May 19, 1953 G. E. JANSSON 2,639,353

CIRCUIT BREAKER WITH ARC CHUTE SHORT CIRCUITING SECTIONS OF THE ARC

Filed Jan. 24, 1950 2 Sheets-Sheet 1

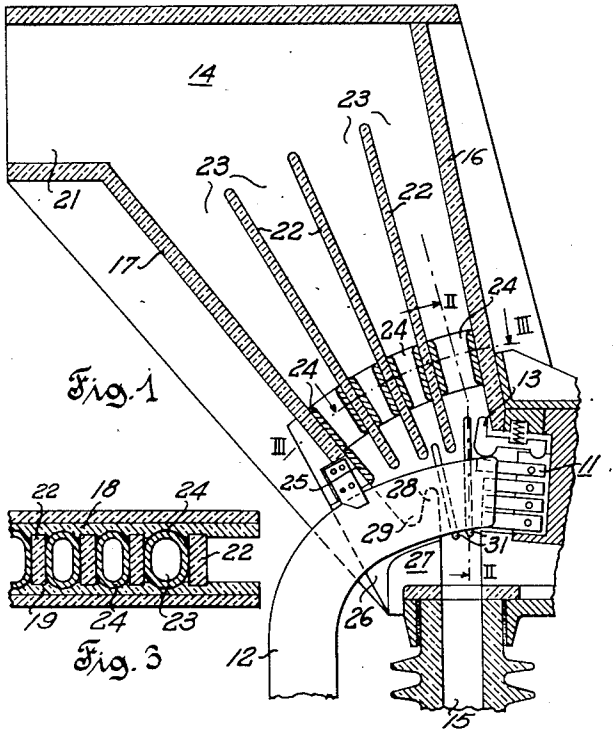


Fig. 1

Fig. 3

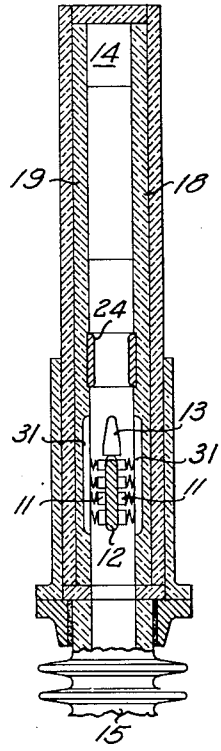


Fig. 2

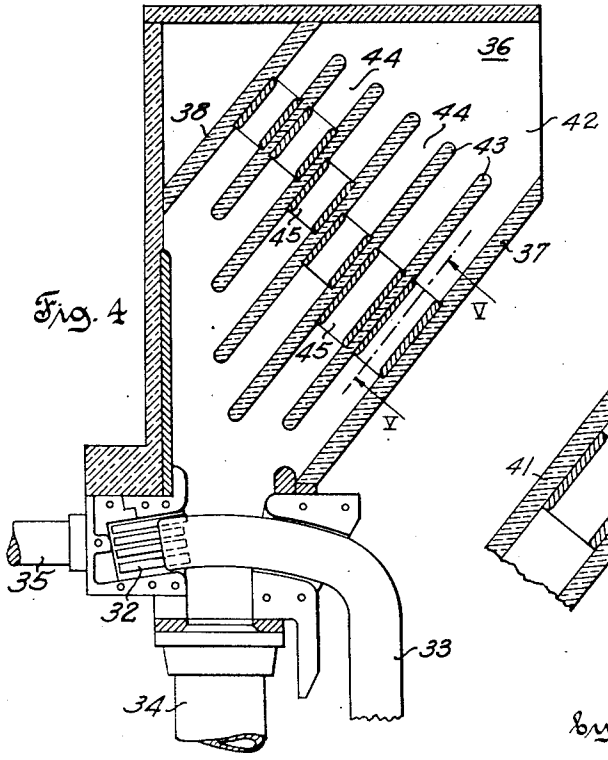


Fig. 4

Fig. 5

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CIRCUIT BREAKER WITH ARC CHUTE SHORT CIRCUITING SECTIONS OF THE ARC

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2 Sheets-Sheet 2

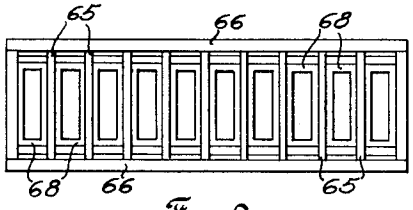


