.....**H01h 33/08**

[58] **Field of Search**.....200/147 B, 147 R, 200/144

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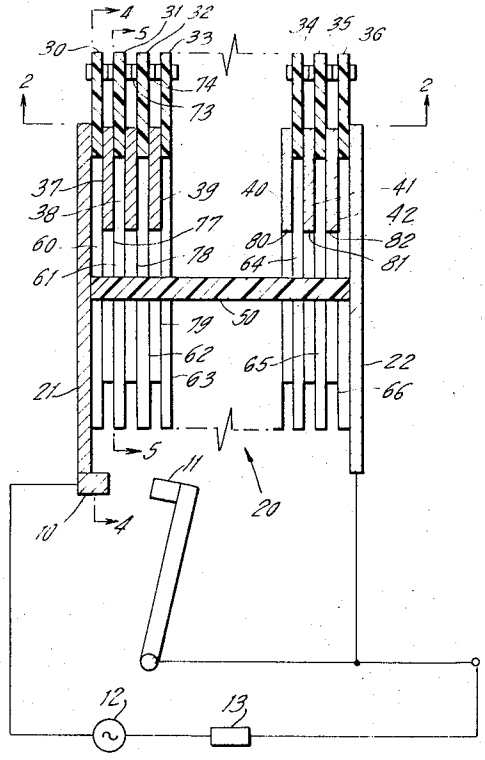
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[57] **ABSTRACT**

An arc chute is provided for use in high voltage circuits which uses a plurality of spaced metallic plates spaced by fiber spacers. The fiber spacer plates have alternately displaced, laterally extending slots, which extend above the tops of the metallic plates, to define a sinuous chamber above the top of the metal plates which encourages arc product turbulence between spaced metal plates and above the top of the metal plates. Each metal plate has a longitudinally extending series of spaced holes displaced from the center of the plate, with the series of holes of adjacent plates being alternately laterally displaced.

