United States Patent

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[73] Assignee **General Electric Company**

[54] **ARC CHUTE HAVING ARC RUNNERS COATED WITH THERMALLY-SPRAYED REFRACTORY METAL**
12 Claims, 5 Drawing Figs.

[52] U.S. Cl. 200/144, 200/147
[51] Int. Cl. H01h 33/18
[50] Field of Search ..... 200/144.3, 148.7, 147, (Cursory)

[56] **References Cited**

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2,901,579	8/1959	Simpson, Jr.	200/147

FOREIGN PATENTS

1,043,353	9/1966	Great Britain	200/148.7

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ABSTRACT: Discloses an arc chute comprising insulating sidewalls and spaced-apart metal runners providing paths along which the terminals of an arc travel as the arc moves into the chute. One of the runners comprises a strip of conductive material and a coating of thermally sprayed refractory metal bonded to a surface of the strip to define at its exposed side an arc-running surface.

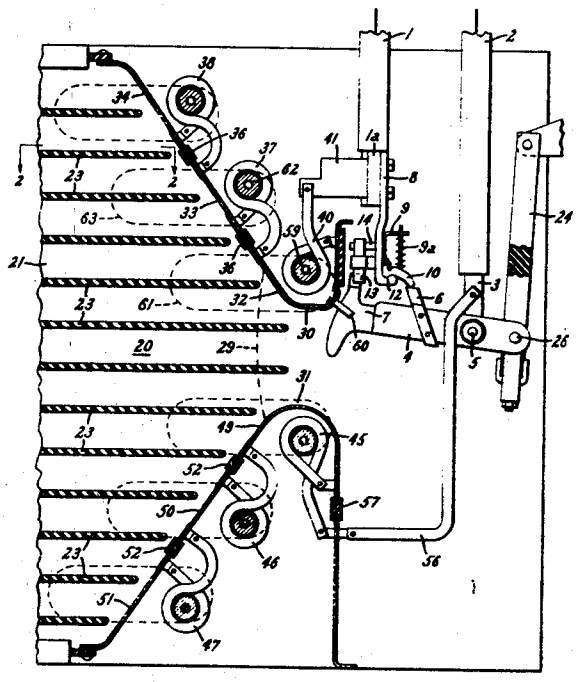


Fig. 1.