Fig. 8

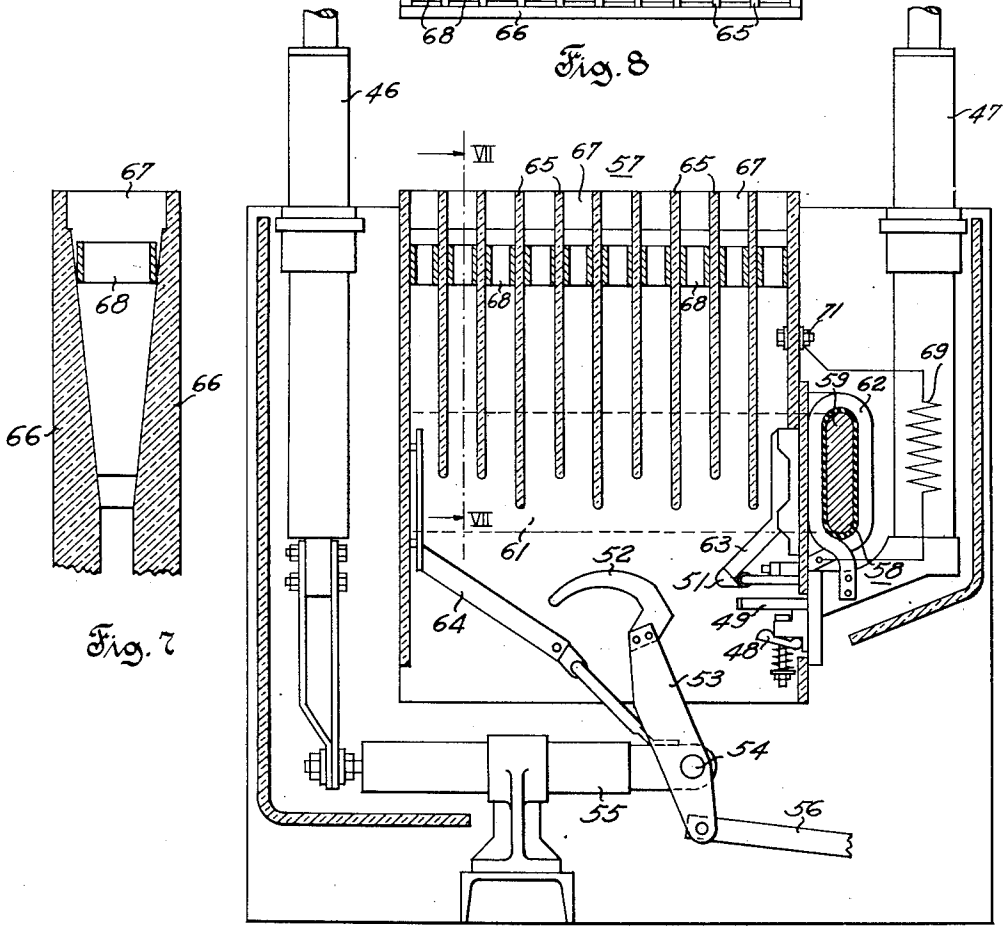


Fig. 6

Fig. 7

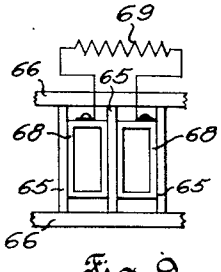


Fig. 9

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CIRCUIT BREAKER WITH ARC CHUTE SHORT CIRCUITING SECTIONS OF THE ARC

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10 Claims. (Cl. 200—147)

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This invention relates to circuit interrupting devices and more particularly to arc extinguishing means for use in connection therewith.

