Jan. 11, 1966 J. W. REID, JR 3,229,156

FLARED RAIL ARC

Filed Sept. 14, 1961

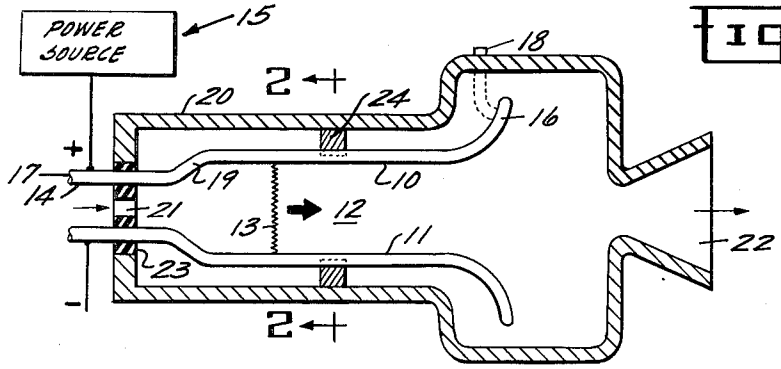


Fig 1

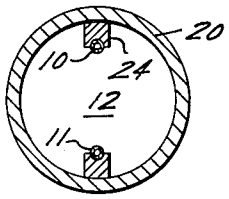
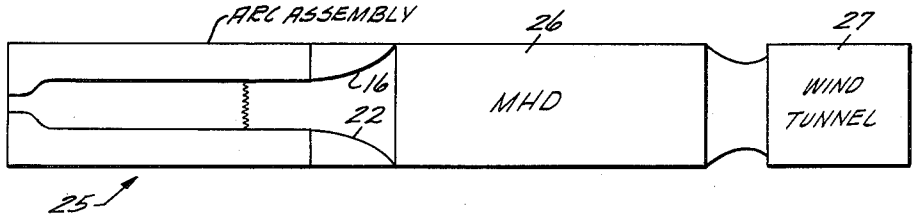


Fig 2

Fig 3



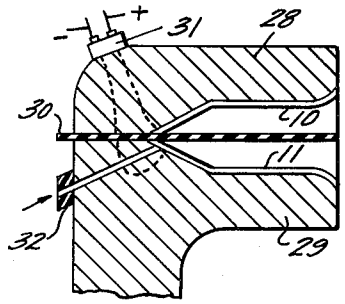


Fig 4

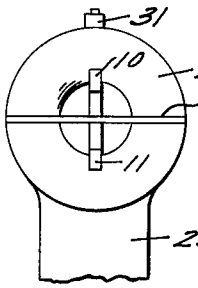


Fig 5

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FLARED RAIL ARC

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2 Claims. (Cl. 315—111)

The present invention relates to a flared rail arc and, more particularly, to a high temperature arc configuration in the form of parallel rails having a flared end for extinguishing the arc.

It is common to use high temperature arcs for many purposes, such as wind tunnel applications, chemical reactions, and the development of high temperature materials. The arc, whether it be A.C. or D.C., is one source of very high temperatures. One of the problems encountered in the use of such arcs is that of providing an arc that does not contaminate the gas or air which is to be heated. This occurs when the arc dwells on the electrodes long enough to ablate them and contaminate the heated atmosphere with clouds of the ablated material. Certain applications, such as those mentioned above, require uncontaminated gas which requires high arc speed in order to prevent the arc from dwelling on the electrodes any appreciable time and permitting ablation to take place. Such arcs have usually been constructed in a circular or ring form which has drawbacks in certain applications where a particular geometrical form is desired. An improved ring configuration of such arcs is shown in applicant's co-pending application Serial No. 138,010, filed September 14, 1961, now abandoned, and assigned to the assignee of the instant application. It is also known to use the self-driving magnetic field principle in such arcs which consists of making the current flow through the electrodes in opposite directions so that the magnetic fields about the electrodes will add. This additive feature then provides a driving force for the arc that is relatively high and moves the arc at high speed. The ring shape of such arc electrodes then presents a continuous path to the arc.

In some applications it is desirable to provide a straight through arc or one that travels in a straight line thus precluding the possibility of making the arc path continuous. In such an application, the arc must then extinguish and re-establish itself so that it will continue to move axially along hte electrodes. With such an arrangement, it is then possible to introduce air or a gaseous medium to be heated at one end of the electrodes and pass it along with the arc to the point of extinguishment whereby the air is heated as it passes through the hot gas generator.

The main object of the present invention is to provide a flared rail arc assembly by which the electrode path is not continuous and the arc is actually made to extinguish itself.

Another object is to provide such an assembly which permits a straight through input of gas or other working media.

A further object is to provide such an assembly in which the hot gas generator portion can be varied to provide different heating rates and can be made as long as necessary to accommodate the installation.