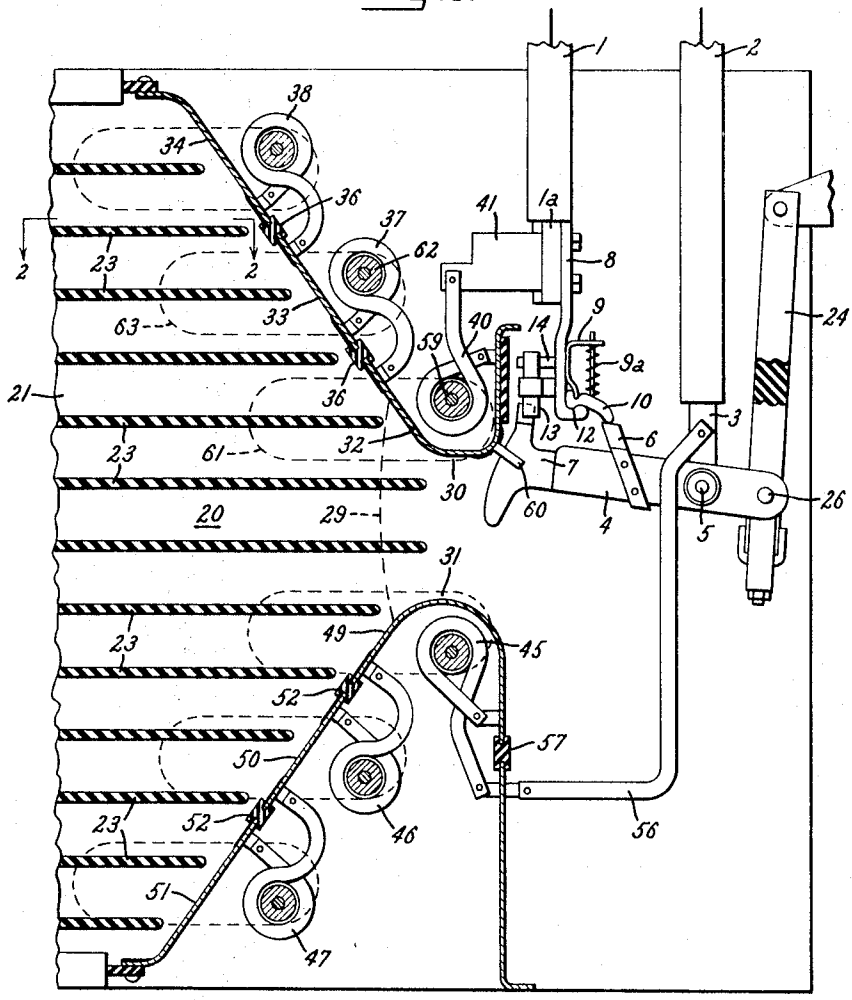


Fig. 4.

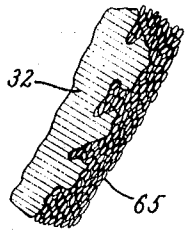


Fig. 5.

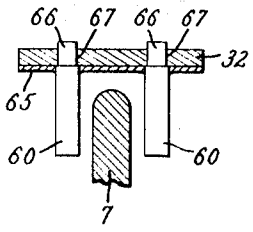


Fig. 2.

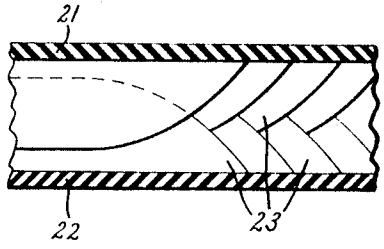
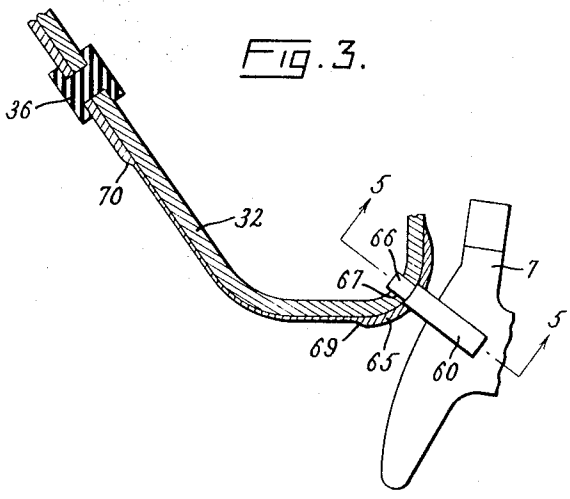


Fig. 3.



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ARC CHUTE HAVING ARC RUNNERS COATED WITH THERMALLY-SPRAYED REFRACTORY METAL

This invention relates to an arc chute for an electric circuit breaker and more particularly to an arc chute comprising metallic runners along which the terminals of the usual arc travel as the arc is driven into the chute.

It has heretofore been customary to construct these arc runners of a high-conductivity metal that has relatively high mechanical strength and can be easily fabricated, e.g.,brass. A high current arc can produce considerable erosion of such runners; and to lessen the extent of such erosion, it has been customary to braze to the runners in certain crucial regions pads of arc-resistant refractory metal. It has been found that such brazed-on refractory metal pads are not as efficient as might be desired in protecting against arc-erosion; and moreover, the current-interrupting ability of a circuit breaker employing such runners has not been as high as might be desired. It appears that the arc has not been moving out of the region of the pads as rapidly as it might and the resulting increased vaporization of metal in the region of the pads appears to be detracting from the current-interrupting ability of the breaker. One reason for the arc's delay in moving out of the region of the pads is that the arc terminal has a tendency to seek out and to hang on any of the brazing alloy which might be exposed in this region.

