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AID TO STRIKING AN ELECTRIC ARC

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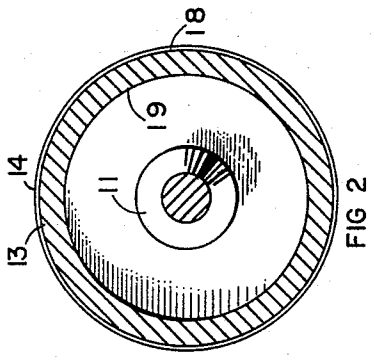


FIG 2

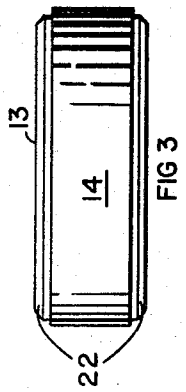


FIG 3

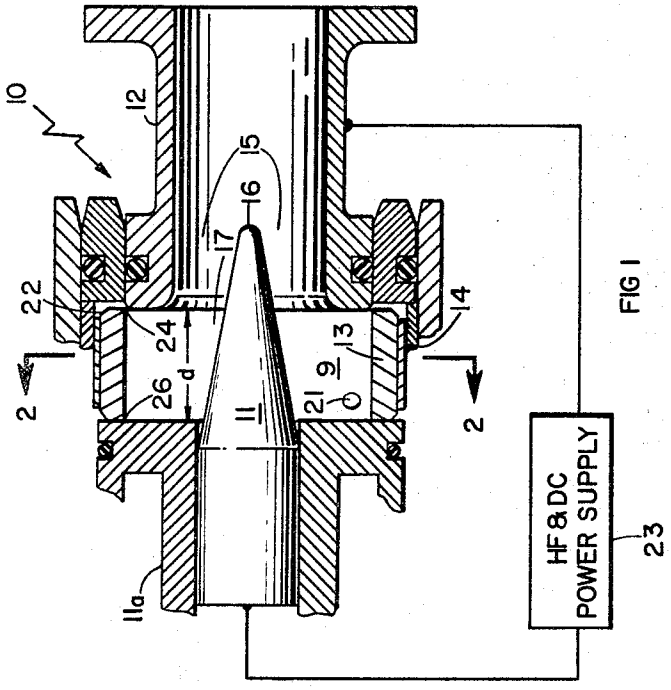


FIG 1

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AID TO STRIKING AN ELECTRIC ARC

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ABSTRACT OF THE DISCLOSURE

The invention relates to a starting mechanism for electric arc devices using a radio frequency power source. Typically, two or more electrodes of an electric arc device are situated in a spaced relationship. Typically, a dielectric spacer is positioned between the electrodes to maintain the separation. In this invention, the spacer is coated with an electrical conducting material in such a way that the spacer remains an insulator to the principal arc power supply but greatly reduces the impedance between the electrodes to a radio frequency power source coupled between the electrodes. This arrangement provides a quick, efficient, very reliable starting circuit for electric arc devices.

This invention relates to an aid to striking an electric arc, and more particularly a concept for facilitating the striking of an electric arc using high-frequency electrical energy.

One of the more popular methods used to initiate and strike an electric arc between spaced electrodes is to ionize a working fluid between the spaced electrodes by bridging the arc gap between the spaced electrodes with a high-frequency electrical spark discharge.

One important limitation of this method is that the arc gap between the spaced electrodes may differ for starting purposes and for normal running conditions. This problem is present in electric arc plasma generators of the type used in commerce to spray materials on substrates or to cut through metals. The recommended operating arc gap spacing is very often larger than the optimum arc gap ignition spacing. As a result, initiating and striking electric arcs with conventional high-frequency spark discharge equipment becomes unreliable unless the arc gap spacing is first adjusted for optimum starting and then adjusted for optimum operation.

It is an object of this invention to provide a concept whereby an electric arc may be initiated and struck between spaced electrodes in a simple and facile manner using high-frequency electric power without the necessity of adjusting the spacing between the electrodes.

It is another object of the invention to provide an aid for striking an electric arc between two electrodes having a fixed, predetermined spacing by providing a second predetermined spacing which is a low-resistance path to high-frequency electrical energy, but a high-resistance path to the normal operating power supply.

It is yet another object of the invention to provide an aid to starting an electric arc between two spaced electrodes having a predetermined spacing by providing passive means in a second predetermined spacing which is nominally larger than the arc gap spacing, the passive means providing a preferred alternate path for a high-frequency electrical power source.

In accordance with the invention, an aid to an electric arc device comprises a first electrode and a second electrode spaced from the first electrode by a first predetermined arc gap spacing. There is also provided a second predetermined spacing, geometrically, longer than the arc gap spacing.

A normally insulating means, such as a ceramic sleeve, is placed in the second predetermined spacing. The insulating means has a remote and a proximate surface, the latter defining a passage in fluid communication with the arc gap spacing. The electric arc device also includes a means for supplying a working fluid to said passage for passing the working fluid between the electrodes.