In the construction and operation of circuit interrupters, it is frequently necessary to provide means for extinguishing quickly the arc which is drawn between separable arcing contacts. This arc is usually blown by blowout means, such as an air blast or a magnetic blowout coil into an arc chute which is arranged to quench the arc by lengthening it, cooling it, deionizing it, or a combination thereof.

In addition, the interruption of heavy current power arcs is often accompanied by a great deal of flame composed of incandescent particles of arc products including metal or other inorganic substances, and burning gases. This flame is objectionable if not completely confined since it tends to break down the dielectric strength of the surrounding air and thereby cause failure of the circuit breaker and possible damage to adjacent apparatus.

Heretofore, various barriers and cooling devices have been employed in arc chutes for cooling the arc and gases, but these arrangements have been, in general either inadequate in case of large currents or have been intended to work only when placed at points of the arc chute where the cross section of the blast passage is small, thus constituting a serious impediment to the free flow of air or other gas through the arc chute.

In accordance with the invention claimed, an arc chute is provided adjacent a pair of arcing contacts for receiving the arc at one end thereof and exhausting the arcing products at the other end thereof. The arc chute employs an arc extinguishing device comprising a plurality of spaced partitions of insulating material forming with the side walls of the chute a plurality of arc passages. The partitions are arranged across the chute to extend transversely of the arc. Within the passages or interbarrier spaces are located relatively short metallic tubes or rings for the purpose of limiting arc elongation and arc energy. When the tubes or rings are engaged by the ends of the arc loops driven into the passages the arc loops are short circuited thereby converting each arc loop into two adjacent, serially related arc sections, thus limiting arc elongation and arc energy. These sections, being in close contact with the surfaces of the barriers which form the passages, are quickly cooled and extinguished. The tubes or rings closely fit against adjacent barriers and lateral insulating elements of the chute, thereby permitting a free

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flow of air or other gas through the passages. Although wall hugging rings or tubes are preferable the rings and tubes may be spaced from the partitions and chute elements along at least a part of their periphery provided that the spacing therebetween is sufficiently narrow to preclude the arc from looping through the gaps so formed.

It is, therefore, one object of the present invention to provide a new and improved arc interupting device in which the arc is divided into a plurality of loops which are short circuited when they reach a predetermined length.

Another object of the present invention is to provide a new and improved arc interrupting device that limits arc elongation and arc energy.

A further object of the invention is to provide a new and improved arc interrupting device in which arc elongation and arc energy are limited without impeding the flow of an arc extinguishing blast.

Objects and advantages other than those above set forth will be apparent from the following description when read in connection with the accompanying drawings, in which:

Fig. 1 is a partial view in elevation, partly in cross section, of a fluid blast circuit breaker embodying the present invention;

Fig. 2 is a view in cross section of the embodiment illustrated in Fig. 1 taken along the line II—II;

Fig. 3 is a view in cross section of the embodiment illustrated in Fig. 1 taken along the line III—III;

Fig. 4 is a partial view in elevation, partly in cross section, of a fluid blast circuit breaker employing a modification of the invention illustrated in Fig. 1;

Fig. 5 is a view in cross section of the embodiment illustrated in Fig. 4 taken along the line V—V;

Fig. 6 is a view in elevation, partly in cross section, of a magnetic blowout type circuit breaker embodying the present invention;

Fig. 7 is a view in cross section of the embodiment illustrated in Fig. 6 taken along the line VII—VII;

Fig. 8 is a top view of the embodiment illustrated in Fig. 6; and

Fig. 9 is a partial view of the arc chute illustrated in Fig. 8 employing a modification of the invention.