A further object is to provide such an assembly wherein the gas or working media is not contaminated by ablation of the electrodes.

Briefly stated, the flared rail arc assembly of the instant invention provides a pair of parallel rail electrodes which are connected to an electric power supply at one end and are electrically floating at the opposite end. The electrodes are spaced from one another to provide an arc gap and are parallel and close to one another near the power supply. They are parallel at the beginning and then taper away from one another to provide a section at which the arc will re-establish itself and the rail electrodes then parallel one another through a heating or working section in which the gas is heated, and then at the opposite end from the power source, the rail electrodes flare away from one another rapidly in order that the arc may extinguish itself. A casing forms part of the arc assembly and surrounds the electrodes so that gas to be heated may be funneled through the casing.

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter which I regard as my invention, it is believed the invention will be better understood from the following description taken in connection with the accompanying drawing in which:

FIGURE 1 is a cross-sectional view of the flared rail arc assembly;

FIGURE 2 is an end view taken on line 2—2 of FIGURE 1;

FIGURE 3 is a diagrammatical representation of a flared rail arc assembly as it might be used with an MHD accelerator;

FIGURE 4 is a partial illustration in cross-section of the application of the flared rail arc assembly to a spray gun; and,

FIGURE 5 is an end view of FIGURE 4.

Referring first to FIGURE 1, the flared rail arc assembly is shown in cross-section comprising two spaced rail electrodes **10** and **11** having a gap **12** therebetween. Each electrode is in the form of a rail of a particular configuration to be described, and the two electrodes **10** and **11** lie in the same plane as may be seen in FIGURE 2. In order to provide for the movement of an arc **13**, from left to right as shown by the arrow in FIGURE 1, each electrode is formed the same and only one need be described. The first electrode **10** is in the form of a rail and has a first terminal **14** at one end thereof for connection to an electric power supply generally indicated at **15**. For purposes of description it may be connected to the positive terminal of the power supply. The opposite end of electrode **10** is made to float electrically at terminal **16**. Thus, terminal **16** merely ends at that point and floats electrically having no return path or ground. The opposite electrode **11** is similarly connected so that it can be seen that current flows from the positive terminal of electrode **10**, out through the electrode, across the arc **13** and returns through electrode **11** to the negative terminal. Thus, the direction of current flow provides an adding magnetic field about the electrodes which field exerts force to drive the arc **13** in the direction of the arrow.

Because of the high temperatures involved, it is common to make the electrodes in the form of tubes for the passage of a cooling fluid, such as water, therethrough. Thus, cooling water may enter electrode **10** at **17** and exit at **18** through a non-electrically conductive tube. The particular configuration of the electrodes is important for the achievement of the objects herein stated and, to this end, the electrodes are parallel to one another at the power supply ends or terminals in the vicinity of terminal **17**. The electrodes then taper away from one another as shown at **19** which is for the purpose of re-establishing the arc as will be explained. The electrodes then continue to a second parallel section, indicated at numerals **10** and **11** on the electrodes, and then are curved at the floating terminals to flare away from one another and from the parallel portions **10** and **11** as shown at **16**. Preferably the curvature of the diverging or flared portion to terminal **16** is greater than the tapered portion **19** and the spacing between terminals **16** is at least twice the size of gap **12**. Depending upon the design in which the arc assembly is to be used, it can be seen that

the parallel portion **10** may be any suitable length and that the tapered portions **19** and flared tapered portions **16** may vary somewhat.

In order to confine the electrodes and provide a useful device, the electrodes are surrounded by a casing **20** which may be of any suitable shape but probably would be circular as shown in FIGURE 2. Air or other media to be heated by the electrodes is directed through casing **20** by means of an inlet **21** and escapes through an outlet **22** which may be in the shape of a nozzle as shown in FIGURE 1. The electrodes are suitably insulated from the casing by insulating means **23**. Because of the outward force exerted by the magnetic fields, the electrodes will have a tendency to move outwardly toward the casing and, to prevent this, suitable supporting means **24** may be provided between the electrodes and the casing. Only one is shown in the figures although as many as are required will be used. It is to be noted that the support means are exposed only to compressive stresses due to the outward force of the magnetic field and thereby may be placed as shown out of the path of the arc. Any suitable ceramic type support **24** such as boron nitride may be employed and, being out of the path of the arc, it is not heated by the arc to vaporize it and contaminate the air or media in gap **12** as it is heated.

The three general sections of the arc assembly configuration may be thought of as the arc establishing section in the tapered portion **19**, the gas heating or working section which is shown by the parallel electrode portions in the area of numeral **10** and the expanding or arc extinguishing portion which is the flared portion ending at terminal **16**.