An object of our invention is to construct the arc runners in such a manner that, as compared to the prior arc runners described hereinabove, arc erosion is substantially reduced and current-interrupting ability is substantially improved.

Another object is to increase the speed with which the arc terminal moves along the arc runner.

Still another object is to distribute arcing duty over a greater portion of the width of the arc as the arc terminal moves along the length of the runner into the chute, thus further reducing erosion and vaporization.

Still another object is to obviate the need for any brazing alloy for attaching the refractory metal to the arc runner.

In carrying out the invention in one form, we provide an arc chute comprising spaced-apart sidewalls of insulating material extending along the length of the usual arc that is present in the chute. A pair of conductive arc runners are disposed in spaced-apart relationship within the chute for defining paths along which the terminals of the arc travel as the arc moves into the chute. At least one of the runners comprises a strip of conductive material and a coating of thermally sprayed refractory metal bonded to a surface of said strip for defining at its exposed side an arc-running surface along which said arc terminal moves. The coating comprises superimposed flattened and interlocking particles of refractory metal bonded together and forming a porous structure. In one embodiment, we include high-conductivity metal in the pores of said refractory metal structure.

For a better understanding of the invention, reference may be had to the following description taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a side elevational view, partly in section, showing an electric circuit breaker embodying one form of our invention.

FIG. 2 is a cross-sectional view taken along the line 2–2 of FIG. 1.

FIG. 3 is an enlarged sectional view of a portion of the circuit breaker of FIG. 1.

FIG. 4 is an enlarged simplified representation of the microstructure of the coating on one of the arc runners.

FIG. 5 is a sectional view along the line 5–5 of FIG. 3.

The invention is illustrated in connection with a circuit breaker of the type shown and claimed in U.S. Pats. 2,901,579 to Simpson and 3,050,062 to Korte et al., assigned to the assignee of the present invention. Referring now to FIG. 1, the circuit breaker shown therein comprises a pair of terminal bushings 1 and 2, both of which are fixed in position relative to the supporting frame of the circuit breaker. The bushing 2 comprises a downwardly extending conductive stud 3 at the lower end of which a movable conductive switch blade 4 is mounted by means of a fixed pivot 5. At its outer end, the blade 4 carries suitable circuit-controlling contacts such as a current-carrying contact 6 and an arcing contact 7.

Bushing 1 comprises a conductive stud 1*a* to which a downwardly extending conductive member 8 is electrically connected. Attached to this conductive member 8 is a curved contact-retaining member 9 which coacts with the member 8 to form a holding pocket for receiving the anchored ends of main current-carrying contact fingers 10. These fingers 10 are pivotally mounted on a curved portion 12 of the conducting member 8 and are biased for limited rotative wiping movement in a closing direction by means of suitable compression springs 9*a*. These compression springs 9*a* provide for high pressure circuit-closing engagement between the stationary current-carrying contact 10 and the movable current-carrying contact 6.

The movable arcing contact 7 cooperates with a stationary arcing contact 13, which is mechanically and electrically connected to the conducting member 8 by suitable clamping means 14. The material of the arcing contacts 7 and 13 is capable of withstanding arcing and is also of a relatively high resistivity in comparison to the material of the current-carrying contacts 10 and 6. Accordingly, when the switch blade 4 is in the closed position shown, most of the circuit current flows through the current-carrying contacts. It is only when the switch blade 4 is driven counterclockwise to open the breaker that the arcing contacts carry appreciable current. During such opening action, the current-carrying contacts first part, thereby diverting current through the arcing contacts which are still in engagement due to their extensive wipe. Thereafter, the arcing contacts part and draw a circuit interrupting arc which is driven into an arc chute 20 and there lengthened, cooled, and extinguished in a manner soon to be described.