12 Claims, 7 Drawing Figures



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SHEET 1 OF 2

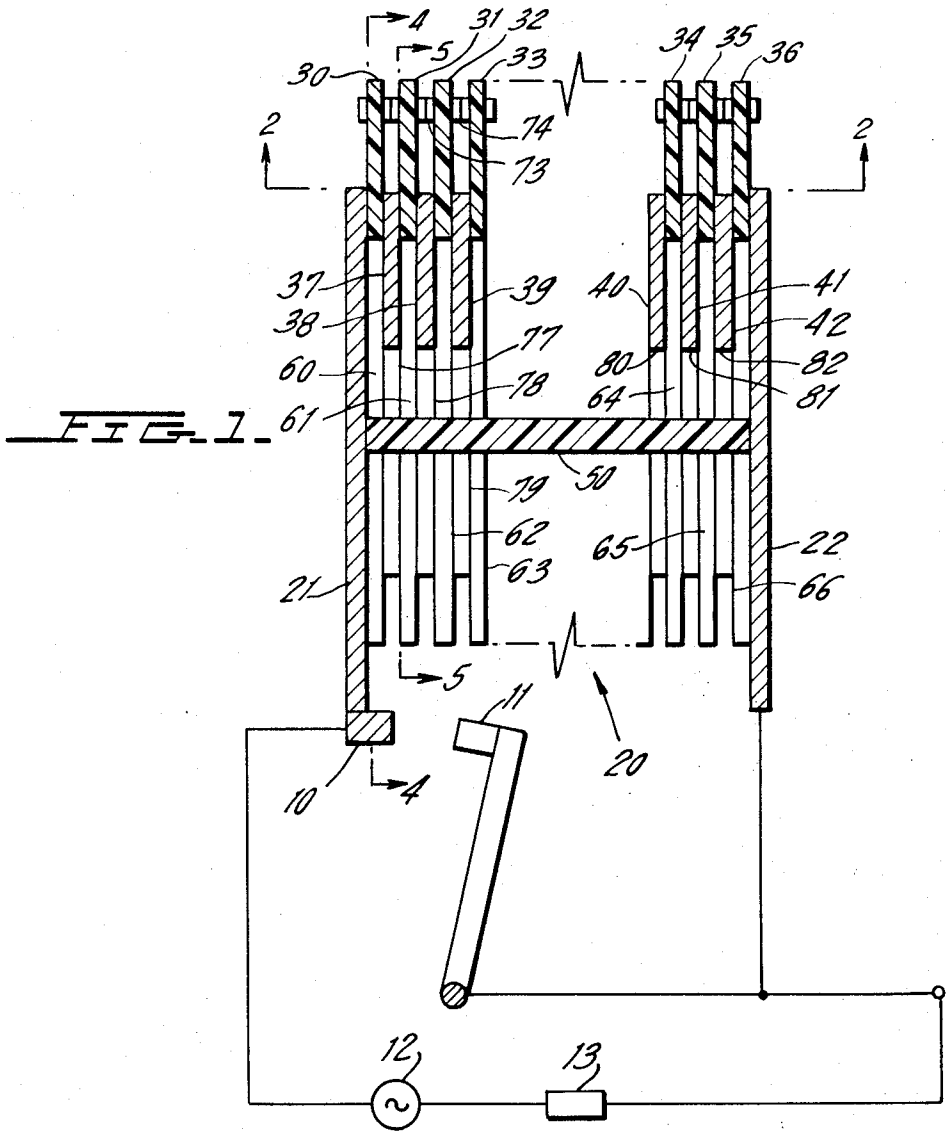


FIG. 1

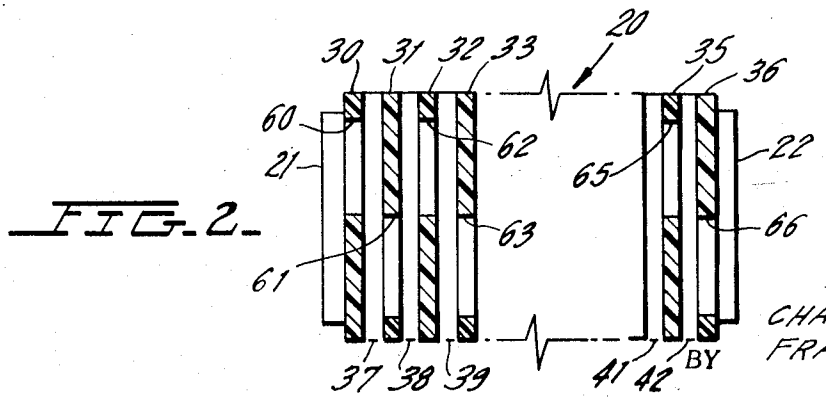


FIG. 2

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FIG. 3.