Referring more particularly to the drawings by characters of reference, Figs. 1–3 illustrate a fluid blast circuit breaker structure embodying the new

and improved arc extinguishing device. Although in general, circuit breakers of the type illustrated in Figs. 1 to 3 are provided with a plurality of similar pole structures, one for each phase of a polyphase electric circuit, only one such pole structure is shown in the drawings and the circuit breaker will be described in detail as if it were of the single pole unit type. The circuit breaker comprises relatively movable arcing contacts such as fixed contact structure 11 of the finger type and a pivoted blade like contact 12. The fixed contact structure may comprise a plurality of current carrying contacts and an arcing contact 13 provided with an arc runner as is well known, and is electrically connected to one line terminal of the breaker.

The movable contact 12 is suitably connected to an actuating mechanism (not shown) for actuating the movable contact between closed and open circuit positions.

For the purpose of extinguishing the arc formed between the contacts when a power circuit connected thereto is opened, an insulating arc extinguishing structure such as arc chute 14 is arranged with respect to the contacts so that the arc is drawn at the entrance of the chute directly opposite a gas blast supply conduit 15. The conduit forms part of any suitable known source of arc extinguishing fluid, which source may also comprise a blast valve (not shown) joining the conduit to a storage tank and air compressor equipment (not shown).

The arc chute 14 defines a narrow, diverging space into which the arc is driven and extinguished by the blast and is formed by diverging end walls 16 and 17 and comparatively closely spaced parallel side walls 18 and 19 more clearly shown in Figs. 2 and 3. The walls of the chute are composed of a suitable insulating material such as a molded laminated structure. The exhaust end of the chute is closed except for a laterally extending conduit or stack 21 which directs the heated blast gases away from the circuit breaker proper.

The arc chute comprises a plurality of spaced diverging barriers or partitions 22 of insulating material which form with the side walls 18 and 19 a plurality of diverging arc passages 23. Partitions 22 are arranged across the arc chute 14 to extend transversely of the arc. Within each interbarrier space or passage 23 is located a relatively short, oblong metallic tube 24, as more clearly shown in Figs. 2 and 3, which is disposed between the ends of passage 23 which its longitudinal axis transversely of the arc. Tubes 24 may be made of any suitable metal or alloy, but are preferably made of material of low electrical resistivity, such as bronze.

Tubes 24 may be mounted to closely fit against adjacent partitions, thereby permitting the free flow of the arc extinguishing blast through the passages 23. As shown the tubes 24 may be spaced from the partitions 22 and side walls 18 and 19 along at least a part of their periphery provided that the spacing is sufficiently narrow to preclude the arc from looping through the gap formed. End walls 16 and 17 may be provided with arc runners 25 (one of which is shown in Fig. 1), which may be conductively connected to the adjacent tubes 24. Contact 13, which also defines an arc runner, may likewise be conductively connected to the nearest tube 24.

In order to concentrate the blast on the arc section which is first formed and is directed into the first passage 23, and to limit escape of arc products and compressed air through a slot 26 provided in arc chute 14 for permitting movement of movable contact 12, the arc chute defines a nozzle structure 27 connected to supply conduit 15. The inner surfaces of nozzle 27 define a pair of finger shaped projections 28 (only one of which is shown in Fig. 1) located one on each side of movable contact 12 to cause a preponderance of the blast to flow in the direction of the first-formed arc section and limit the amount of compressed air flowing through the blast passages 23 situated remotely from the first formed arc section. Projections 28 form with the side walls of arc chute 14 a pair of pockets or zones 29 (only one of which is shown in Fig. 1), one on each side of contact 12, which tend to form an eddy in each zone, thus limiting the escape of arc products and compressed air through slot 26. Grooves 31 extending transversely of the direction of movement of contact 12 are provided in walls 18 and 19 of chute 14 for increasing the creepage path across the area where the arc gap is formed upon separation of the arcing contacts 11 and 12.