Preferably, the remote surface of the insulating means is partially coated with an electrical conducting material such as aluminum or silver paint whereby a portion of the surface will conduct electricity and a second portion of the surface remains an insulator. The conducting and insulating portions are in series, and their combined length bridges the second predetermined spacing. The length of the insulating portion of the remote surface is constructed to be less than the arc gap spacing.

The novel features that are considered characteristic of the invention are set forth in the appended claims; the invention itself, however, both as to its organization and method of operation, together with additional objects and advantages thereof, will best be understood from the following description of a specific embodiment when read in conjunction with the accompanying drawings, in which:

FIGURE 1 is a sectional schematic representation of a typical plasma-generating device;

FIGURE 2 is a section taken along lines 2—2; and

FIGURE 3 depicts an insulating sleeve used in the FIGURE 1 device.

Referring to FIGURE 1 of the drawings, there is shown a schematic cross section of a typical plasma-generating device **10** containing a first electrode **11** spaced from a nozzle electrode **12** by a first predetermined arc gap spacing **15**. The electrode **11** is a pencil-shaped electrode having a terminal end **16** extending into the nozzle electrode **12**, as shown. The above-described construction is typical of many such devices.

The electrodes **11** and **12** are also separated by a second predetermined spacing "*d*" in which is placed a normally electrical insulating means **13**. The insulating means **13** is preferably formed in the shape of a sleeve, as shown. Although sleeve **13** may be formed from any conventional electrical nonconductor, it is preferably made of alumina or "ROSITE," an asbestos based material, both of which are porous to high-frequency electrical energy.

Referring to FIGURES 2 and 3 of the drawings, it is seen that the sleeve **13** contains a remote surface **18** and an interior or proximate surface **19**. The latter (see FIGURE 1) forms a passage **17** for supplying a working fluid, which enters through aperture **21**, to the arc gap spacing **15** between the electrodes **11** and **12**.

The remote surface **18** of the sleeve **13** includes a coating **14**. The coating **14** is an electrical conducting material and is preferably silver or aluminum paint. It will be noted, in particular, with respect to FIGURE 3 that the coating **14** does not cover the entire length of the surface **18** and that, in particular, portions of the surface **18**, designated **22**, are deliberately not coated, and thereby remain electrical insulating portions. The combined length of the electrical conducting and electrically insulating portions **14** and **22** equals the second predetermined spacing "*d*."

The bushing **11***a* in FIGURE 1 is constructed of metal and provides a support for the electrode **11**. In effect, the bushing **11***a* is an extension of the electrode **11**, and the contact between the two parts forms an excellent electrical conducting path.

In a traditional fashion, electrical power is supplied between the electrode **11** and the nozzle electrode **12**. As indicated in FIGURE 1, the electrical power supply **23** is a combination of high frequency and direct current supplies such as a commercial welding electrical supply.

The high frequency imparts a potential difference between the electrode **11** and the nozzle electrode **12** which varies at a high-frequency rate of several thousand cycles per second. The D.C. power supply is a low voltage, typically in the order of 100 volts or less and high current, typically in the order of 1,000 amperes, supply means. Power supply means **23** may be a conventional welding electrical supply.

In the course of a normal operating cycle, a working fluid is fed through aperture **21** into the passage **17** and then between the arc gap spacing **15** between the electrodes **11** and **12**. In order to initiate or strike an arc, the working gas must first be ionized and thereby converted from a nonconducting medium to an electrical conducting medium. To do this, high-frequency power is first coupled to electrodes **11** and **12**. Since it is desired to maintain the arc gap spacing **15** between electrodes **11** and **12** fixed, and further since it is assumed that, with this spacing, some difficulty will be encountered in starting or initiating an arc, an alternate starting circuit has been provided through the specially constructed sleeve **13**.

One of the characteristic properties of a high-frequency energy is its ability to spark across or bridge air spaces and porous insulators with comparative ease, providing there is a reasonable relationship between the high-frequency voltage and the spacing that is to be traversed. In this particular concept, the high-frequency electrical power is made to pass from the nozzle electrode **12** to the electrical conducting coating **14** across a space which has been designated **24**, through the electrical conducting coating **14** across a space designated **26** to the bushing **11***a* and thence to the pencil electrode **11**. The total length of the spaces **24** and **26** is appreciably less than the length of the air gap space **15**. In the course of passing from the nozzle electrode **12** to the electrode **11**, the high-frequency electrical energy (spark) ionizes the working fluid present in the spaces **24** and **26** and in the passage **17**. As the ionized working fluid passes between the electrodes **11** and **12** in the arc gap space **15**, it forms a conductive path of sufficiently low resistance to permit the flow of low-voltage, high-current power between the electrodes, creating an arc. The low-voltage, high-current power is supplied from the D.C. portion of the power supply means.

Although the previous discussion has been limited to D.C. energy for the arc, it is quite clear that A.C. energy may also be used.