For driving the switch blade 4 counterclockwise to effect circuit interruption, a reciprocable operating rod 24 pivotally joined to the switch blade at 26 is provided. When this operating rod is driven upwardly, it acts to move the switch blade counterclockwise to effect a circuit interrupting operation. The circuit can be reestablished simply by driving the operating rod downwardly to return the switch blade 4 in a clockwise direction to the closed position shown. The operating rod 24, which is of insulating material, is actuated by means of a suitable conventional operating mechanism (not shown).

Referring now to FIGS. 1 and 2, the arc chute assembly 20 comprises a pair of sidewalls 21 and 22 constructed of appropriate arc-resistant insulating material. These sidewalls are clamped together in spaced-apart relationship by suitable means, not shown. Each sidewall preferably comprises ribs 23 projecting toward the other sidewall and arranged to mutually interleave with the corresponding projecting ribs on the other sidewall, thereby forming a sinuous or zigzag passage as viewed from the entrance end of the chute. As shown in FIG. 2, these ribs taper toward the entrance of the chute and thereby provide a throat portion through which the arc first passes before entering the zigzag passage between the ribs 23. Generally speaking, this construction is of the type disclosed in U.S. Pat. No. 2,293,513 to Linde, assigned to the assignee of the present invention. A position of the arc as it moves into the chute is illustrated by the dotted line 29.

For facilitating movement of the arc into the arc chute, a pair of conductive arc runners 30 and 31 are provided along the upper and lower edges of the chute. As shown in FIG. 1, these runners 30 and 31 extend transversely to the path of the arc and in generally divergent relationship with respect to each other from the region in which the arc is initiated.

The upper arc runner 30 is made up of a plurality of segments 32, 33 and 34 disposed in end-to-end relationship, with the adjacent ends thereof separated by insulating spacers 36. Electrically bridging the spacer 36 nearest the arc-initiation region is a magnetic blowout coil 37 having one terminal connected to runner segment 32 adjacent the spacer 36 and its other terminal connected to runner segment 33 immediately

adjacent this same spacer **36**. The other spacers **36** is bridged by blowout coil **38** connected between adjacent runner segments in a corresponding manner. The runner segment **32** located nearest the arc-initiation region is preferably of a generally U-shaped configuration and is electrically connected to the terminal stud **1***a*. This electrical connection is through a conductive adapter **41** and an additional blowout coil **40**, which has one terminal connected to the adapter **41** and its other terminal connected to the innermost end of runner segment **32**. Considering an electrical circuit which extends between the outermost runner segment **34** and the terminal conductor **1***a*, it will be noted that the blowout coils **38**, **37**, **40** are connected in series-circuit relationship with each other as well as with the runner segments **32**, **33**, **34**.

The lower arc runner **31** is constructed in substantially the same manner as the upper arc runner **30**. In this respect, the lower arc runner comprises a plurality of elongated segments **49**, **50** and **51** disposed in end-to-end relationship and separated by insulating spacers **52**. Spacers **52** are respectively electrically bridged by blowout coils **46** and **47** connected between the adjacent runner segments. The runner segment **49** nearest the arc-initiation region is of a U-shaped configuration and is electrically connected to the terminal conductor **3** of the circuit breaker through blowout coil **45**. In this regard, a conductive strap **56** is electrically connected between the terminal conductor **3** and one terminal of blowout coil **45**, whereas the other terminal of the blowout coil **45** is connected to the innermost end of the runner segment **49**. An insulating spacer **57** is provided at the lower end of runner segment **49** to prevent the coil **45** from being short-circuited by the runner structure located across its terminals.