The circuit breaker illustrated in Fig. 1 is shown with the cooperating arcing contacts in the closed circuit position. An opening operation is initiated by admission of gas under pressure to supply conduit 15 and the actuation of blade contact 12 to the left to open the electric circuit.

As the blade contact 12 is separated from the fixed arcing contact 13, an arc is drawn and a blast of gas of high intensity from the supply conduit 15 drives or loops the arc into arc chute 14 and more particularly into passages 23.

In accordance with the invention the arc is driven into passages 23 until the loops thereof contact the metallic tubes 24. When each tube 24 is engaged by the end of the arc loop driven into the particular passage, the loop is short circuited by the tube, which is located near the upstream end of the adjacent partitions 22, thus dividing the particular loop into two serially related arc sections interconnected by the tube. The arc loop is effectively short circuited, thus limiting its length and energy.

Figs. 4 and 5 illustrate a modification of the invention so far described as embodied in a modified fluid blast circuit breaker. The circuit breaker structure of Fig. 4 comprises relatively movable arcing contacts such as finger type fixed contacts 32, pivoted blade like contact 33, a source of arc extinguishing fluid comprising a gas supply conduit 34, and an arc extinguishing structure.

The fixed contact 32 comprises a plurality of current carrying contacts and an arcing contact, as described heretofore, and is electrically connected to one line terminal 35 of the breaker. The movable blade contact 33 is connected to the other line terminal (not shown), and is actuated by a connected rod (not shown) for moving contact 33 between open and closed positions.

The arc extinguishing structure comprising an arc chute 36 is mounted adjacent the arcing contacts 32 and 33 for extinguishing the arc formed between the contacts when a power circuit connected thereto is opened. Arc chute 36 is formed by end walls 37 and 38 and comparatively closely spaced parallel side walls 39 and 41. The walls of the chute may be composed of any suitable insulating material. The exhaust end of the arc chute is provided with an outlet 42 for directing the heated blast gases away from the circuit breaker proper.

Arc chute 36 further comprises a plurality of parallel spaced barriers or partitions 43 of varying lengths mounted so as to extend transversely of the arc and forming with the walls of the chute a plurality of spaced parallel passages 44.

The partition 43 immediately adjacent the right end of arc chute 36 is illustrated as being a little shorter than the partition immediately adjacent it. These two partitions, however, may be equal in length. The remainder of the partitions usually decrease in length progressively from right to left. Within each interbarrier space or passage 44 is located a relatively short, thin metallic tube 45, as illustrated in Fig. 5, which is disposed between the ends of passage 44 and is usually coaxially aligned therewith. Tubes 45 may be embedded in the adjacent partitions, thereby permitting the free flow of the arc extinguishing blast through the passages 44. The tubes, however, may also be applied to the walls of the partitions as shown in Fig. 1 or in any other suitable manner.

As illustrated in Fig. 4 tubes 45 are spaced at varying distances from the upstream edges of passages 44, however, tubes 45 may be mounted at other distances without ceasing to function as claimed.

As the blade contact 33 is separated from the fixed contact 32, an arc is formed which is rapidly elongated by a blast of gas of high intensity from supply conduit 34. The arc loop is initially driven substantially perpendicularly to the direction of movement of contact 33. Further elongation is limited to a plurality of loops extending within passages 44 and occurs at a relatively slower rate than for the original arc loop. As described above, the arc loops into passages 44 and contacts the metallic tubes 45. When each tube is engaged by the end of the arc loop driven into the particular passage, the loop is short circuited by the tube, thus dividing the loop into two parallel, serially related arc sections. Each arc loop is effectively short circuited, thus limiting its length and energy.