The spaces **24** and **26** may be constructed by making the length of the sleeve **13** slightly smaller than the separation between the nozzle electrode **12** and the bushing **11***a* so as to allow working fluid to flow into these spaces easily. This construction would be necessary if a nonporous sleeve were used. As a practical matter, the sleeve **13** need not be constructed in this manner, since alumina and "ROSITE", previously mentioned as the most desirable materials, are extremely porous to the high-frequency electrical energy. Thus, the energy can be made to flow through the wall of the sleeve **13** as well as over one surface thereof. This is particularly significant in the area of the space **24** in the structure shown in FIGURE 1, where the shortest distance between the coating **14** and the nozzle electrode **12** is through the sleeve **13**.

When the arc is initiated in the nozzle electrode, the high-frequency energy is turned off. Since, in general, the arc is supplied by a low voltage D.C. power source, the nonelectrical conducting portions **22** of the remote surface **18** of the sleeve **13** act as an adequate insulating barrier for preventing a flow of current from the nozzle electrode **12** to the bushing **11***a* and electrode **11** through the alternate path taken by the high-frequency energy.

In summary, the construction described provides a passive system wherein high-frequency energy is provided a comparatively low-resistance path for ionizing a working fluid for creating a low-resistance conductive path between the principal electrodes **11** and **12** in the vicinity of the arc gap spacing **15**. Additionally, this same passive starting circuit is designed to prevent the passage of low-voltage, high-current power from the D.C. portion of the power supply means.

The various features and advantages of the invention are thought to be clear from the foregoing description. Various other features and advantages not specifically enumerated will undoubtedly occur to those versed in the art, as likewise will many variations and modifications of the preferred embodiment illustrated, all of which may be achieved without departing from the spirit and scope of the invention as defined by the following claims:

What is claimed is:

1. In an electric arc device containing at least two spaced electrodes having a predetermined arc gap spacing and means for coupling said electrodes to high-frequency starting power supply means and normal operating power supply means, a spacer separating the electrodes by a second predetermined spacing longer than said arc gap spacing, said spacer containing at least one normally insulating portion in series with at least one electrical conducting portion, the combined lengths of said normally insulating and electrical conducting portions bridging said second predetermined spacing between said electrodes, said normally insulating portion having a length less than said arc gap spacing.

2. In an electric arc device containing at least two spaced electrodes having a predetermined arc gap spacing and means for coupling said electrodes to high-frequency starting power supply means and normal operating power supply means, a spacer separating the electrodes by a second predetermined spacing longer than said arc gap spacing, said spacer containing at least one porous, normally insulating portion in series with at least one electrical conducting portion, the combined lengths of said normally insulating and electrical conducting portions bridging said second predetermined spacing between said electrodes, said porous, normally insulating portion having a length less than said arc gap spacing.

3. In an electric arc device containing at least two spaced electrodes having a predetermined arc gap spacing and means for coupling said electrodes to high-frequency starting power supply means and normal operating power supply means, a spacer separating the electrodes by a second predetermined spacing longer than said arc gap spacing, said spacer containing two normally insulating spaced portions in series with an intermediate electrical conducting portion, the combined lengths of said normally insulating and electrical conducting portions bridging said second predetermined spacing between said electrodes, said normally insulating portions having a combined length less than said arc gap spacing.

4. In an electric arc device containing a first electrode, a second electrode spaced from said first electrode by a first predetermined arc gap spacing, and means for supplying high-frequency starting and normal operating electrical power to said electrodes:

(a) a normally insulating sleeve, having an exterior surface, positioned between said first electrode and said second electrode, the height of said sleeve being longer than said arc gap spacing; and

(b) electrical conducting means overlying said exterior surface defining an electrical conducting portion and a normally insulating portion on said exterior surface, the length of the normally insulating portion being less than said arc gap spacing.

5. An electric arc device comprising:

(a) a nozzle electrode;

(b) a pencil electrode having a terminal end protruding into said nozzle, said terminal end being spaced from said nozzle by a first predetermined arc gap spacing, said pencil electrode also being spaced from

said nozzle electrode by a second predetermined spacing which is longer than said arc gap spacing;

(c) a normally insulating sleeve, having an exterior surface, positioned between the nozzle electrode and said pencil electrode in said second predetermined spacing, said pencil electrode passing through said sleeve into said nozzle; and

(d) an electrically conducting means overlying said exterior surface defining an electrically conducting portion and a normally insulating portion of said exterior surface, the length of the normally insulating surface being less than said arc gap spacing.

6. An electrical arc device as defined in claim 5 in which said sleeve is porous to high-frequency electrical energy.

7. An electrical arc device as defined in claim 5 in which said electrically conducting portion comprises a metallic coating on said sleeve.

8. An electric arc device comprising:

(a) a first electrode;

(b) a second electrode spaced from said first electrode by a first predetermined arc gap spacing and a second predetermined spacing longer than said arc gap spacing;

(c) a normally insulating means bridging said second predetermined spacing, said insulating means having a remote and a proximate surface, the latter defining a passage in fluid communication with said arc gap spacing;

(d) means for supplying a working fluid to said passage for passing the working fluid between said electrodes; and

(e) an electrically conducting means overlying said insulator defining an electrically conducting portion and a normally insulating portion, the length of the normally insulating portion being less than said arc gap spacing.

9. An electric arc device as described in claim 8 in which said normally insulating means is porous to high-frequency electrical energy.

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