The purpose of the above-described blowout coils is to accelerate the movement of the arc along the runners into the interior of the chute. In this regard, each blowout coil is provided with a centrally located core insulated from the coil and attached to pole pieces mounted on the outer surfaces of the sidewalls of the chute. For example, the coil **40** has a core **59** attached to pole pieces such as **61** shown by dotted lines in FIG. **1**. The coil **37** has a core **62** attached to similar pole pieces **63**. In a like manner, all of the other blowout coils have similar cores and pole pieces, only some of which are shown. When a particular coil is energized, its pole pieces provide a magnetic field transverse to the arc path, and this magnetic field reacts with the magnetic field surrounding the arc to produce a resultant force which drives the arc at high speed along the runners into the interior of the chute. The general manner in which these magnetic fields react to produce the arc-motivating force is well known and therefore will not be described in further detail.

When the switch blade **4** is driven counterclockwise to open the breaker, an interrupting arc is established between the arcing contacts **13** and **7** as soon as these contacts part. The upper terminal of this arc quickly transfers to the runner segment **32**, thereby connecting the blowout coil **40** in series with the arc. The energized coil immediately creates a magnetic effect which begins to drive the upper arc terminal along the upper runner **30** toward the interior of the chute. As the upper arc terminal moves along the runner **30** past the insulating spacers **36**, it acts to successively insert the connected blowout coils in series with the arc, thereby progressively increasing the magnetic forces tending to drive the arc into the chute.

In the meantime, the movable switch blade **4** has swung rapidly away from the stationary contact **13**. When the switch blade **4** moves downward into proximity with the runner segment **49** of the lower arc runner, the lower terminal of the arc transfers to the runner segment **49**, thus inserting the lower blowout coil **45** in series with the arc. The energized coil **45** immediately creates a magnetic blowout effect which drives the lower terminal of the arc along the lower runner **31** toward the interior of the chute. When the lower terminal of the arc passes the first insulating spacer **52**, it acts to insert the next blowout coil **46** in series with the arc and the first blowout coil **45** thereby providing increased magnetic force for driving the arc into the chute. As the arc moves into the chute, it becomes elongated and cooled by the projecting ribs **23**, and thus acts to quickly deionize and thereby extinguish the arc so as to interrupt the circuit.

To facilitate transfer of the upper arc terminal from the arcing contact **13** to the first runner segment **32**, a pair of projecting electrodes **60** are provided at opposite sides of the movable arcing contact **7**. Each of these electrodes **60** is made of an arc-resistant material such as tungsten impregnated with copper or silver. The arc that is drawn between contacts **7** and **13** upon arc-separation strikes one of the electrodes, causing its upper terminal to attach thereto; and immediately thereafter the upper terminal moves toward the base of the electrode onto the runner segment **32**.

In the past, it has been customary to provide a small pad of refractory metal adjacent the base of the electrodes **60**. This pad and the electrode **60** were integrally formed, and the pad was brazed to the runner segment **32**. In the present circuit breaker, this pad is omitted, and in place thereof, we thermally spray onto the runner segment **32** a composite coating made of refractory metal and high-conductivity metal. This coating is best illustrated at **65** in the enlarged sectional view of FIG. **3**. Referring to FIG. **3**, it can be seen that coating coating **65** is located not only in the immediate region of the electrode **60** but that it extends around the bend in the runner segment **32** and along the length of the segment up to the insulating spacer **36**. Each of the electrodes **60** has a reduced diameter portion **66** at its base fitting it to a hole in the runner segment **32**, and a brazed joint **67** is provided between the contiguous surfaces of the electrode **60** and the runner in order to securely attach the electrode to the runner. The coating **65** completely covers this brazed joint **67** and thus completely isolates it from the above-described arc.

The coating **65** is relatively thick (e.g., about 30 mils) in the region of the electrodes **60** and from the electrodes **60** along the length of the runner segment up to a point **69** (FIG. **3**). In the region extending from point **69** to point **70**, a much reduced thickness of coating is present (e.g., a thickness of about 10 mils). From point **70** to the end of the runner segment **32**, the thickness is again increased, being about 30 mils.

On each of the remaining runner segments **33** and **34**, a similar thermally sprayed metal coating is present adjacent the ends of the segment. Each of these runner segments is left uncoated in the region between the end regions where the sprayed coating is present.