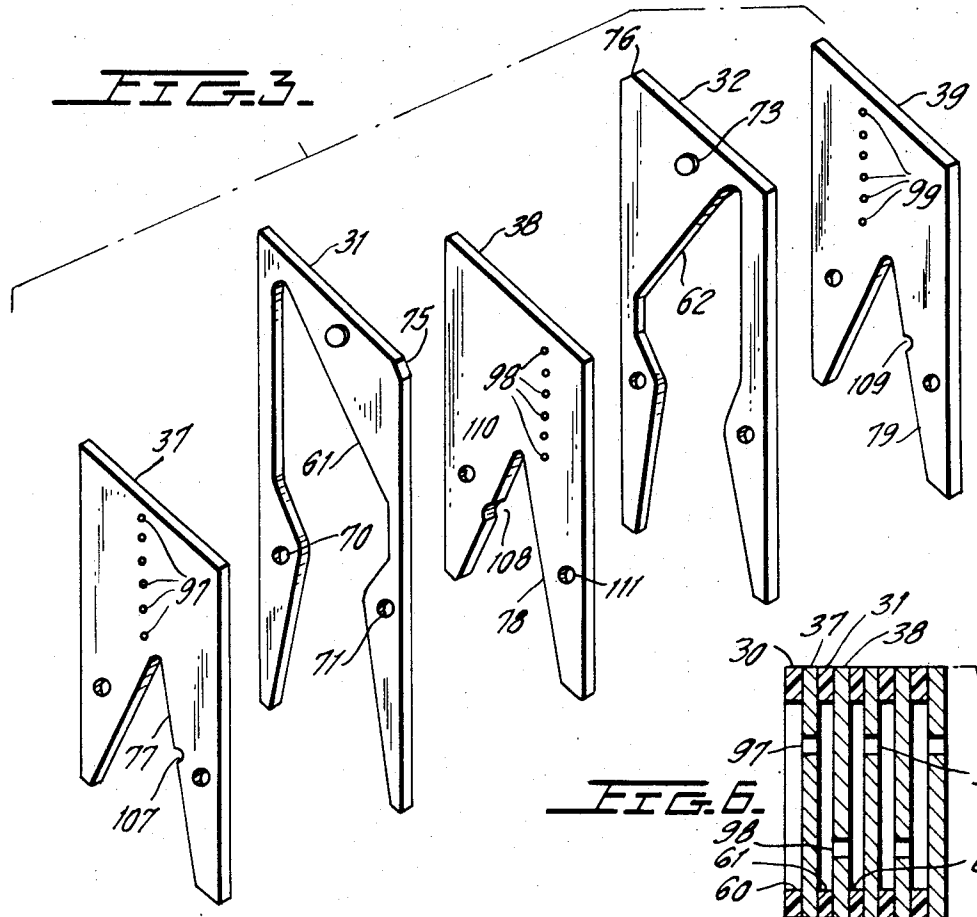


FIG. 6.

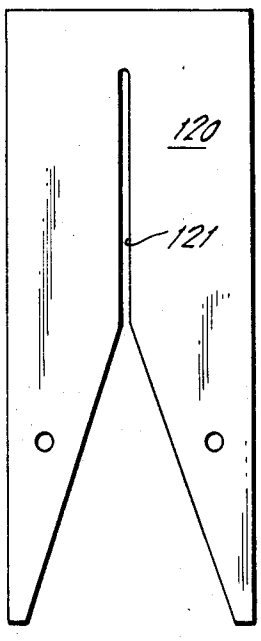


FIG. 7.

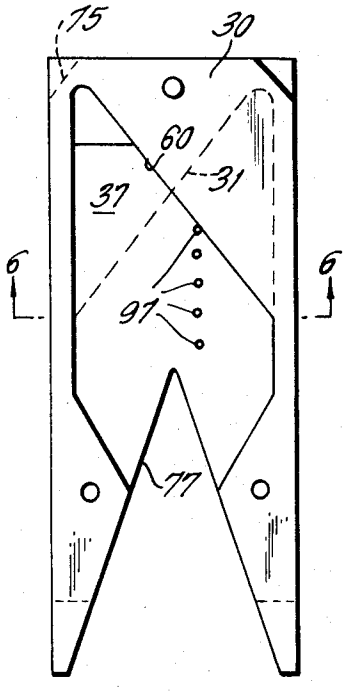


FIG. 4.

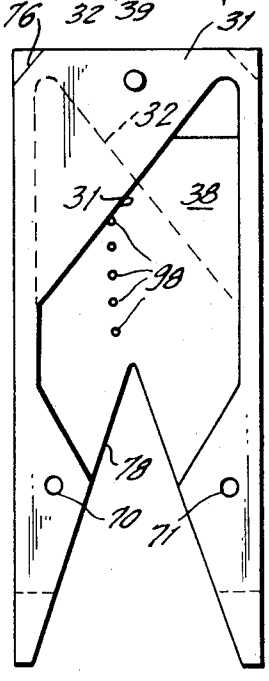


FIG. 5.

SHOCK-PROOF ARC CHUTE FOR HIGH VOLTAGE CIRCUIT BREAKER WITH METALLIC ARC PLATES HAVING OFF-SET LINES OF OPENINGS

BRIEF SUMMARY OF THE INVENTION

This invention relates to air-magnetic circuit interrupter devices, and more particularly relates to an arc chute construction particularly adapted for use in high voltage air-magnetic circuit breakers.

Industry standards define "high voltage" air-magnetic circuit breakers as those which are rated at one thousand volts or more, while "low voltage" breakers of this type are rated at less than one thousand volts. This standard shall be followed herein when referring to "high" and "low" voltage breakers.

The term "air-magnetic" breaker hereinafter refers to that type of breaker which employs magnetic fields for moving the arc drawn between separating contacts into an arc chute containing spaced plates of materials which contain and deionize the arc using various well-known principles.

In the conventional high voltage air-magnetic breaker, the arc chute is formed of spaced ceramic plates which are slotted to reduce the cross-sectional area of the arc, and force the arc to travel a tortuous path, and which rapidly cool the arc. The assemblage of such plates, however, is relatively fragile because the ceramic plates are easily broken by shock forces.

Low voltage air-magnetic breakers conventionally use spaced metal plates in their arc chute which effect interruption of an arc by breaking the arc into short segments, from plate to plate. Thus, the arc voltage is increased and each arc segment is appropriately cooled. The arc chutes of low voltage breakers are relatively shock-proof because they use relatively strong metal plates.