Fig. 6 illustrates a magnetic blowout type of circuit breaker including as elements thereof a pair of terminal studs 46 and 47 for connecting the circuit breaker to line conductors (not shown). The circuit interrupter or breaker in Fig. 6 comprises essentially means for opening the circuit to form an arc, and an arc extinguishing structure. Specifically, the circuit opening means comprises fixed contacts 48 and 49, a fixed arcing contact 51, and a movable arcing contact 52. Arcing contact 52 is mounted on a lever 53 which is pivotally mounted at 54 on an extension 55 of the circuit breaker stud 46 and is operated by means of a reciprocally movable rod 56. The operating rod 56 is suitably connected to an actuating mechanism (not shown) for operating the movable contact between closed and open circuit positions. Fig. 6 illustrates the movable arcing contact 52 in a partially open position. The contacts 48, 49, 51 are electrically connected to the lower end of terminal stud 47. Accordingly, when the breaker is connected in series in a power circuit and the arcing contacts are separated, an arc forms across the gap indicated.

For the purpose of interrupting this power arc, an arc extinguishing structure, such as an arc chute 57 may be mounted so as to receive the power arc, which is under the influence of a magnetic blowout means 58. The arc chute preferably is disposed directly above the arcing contacts, as shown, when the blowout means act upward, but may be mounted in any other suitable location when the blowout means act in other directions. The arcing contacts and the magnetic blowout structure can assume any suitable known form so that a brief description thereof will be sufficient. The magnetic blowout means 58 comprises a core 59, poles 61, and a coil 62 which is inserted in the connection between the terminal stud 47, contact 51 and an arc runner 63, so that the arc current (as the arc travels along the runner) flows through the blowout coil in a manner well known in the art. Core 59 and poles 61 embrace at least part of arc chute 57 for driving the arc into the chute and toward the exhaust end thereof.

Normally the current is carried in the closed circuit position of the breaker by the spring biased contact 48. As the movable arcing contact 52 is actuated to open circuit position, current is shunted from fixed contact 48 sequentially to fixed contact 49 and to fixed arcing contact 51. As the arc is drawn by the movable arcing contact 52, the arc terminal on arcing contact 51 is transferred to arc runner 63 which is usually an extension arm of the fixed arcing contact 51. As the movable arcing contact 52 reaches its full opening stroke the arc terminal transfers from the movable arcing contact 52 to an arc runner 64 which directs the arc into the arc chute 57. As above set forth, the arcing contact 51 and the arc runner 63 are electrically connected in series with the blowout coil 62 and stud 47. Accordingly, the blowout coil is already energized at the inception of the arc interruption to influence the arc in a well known manner, i. e. to drive it into the arc chute 57 in an expanding loop.

In accordance with the invention, arc chute 57 comprises a plurality of spaced barriers or partitions 65 or suitable insulating material forming with a pair of diverging side walls 66 a plurality of diverging arc passages 67 parallel to each other. Partitions 65 are arranged across the arc chute 57 to extend transversely of the arc. Within at least one interbarrier space or passage 67 or within each passage 67 there is located a relatively short, thin conductive ring or tube 68 which, for example, may be a relatively short, thin rectangular metal tube, as shown in Figs. 6–8, mounted with its longitudinal axis extending transversely of the arc. It is desirable to use metallic tubes having a minimum thickness in order to retain the maximum possible passage across sectional arc; but nevertheless, these tubes must be thick enough to be able to carry heavy short circuit currents. Tubes 68 are mounted in any suitable manner to fit against adjacent partitions and against the side walls, thereby permitting the free flow of air and hot arc products through passages 67. The tubes are preferably disposed near the top of the arc chute in magnetic blowout breakers to insure that the arc will be retained within the chute on high short circuit currents and to permit a predetermined arc elongation before short circuiting portions of the arc. Arc energy increases as the arc length is increased to a predetermined critical length. Further elongation beyond this critical length results in a decrease of arc energy. In air blast breakers the short-circuiting tubes are used to limit elongation at a low point of the ascending branch of the arc energy curve and thereby also limit the arc energy. In the air magnetic breaker, the short circuiting tubes are used merely to limit arc elongation at a low point of the descending branch of the arc energy curve.