In one embodiment of the invention, the segments of the lower runner are provided with thermally sprayed coatings adjacent to the insulating spacers **52** in the same manner as the segments of the upper runner. I have found, however, that the presence of these coatings is not as important on the lower runner as on the upper runner. In many applications, it is possible to omit the coatings on the lower runner.

The above-described thermally sprayed-on coating is preferably applied by the plasma-arc spraying process described and illustrated in our copending application Ser. No. 731,466 filed May 23, 1968 and assigned to the assignee of the present invention. As pointed out in that application, a conventional plasma arc spraying gun is utilized. Inside this gun, a high current electric arc is formed and a suitable gas is passed through the region of the arc to form a stream of extremely hot arc plasma. Metal, preferably in powdered form is fed into the arc plasma stream, where it is melted and converted into atomized droplets of molten metal, which are ejected through a suitable nozzle at high velocity in the plasma stream. The plasma stream containing the molten droplets is projected onto the arc-runner, and upon striking its surface, the molten particles flatten and freeze into an adherent coating. FIG. **4** is an enlarged sectional view, somewhat schematic, of the microstructure of the coating, showing the flattened particles interlocking with each other.

In one form of the invention, the sprayed-on coating is formed of tungsten and copper. Preferably powders of these

metals are mixed together before being fed into the plasma stream, and molten particles of these two metals entrained in the plasma stream are projected onto the surface being coated. The resulting coating may be thought of as comprising flattened, interlocking particles of tungsten forming a porous refractory metal structure and particles of copper contained within the pores of this structure. We prefer to add a small percentage of titanium hydride to the sprayed materials to reduce oxidation of the particles forming the coating.

Before the above-described plasma-arc spraying process is begun, the surface of the runner is prepared for coating by subjecting it to a roughening operation, which is performed, preferably, by grit blasting. This not only roughens the surface, leaving small irregularly shaped projections thereon, but also cleans it. The subsequently applied sprayed coating interlocks with the surface projections to form a strong bond therewith.

Spraying onto the roughened surface is continued until the desired thickness of coating is obtained. In the illustrated arc runner segment **32**, we make the coating thicker in the region of the electrode **60** and at its opposite end by repeated passes of the spray gun over the runner in these regions. Fewer passes of the gun are made in the region between points **69** and **70**, thus leaving the coating relatively thin is this particular region. A smooth and gradual transition between the thick sections of the coating and the thin section is made by suitably moving the spray gun to avoid a sharp edge at **69** or **70**.

The prior arc chutes referred to hereinabove having the brazed-on pads for holding the electrode **60** in place have not been capable of consistently interrupting as much current as might be desired. For example, in seven interrupting tests made with such an arc chute at currents of 21,000 to 26,000 amperes, four failures-to-interrupt were experienced. But when the pad was replaced by a thermally sprayed coating, even one confined to the immediate region of the electrodes **60**, we experienced only one failure-to-interrupt in fourteen interrupting tests at substantially the same currents. When the thermally sprayed coating was extended along the entire runner segment **32**, as illustrated in FIG. **3**, we experienced only one failure-to-interrupt in 21 interrupting tests at substantially the same currents. All of the above tests were conducted at substantially the same voltage. This drastic reduction in failures-to-interrupt was quite unexpected.

We attribute this greatly improved performance to a number of factors. One of these is that the construction comprising the sprayed-on coating has no brazed joints exposed to the arc in the region of the electrodes **60**. Since the sprayed-on coating is applied directly to the runner surface, there is no intermediate brazing metal between the coating and the body of the runner and therefore no brazing metal exposed at the boundaries of the coating, as there would be with a brazed-on pad. Even the restricted-area brazed joint (**67**) that is used for attaching each of the electrodes (**60**) is completely covered with the sprayed-on refractory metal coating. By having no brazing metal exposed to the arc terminal, we can eliminate any delays in arc movement caused by the tendency of the arc terminal to seek out and hang on the more volatile brazing metal. Thus, the arc moves more rapidly away from the arc-initiation region and has less chance to vaporize metals in this region; and this reduced volume of metal vapors seems to improve interrupting ability. Also, the fact that the arc is burning on a refractory metal instead of on the much more volatile brazing alloy reduces the volume of metal vapor generated by the arc.