In operation, because of the tapered portion **19**, the arc **13** there establishes itself and then is driven to the right by the magnetic field to be expanded in the flared portion and extinguished at terminal **16**. Simultaneously, air entering the casing at **21** is heated through the central parallel portion at numeral **10** and the air assists the extinguishment of the arc as the arc is expanded in the flared portion. The rapid movement of the arc prevents ablation of the electrodes and the heated gas exiting at outlet **22** is relatively free of contamination.

By referring to FIGURE 3, it can be seen that the flared rail arc assembly as described lends itself well to use with an MHD accelerator. In such an application, the arc assembly generally indicated at **25** is placed upstream of an MHD accelerator **26** which, in turn, feeds into a wind tunnel **27**. At the entrance to the MHD accelerator it is necessary that high temperature gas at a relatively high velocity, above Mach 1, be supplied. The expansion of the gas in the nozzle **22** provides the high velocity required by the accelerator. Thus, the arc flows in the same direction as the gas to be heated and heats the gas as it goes down the rails to expand into the accelerator due to the flared electrode shape at **16**. As the arc lengthens itself in the flared portion it tends to break down and extinguish itself and this is in the portion where the gas velocity is being increased due to the expansion of the gas in the nozzle so that the gas velocity tends to keep the arc moving and consequently the high gas velocity and the weakening arc work together to extinguish the arc rapidly at the end of the electrodes and the heated gas arrives at the entrance of the accelerator in the conditions required by the accelerator, which are high gas velocity and high temperature. In addition, it appears that the gas at the entrance to the accelerator would be highly ionized because of the arc and this is a further condition that is advantageous to entrance to the accelerator. The MHD accelerator, of course, is designed to put further energy into the gas that it receives and subsequently pass the gas to the wind tunnel in a typical application as shown at **27** in FIGURE 3.

The flared rail arc assembly also lends itself well to other applications as shown in FIGURE 4. In this figure the assembly is shown as applied to a spray gun wherein **10** and **11** are the electrodes as shown in FIGURE 1. These are embedded or suitably attached to members **28** and **29** forming the nozzle of the gun. Members **28** and **29** are suitably insulated from one another by insulating means **30** and a source of power supply **31** is connected to the electrodes in the manner shown in FIGURE 1. A gas or other fluid inlet **32** may be provided in the same manner as inlet **21** in FIGURE 1. The gun may be used as merely a torch or, by suitable feeding mechanism well known in the spray gun art, a rod of material may be fed into the gun to be vaporized by the heat and sprayed by the gas.

The flared rail arc assembly thus lends itself, by its configuration, to a straight through path for the heating of a fluid medium and provides an ideal upstream component for an MHD accelerator to deliver a fluid media to the accelerator at the conditions demanded by the accelerator. Furthermore, the tapered starting section of the electrodes can be made to take care of initial variation in input gas to permit striking of the arc and the straight or heat addition portion can be varied to provide different heating rates.

While I have hereinbefore described preferred forms of my invention, obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

I claim:

1. A high temperature arc comprising a hollow casing closed at one end and open at the other, a pair of hollow rail electrodes mounted within the casing, each of said rail electrodes being mounted so that one end passes through the closed end of said casing, each of said electrodes within the casing having three sections, an arc establishing section in which the electrodes diverge from one another, said arc establishing section being located nearest the closed end of said casing, a working section in which the electrodes are substantially parallel to one another, and an arc extinguishing portion in which the electrodes diverge from one another and electrically terminate, means for connecting the ends of the electrodes passing through the end of the casing to a source of electrical power, means for causing a coolant to flow through said electrodes, inlet means in the casing through which the fluid to be heated by the arc enters the casing, and electrically insulating support means mounted between the rail electrodes and said casing to prevent said electrodes from speading apart due to the interaction of the magnetic fields around said electrodes during the operation of the arc.

2. A high temperature arc comprising a hollow casing closed at one end and having a nozzle at the other, a pair of hollow rail electrodes mounted within the casing, each of said rail electrodes being made of an electrical conductor and being mounted within the casing so that one end of each electrode passes through the closed end of said casing, each of said electrodes within the casing having three sections, an arc establishing section in which the electrodes approach most closely to one another and then diverge, said arc establishing section being located nearest said closed end of said casing, a working section in which the electrodes are substantially parallel to one another, and an arc extinguishing portion in which the electrodes diverge from one another and electrically terminate, means for connecting the ends of the electrodes passing through the end of the casing to a source of D.C. electrical power, means for causing water to flow through said electrodes to keep the temperature below the melting point of the material from which the electrodes are made, inlet means in the casing through which

air to be heated by the arc between the electrodes enters the casing, and electrically insulating support means mounted between the casing and the rail electrodes in the working section of the rail electrodes to prevent said electrodes from spreading apart due to the interaction of magnetic fields around said electrodes during the operation of the arc.

References Cited by the Examiner

UNITED STATES PATENTS

2,655,209 10/1953 Newton ---------- 313—231 X

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