In accordance with one feature of the present invention, we have found that metal plates of the type conventionally used in low voltage breakers can be used in place of the conventional ceramic plate of the high voltage breaker, thereby to provide a high voltage breaker having relatively shock-proof characteristics. Experiments we have performed with such breakers have demonstrated that metal plates can be used in the arc chutes of breakers rated in excess of 4,000 volts, contrary to the expectations of those skilled in this art who have accepted the concept that ceramic plates must be used at voltages above 1,000 volts.

In order to improve the operation of the arc chute at high voltage, the conventional slot placed in the metal plate, to define a magnetic field for urging the arc to rise in the arc chute, was replaced by a series of spaced holes. Moreover, the holes in the plates were off-set from the center of the plate, and the lines of holes in adjacent metal plates were displaced in opposite directions to prevent a line-of-sight through the plates. The conventional slot of the metal plate was found to permit the arc to move up to the top of the arc chute too quickly to permit the best deionization of the arc. The use of the spaced holes defined the same necessary magnetic field for moving the arc, but also tends to slow down the arc to improve the interrupting characteristics of the arc. It should be noted that the use of a series of holes instead of a slot in an iron plate is a feature which could be used in the metallic plate of a low voltage breaker as well as in a high voltage breaker.

A further feature of the present invention, as related to high voltage breakers, is in the construction of the spacer plates. Thus, the spacers are formed of an insulation material of any desired type, such as a fiber, and are provided with laterally extending slots which reach above the tops of the metal plates. These slots extend in opposite directions for alternate spacers such that there is no line-of-sight through the slots over the top of the metal plates. Each slot then defines a chamber between adjacent and metal plates, with the individual chambers communicating with one another over a tortuous path above the tops of the metal plates. These chambers allow the venting of ionized gas products through the top of the chamber and insure turbulence which causes mixing of the arc products and improves the deionization of the arc chamber.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a cross-sectional, schematic drawing of a circuit breaker employing the arc chute of the present invention.

FIG. **2** is a cross-sectional drawing of FIG. **1** taken across the section line **2** — **2** in FIG. **1**.

FIG. **3** is an exploded perspective view of a few of the plates of the arc chute of FIGS. **1** and **2**.

FIG. **4** is a cross-sectional view of FIG. **1** taken across the section line **4** — **4** in FIG. **1** to illustrate a first pair of insulation and metal plates in the arc chute.

FIG. **5** is a cross-sectional view of FIG. **1** taken across section line **5** — **5** in FIG. **1** to illustrate a second pair of insulation and metal plates which are stacked adjacent the plates of FIG. **4**.

FIG. **6** is a cross-sectional view of FIG. **4** taken across the section lines **6** — **6** in FIG. **4**.

FIG. **7** is a plan view of a conventional metal plate of the prior art.

DESCRIPTION OF THE DISCLOSED EMBODIMENT

Referring now to the figures, FIG. **1** schematically illustrates a circuit interrupter having a stationary contact **10** and movable contact **11**, which are connected in a circuit having a voltage source **12** and load **13**. In accordance with certain features of the invention, source **12** may be a source of a-c or d-c voltage. The value of the d-c voltage or its RMS a-c voltage may be in excess of one thousand volts so that the circuit breaker is defined as a high voltage circuit breaker. While FIG. **1** shows the breaker for a single phase circuit, it will be apparent to those skilled in the art that the breaker could be made as a multiphase unit for use in a multiphase circuit.

The circuit breaker of FIG. **1** is provided with an arc chute **20** which has conventional arc runners **21** and **22** at its opposite ends, which are respectively connected to the contacts **10** and **11** and serve to receive the outer ends of the arc drawn by the contacts **10** and **11** when they separate.

Arc chute **20** consists of a stack of plates including the alternately disposed insulation spacers **30** to **36**, and metal plates **37** to **42**. The stack of plates can be held together in any desired manner by brackets (not shown) and by aligning and securing members, such as shaft **50** (FIG. **1**) which extends through aligned openings in the plates of the stack.