Another factor contributing to the improved performance is that there are no surface discontinuities, such as cracks or sharp edges, directly exposed to the arc terminal on the surface of the runner segment **32**. Arc terminals have a tendency to hang on such discontinuities, and this would delay movement along the runners into the chute. By eliminating such discontinuities, we eliminate the resultant delays, and this again contributes to reduced heating and vaporization.

The reduced heating not only is important in reducing the quantity of vapors generated when the arc is present on the runner but is important in reducing the chances for a restrike of the arc at current zero immediately following extinction of the arc. There is a greater likelihood of a restrike occurring from a localized hot spot on the runner.

It has been observed in prior constructions, (e.g., with brass arc runners) that the arc terminal in running along the uncoated portion of the brass runner segment **32** is confined to a laterally restricted path in the center of the runner segment. But with our sprayed-on coating present, the arc terminal is much more diffused, spreading our over substantially the entire width of the runner as it moves along the length of the runner. This diffusion of the arc terminal along substantially the entire runner width contributes to reduced erosion and vaporization of the runner material.

The arc terminal moves relatively rapidly between the points **69** and **70**, and for this reason we can use a thinner coating in this region without risking exposure of the underlying brass to the arc terminal. In the region where the arc terminal moves less rapidly, we make the coating of a greater thickness so that more arc erosion can be accommodated without exposing the underlying brass of the arc runner body. For this reason, we make the coating relatively thick (e.g., about 30 mils in thickness) around the electrodes **60** and up to the point **69** and also in the region between point **70** and the end of the adjacent arc runner. The region at the end of the arc runner tends to be more susceptible to erosion than between points **69** and **70** because the arc terminal sometimes delays slightly before jumping across the insulating spacer **36** onto the next runner segment **33**.

The plasma-arc spraying process lends itself exceptionally well to providing precisely controlled thicknesses of coating of whatever values desired in the particular regions desired. If pads or covers brazed into place were used, it would sometimes be necessary to build up thickness by using several layers brazed together, and this would detrimentally expose more brazing metal to arcing. Also, it is difficult to work with a brazed-on cover as thin as might sometimes be desired in certain regions; and a relatively thick cover might therefore be used, wastefully resulting in the presence of material unnecessary for operation of the arc chute.

In the above-described embodiment, the sprayed-on coating is made of a composite material comprising refractory metal and a high thermal and electrical conductivity metal, such as copper or silver. It is to be understood, however, that our invention in its broader aspects comprehends the use of a thermally sprayed-on coating of pure tungsten or other refractory metal.

The thermal spraying process also permits the composition of the coating to be varied throughout its thickness or its length. For example, the initial deposit can be made of a high percentage of the high conductivity metal and this percentage reduced, either gradually or sharply, as the thickness of the coating is built up so that a relatively high percentage of refractory metal is present near the exposed surface of the coating in comparison to that present near the body of the runner.

For example, in one form of the invention which has been found particularly successful in interrupting high currents, the initial sprayed-on deposits were a mixture of tungsten and copper, and the final deposit at the exposed surface was of substantially pure tungsten. The tungsten deposit was relatively thin compared to the underlying layer of tungsten-copper. The tungsten-copper composite material is more ductile than the pure tungsten, and a relatively thick coating of the composite material may be present without materially interfering with various handling steps that might subsequently be relied upon in incorporating the runners into the arc chute. The pure tungsten layer, which is more brittle, is kept thin to avoid any such interference.

As mentioned hereinabove, the composition of the sprayed-on coating can also be varied along its length. This permits a

higher percentage of refractory metal, or pure refractory metal, to be used in local areas of severe arcing where the underlying composite material might be less needed for its ductility or its other properties.