As the tubes are merely required to short circuit portions of the arc, they may be made of any suitable length providing sufficient material to carry the arc current, and may be in other equivalent forms, such as wire rings for example.

The length of the barrier portions extending from the tubes toward the contacts is so chosen as to limit the arc elongation to the desired value. As shown, the edges of the barriers meeting the arc may be staggered to cause the arc to assume a zig-zag shape before being looped into the arc passages.

The barrier portions extending from the metallic tubes to the exhaust end of the arc chute are given a sufficient length to cool the arc products to a safe temperature for discharge into atmosphere. Such barrier portions may be extensions of the barrier portions disposed toward the contacts or may be differently arranged. Walls 66 diverge toward the exhaust end of the arc chute to cause expansion and resulting cooling of the air carrying arc products before its discharge into atmosphere.

A resistor 69 may be conductively connected at one end thereof to an electrode 71 which engages the arc upon movement of the arc through arc chute 57. The other end of the resistor is connected to the end of blowout coil 62 which is connected to contact 51, thus forming an arc path through the current limiting resistor for aiding arc extinguishment.

As illustrated in Fig. 9, resistor 69 may be connected between a pair of tubes 68 thereby providing a low resistance shunt across one of the arc portions. Under normal interrupting conditions the arc enters the arc chute 57 along the arc runners 63 and 64 and is driven by the magnetic blowout means, the thermal effect of the arc and the chimney effect of the arc chute, into the passages 67. When each tube 68 is engaged by the end of the arc loop in the particular passage, the loop is short circuited by the tube, thus dividing the particular loop into two parallel, serially related arc sections which are interconnected by tube 68. Tube 68 may, for example, closely fit or hug the surfaces of the barriers by which the interbarrier space or passage is bounded, thereby placing the arc segments in close contact with the barriers for further cooling of the arc.

By limiting the length of the arc, by the use of the short circuiting tubes 68, the arc is confined within the chute during arc interruption. By providing tubes in all the arc chute passages the length of all the arc portions is limited. To obtain a cheaper construction and provide a greater cross section for the flow of gases, tubes may be inserted in only one or less than all the arc chute passages, whereby the length of only part of the arc loops is limited.

Although but a few embodiments of the present invention have been illustrated and described, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claims.

It is claimed and desired to secure by Letters Patent:

1. An electric circuit interrupter comprising means for drawing an arc and an arc chute for receiving the arc at one end thereof and exhausting the arc products at the other end, said chute comprising a plurality of spaced partitions of insulating material defining a plurality of diverging passages and arranged across said chute to extend transversely of the arc and hollow tubes of conductive material mounted one within each of said passages with the longitudinal axis of said tubes extending transversely of the arc for limiting arc elongation, each of said tubes being in contact with all the surfaces defining one of said passages.

2. An electric circuit interrupter comprising means for drawing an arc, an arc chute for receiving the arc at one end thereof and exhausting the arc products at the other end, and magnetic blowout means for driving the arc into said chute and toward the exhaust end thereof, said chute comprising a plurality of spaced partitions of insulating material defining a plurality of passages and arranged across said chute to extend transversely of the arc, hollow tubes of conductive material mounted near the exhaust ends of said passages with the longitudinal axis of said tubes extending transversely of the arc for limiting arc elongation, each of said tubes being in contact with all the surfaces defining one of said passages, and a resistor connected between a pair of adjacent hollow tubes for limiting arc current.

3. An electric circuit interrupter comprising means for drawing an arc, an arc chute for receiving the arc at one end thereof and exhausting the arc products at the other end, and means for driving the arc into said chute and toward the exhaust end thereof, said chute comprising a plurality of spaced partitions of insulating material arranged across said chute and extending transversely of the arc to define a plurality of arc passages and metallic tubes mounted between said partitions, each of said tubes being in contact with all the surfaces defining one of said passages and spaced therefrom along at least a part of its periphery for limiting arc elongation.