Each of the insulation spacers may be of fiber or any other suitable insulation material, and are of identical construction. Thus, the plates are provided with laterally extending slots, shown as slots **60** to **66** for plates **30** to **36**, respectively. Note that each of slots **60** to **66** has a generally U shape, with only the bottom section of the U being laterally displaced from the longitudinal center of the plate. Note also that the plates are alternately reversed in position so that the lateral extension of each slot is reversed from the slots of adjacent plates. Each of the plates **30** to **36** are further provided with mounting openings, shown as openings **70** and **71** for plate **31** in FIGS. **3** and **5**, which openings receive pins, such as pin **50** of FIG. **1**. Each of the plates is further provided with aligned projecting buttons, such as buttons **73** and **74**, extending from the opposite surfaces of plate **32** (FIGS. **1** and **3**). These buttons prevent the warpage of the fiber plates in the stack and are of sufficient height to engage one another when the stack is assembled. In order to insure that the plates are appropriately aligned in the completed stack, a keying notch may be provided on the corner of each plate, shown as keying notches **75** and **76** for plates **31** and **32** (FIGS. **3**, **4** and **5**).

The metallic plates of the arc chute **20** are also identical in construction, and may be of conventional steel material. Each of the plates **37** to **42** contains V-shaped slots **77** to **82**, respectively (FIGS. **1**, **3**, **4** and **5**), and, in accordance with a feature of the invention, further contains a plurality of openings extending longitudinally along, and laterally displaced from the longitudinal center of the plate. Thus, as best seen in FIGS. **3**, **4**, **5** and **6**, each of the metal plates is provided with the series of spaced openings **97**, **98** and **99**, shown for plates **37** to **39**, respectively. These holes may, for example, have diameters of about one-eighth inch and be spaced on three-eighth inch centers. The lines of openings are laterally displaced from the longitudinal center of the plates and adjacent metal plates are reversed so that their lines of openings are laterally displaced. In order to insure proper assemblage, keying notches, such as notches **107**, **108** and **109** are provided in the slots **77**, **78** and **79**, respectively, of plates **37**, **38** and **39**, respectively. As in the case of the fiber plates, the metal plates are provided with mounting openings, such as openings **110** and **111** in plate **38** (FIG. **3**) which aligns with openings **70** and **71** in the fiber plate **31**.

In accordance with a first feature of the invention, an assemblage of stacked fiber spacers **30** to **36** and metal plates **37** to **42** may be used in a high voltage circuit breaker. In this broad aspect of the invention, the metal plates may take the form of the plate conventionally used for low voltage circuit breakers, and shown in FIG. **7**. Thus, in FIG. **7**, the metal plate **120** may be used for each metal plate of FIG. **1**, and contains a central elongated slot **121**. Slot **121** defines a path for the magnetic field created by the arc current (which is generally perpendicular to the slot **121**) such that the arc current tends to move upwards in the arc chute and toward the top of the arc chute plates. It has been found, in accordance with the invention, that such metal plates can be used in a high voltage breaker despite the exclusive use by those skilled in the art of ceramic plates for breakers rated at voltages in excess of one thousand volts. Moreover, the stacking of fiber plates in face-to-face contact with metal plates produces a high voltage breaker of improved shock resistance as compared to high voltage breakers using the conventional ceramic plate, or as compared to low voltage breakers in which the metallic plates are mounted and spaced from one another by slotted side members of insulation material.

In accordance with a further feature of the invention, the conventional elongated slot of the metal plate (slot **121** of FIG. **7**) may be advantageously replaced by the series of spaced openings, shown as openings **97**, **98** and **99** in FIGS. **3** to **6**. The presence of such openings provides substantially the same elongated path of increased resistance as does the full slot, so that the arc current will move up the arc chute. The use of holes, however, has been found to slow down the upward movement of the arc in the arc chute so that more energy can be extracted from the arc before it reaches the top of the arc chute. Thus, in FIG. **6**, the metal plates of the arc chute break the main arc into a plurality of small arcs. Because of the openings, however, rather than a continuous slot, tests suggest that these small arcs extinguish and then reignite adjacent the individual openings as the arc current rises in the arc chute. This requires additional energy, which is extracted from the arc, and slows the upward movement of the arc so that it is in contact with the metal plates for a longer time than in the case of the slotted arc plate. This effect is enhanced by staggering the openings, requiring current flow through the metal plates as shown in FIG. **6**.

A further important feature of the present invention is the use of laterally displaced slots **60** to **66** in the insulation spacer plates, particularly in connection with the high voltage device. Thus, a plurality of chambers are provided for ionized gases which move up the chamber with turbulent flow, and are mixed in the tortuous path above the top of the stack of metal plates. Note in FIGS. **4** and **5** that the edges of slots of adjacent plates intersect below the top of the metal plates so that there is no line-of-sight over the tops of the metal plates. Thus, arc restrike over the tops of the plates, which is a substantial danger in high voltage breakers, is prevented, even though the gases from each insulation plate slot can intermix above the top of the metal plates.