The refractory metal used in our sprayed-on coating can be either tungsten or molybdenum or a carbide thereof, and the high conductivity metal can be copper or silver.

While we have shown and described particular embodiments of our invention, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from our invention in its broader aspects; and we, therefore, intend in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of our invention.

We claim:

1. An electric circuit breaker comprising means for initiating an arc in an arc-initiation region and an arc chute into which said arc is adapted to be driven from said arc-initiation region for the purpose of extinguishing the arc said arc chute comprising:

a. a pair of spaced-apart sidewalls of insulating material extending along the length of said arc when in said chute,

b. a pair of conductive arc runners spaced apart within said chute for defining paths along which the terminals of said arc travel as the arc is driven into the arc chute,

b'. means for transferring one terminal of said arc from said arc-initiation region onto one of said runners before the other arc terminal is transferred onto the other of said runners,

c. at least said one arc runner comprising a strip of conductive material and a coating of thermally sprayed refractory metal bonded to a surface of said strip for defining at the exposed side of the coating an arc-running surface along which said one arc terminal moves,

d. said thermally sprayed coating comprising superimposed flattened and interlocking particles of refractory metal bonded together,

e. said thermally sprayed coating covering at least that portion of the surface of said one arc runner to which said one terminal is first transferred from said arc-initiation region.

2. A circuit breaker as defined in claim 1 and further comprising:

a. means for facilitating transfer of said one terminal of said arc from said arc-initiation region to said one runner comprising an electrode of refractory metal projecting from said one runner into said arc-initiation region,

b. said thermally sprayed refractory metal coating covering the surface of said conductive strip in the immediate region of said electrode and extending along said conductive strip from said electrode toward the interior of said arc chute.

3. The circuit breaker of claim 2 in which:

a. said electrode is attached to said conductive strip by a brazed joint, and

b. said refractory metal coating completely covers said brazed joint and prevents access of said one arc terminal to said brazed joint.

4. The circuit breaker of claim 1 in which said one arc runner comprises a plurality of elongated segments having adjacent ends separated by an insulating spacer, a portion of said refractory metal coating being located on the portion of said one runner immediately ahead of said spacer, considered in the direction of arc movement into said arc

5. The circuit breaker of claim 1 in which:

a. said one arc runner comprises a plurality of segments having adjacent ends separated by an insulating spacer,

b. said arc-initiation region is located adjacent one of said segments and said one terminal of said arc is transferred onto said one segment from said arc-initiation region,

c. said coating is present on said one segment and extends from said arc-initiation region to said insulating spacer, and

d. said coating is relatively thick in the arc-initiation region and adjacent said spacer but relatively thin in the zone intermediate said latter two regions of thick coating.

6. The circuit breaker of claim 1 in which said sprayed-on coating also includes a high conductivity metal having a conductivity higher than said refractory metal, said bonded-together refractory metal particles forming a porous structure, with said high conductivity metal being located in the pores of said structure.

7. The circuit breaker of claim 6 in which said refractory metal is selected from the group consisting of tungsten, molybdenum and carbides thereof and said high conductivity metal is selected from the group consisting of copper and silver.

8. The circuit breaker of claim 6 in which the percentage of high conductivity metal present in the coating is different at different thickness levels.

9. The circuit breaker of claim 6 in which the percentage of high conductivity metal present in said coating is higher in the portion of said coating adjacent said strip than at the exposed arc-running surface.

10. The circuit breaker of claim 6 in which at least a portion of said sprayed-on coating is substantially all refractory metal at its exposed surface, said high conductivity metal being located in the portion of said coating underlying said all-refractory-metal exposed surface.

11. The circuit breaker of claim 6 in which the percentage of high conductivity metal is varied along the length of said coating.

12. The circuit breaker of claim 1 in which said coating is a plasma-arc sprayed coating.