4. An electric circuit interrupter comprising means for drawing an arc, an arc chute for receiving the arc at one end thereof and exhausting the arc products at the other end, a source of fluid under pressure for driving the arc into said chute and toward the exhaust end thereof, said chute comprising a plurality of spaced partitions of insulating material arranged across said chute to define a plurality of passages extending transversely of the arc, a pair of arc runners mounted at the upstream end of said chute for directing the arc, and metallic tubes mounted between said partitions within said passages downstream of said arc runners for limiting arc elongation, each of said tubes being in contact with all the surfaces defining one of said passages, at least one of said arc runners being conductively connected to at least one of said tubes.

5. An electric circuit interrupter comprising means for drawing an arc, an arc chute for receiving the arc at one end thereof and exhausting the arc products at the other end, and magnetic blowout means embracing at least a part of said chute for driving the arc into said chute and toward the exhaust end thereof, said chute comprising a plurality of spaced partitions of insulating material defining a plurality of passages arranged across said chute to extend transversely of the arc and hollow tubes of conductive material mounted near the exhaust end of said passages to limit arc elongation, each of said tubes being in contact with all the surfaces defining one of said passages.

6. An electric circuit interrupter comprising means for drawing an arc and an arc chute for

receiving the arc at one end thereof and exhausting the arc products at the other end, said chute comprising a pair of side walls, a plurality of spaced partitions of insulating material extending from one of said walls to the other transversely of the arc to define a plurality of passages, and tubes of metal of low resistivity mounted within and surrounding said passages for limiting arc elongation.

7. An electric circuit interrupter comprising means for drawing an arc and an arc chute for receiving the arc at one end thereof and exhausting the arc products at the other end, said chute comprising a pair of relatively closely spaced side walls, a pair of relatively widely spaced end plates extending between said side walls, and a plurality of spaced partitions of insulating material disposed between said end plates and extending from one of said side walls to the other transversely of the arc to define a plurality of passages, and metallic ring inserts of low resistivity mounted between adjacent partitions and surrounding said passages for limiting arc elongation.

8. An electric circuit interrupter comprising means for drawing an arc and an arc chute for receiving the arc at one end thereof and exhausting the arc products at the other end, said chute comprising a pair of relatively closely spaced side walls, a pair of relatively widely spaced end plates extending between said side walls and a plurality of spaced partitions of insulating material disposed between said end plates and extending from one of said side walls to the other transversely of the arc to define a plurality of passages, and metallic hollow cylindrical inserts of low resistivity mounted one between each pair of adjacent partitions and surrounding said passages near the upstream ends thereof for limiting arc elongation.

9. An electric circuit interrupter comprising means for drawing an arc and an arc chute for receiving the arc at one end thereof and exhausting the arc products at the other end, said chute comprising a pair of side walls, a plurality of spaced partitions of insulating material extending from one of said walls to the other transversely of the arc to define a plurality of passages, and metallic tubes of substantially less length than said partitions mounted within and surrounding said passages for limiting arc elongation, said tubes being embedded in adjacent partitions.

10. An electric circuit interrupter comprising means for drawing an arc and an arc chute for receiving the arc at one end thereof and exhausting the arc products at the other end, said chute comprising a pair of relatively closely spaced side walls, a pair of relatively widely spaced end plates extending between said side walls and a plurality of spaced partitions of insulating material disposed between said end plates and extending from one of said side walls to the other transversely of the arc to define a plurality of passages, and metallic inserts forming tubes mounted within and closely fitting against adjacent partitions and said side walls for limiting arc elongation, said tubes being of substantially less length than said partitions and disposed intermediate the ends thereof.

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