Although there has been described a preferred embodiment of this invention invention, many variations and modifications will now be apparent to those skilled in the art. Therefore, this invention is to be limited, not by the specific disclosure herein, but only by the appending claims.

The embodiments of the invention in which an exclusive privilege or property is claimed are defined as follows:

1. An arc chute for a high voltage circuit breaker which is rated at a voltage greater than one thousand volts; said arc chute comprising a plurality of alternately disposed metal plates and insulation spacer plates; each of said metal plates being comprised of a relatively thin, generally elongated member having a V-shaped slot extending from an apex disposed generally centrally in said plate to a bottom edge thereof, the tops of said metal plates being aligned with one another; each

of said insulation plates being comprised of a relatively thin, generally rectangular unitary elongated member having a U-shaped slot therein extending from an upper continuous base region to an open bottom edge; the tops of said insulation plates being aligned with one another and extending beyond said tops of said metal plates; said upper base region of said U-shaped slot in each of said insulation plates being disposed above said top of said metal plates, whereby the spaces between adjacent metal plates communicate with one another above the said top of said metal plates through said U-shaped slots in said insulation plates; said metal plates being held in surface-to-surface contact with said insulation plates; the legs defined by said V-shaped slot in said metal plates being substantially coextensive with the legs defined by said U-shaped slot in said insulation plate.

2. An arc chute for a high voltage circuit breaker which is rated at a voltage greater than one thousand volts; said arc chute comprising a plurality of alternately disposed metal plates and insulation spacer plates; each of said metal plates being comprised of a relatively thin, generally elongated member having a slot extending from an apex disposed generally centrally in said plate to a bottom edge thereof, the tops of said metal plates being aligned with one another; each of said insulation plates being comprised of a relatively thin, generally rectangular unitary elongated member having a slot therein extending from an upper continuous base region to an open bottom edge; the tops of said insulation plates being aligned with one another and extending beyond said tops of said metal plates; said upper base region of said slot in each of said insulation plates being disposed above said top of said metal plates, whereby the spaces between adjacent metal plates communicate with one another above the said top of said metal plates through said slots in said insulation plates; said metal plates being held in surface-to-surface contact with said insulation plates; the legs defined by said slot in said metal plates being substantially coextensive with the legs defined by said slot in said insulation plate.

3. The arc chute of claim 1 wherein said metal plates are each identical to one another, and herein said insulation plates are each identical to one another.

4. The arc chute of claim 2 wherein said slots in said insulation plates have laterally extending straight portions extending to one side of each of said plates in a region adjacent the said top of said plates; said laterally extending portions of adjacent insulation plates extending in opposite directions.

5. The arc chute of claim 4 wherein all portions of said slots in said insulation plates are on one side of the longitudinal center of said insulation plates at regions above the top of said metal plates.

6. The arc chute of claim 4 wherein said slots in said insulation plates have generally U shapes and herein said slots in said metal plates have generally V shapes.

7. The arc chute of claim 2 wherein said metal plates each contain a line of spaced openings extending parallel to the longitudinal center line of each of said plates.

8. The arc chute of claim 7 wherein each of said lines of spaced openings is laterally displaced from said longitudinal center line of said metal plates; said lines of openings of each of said plates being displaced to a side opposite from that of the line of openings of an adjacent metal plate.

9. The arc chute of claim 6 wherein said metal plates each contain a line of spaced openings extending parallel to the longitudinal center line of each of said plates and wherein each of said lines of spaced openings is laterally displaced from said longitudinal center line of said metal plates; said lines of openings of each of said plates being displaced to a side opposite from that of the line of openings of an adjacent metal plate.

10. The arc chute of claim 3 wherein each of said insulation plates contains aligned protrusion means disposed above the top of said metal plates to prevent the warpage of said insulation plates toward one another.

11. The arc chute of claim 9 wherein each of said insulation plates contains aligned protrusion means disposed above the top of said metal plates to prevent the warpage of said insulation plates toward one another.

12. The arc chute of claim 11 which further includes first notch means on a side of said insulation plates which is exposed to view in the assemblage of plates, and which further includes second notch means on a side of said metal plates which is exposed to view in the assemblage of plates; said first and second notch means being disposed away from the longitudinal center of said insulation and metal plates, and visually indicating the spacial relation of said laterally displaced openings and of said laterally extending portions of said slots.

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