

Oct. 30, 1962

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3,061,710

ELECTRIC ARC TORCHES

Filed Jan. 24, 1961

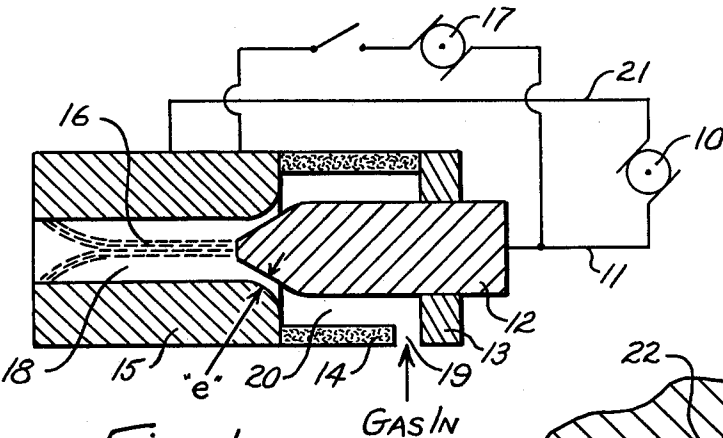


Fig. 1

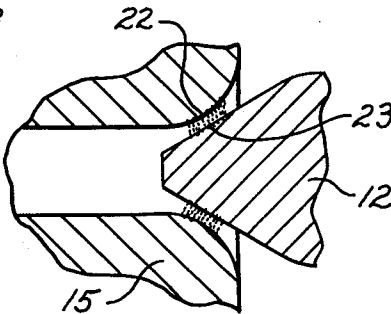


Fig. 2

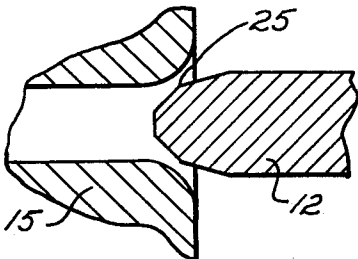


Fig. 3

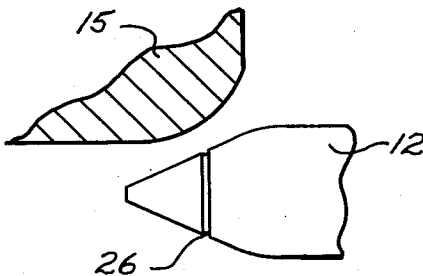


Fig. 5

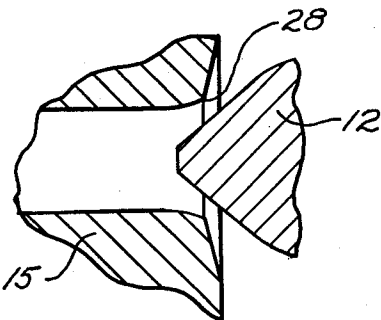


Fig. 4

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3,061,710

## ELECTRIC ARC TORCHES

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Filed Jan. 24, 1961, Ser. No. 84,569

6 Claims. (Cl. 219-75)

Our invention relates to electric arc torches, and relates more particularly to improvements in such torches whereby reliable means for initiating electric arcs are provided.

It is known that gases introduced in proximity to, or flowing along an electric arc may be heated to extremely high temperatures. The dissociated and ionized gas streams resulting from such heating (referred to as plasma jets) may be used in a wide variety of application in high temperature technology. A practical device for generating and using streams of gases in the plasma state is shown and described in U.S. Patent Number 2,960,594, issued to Merle L. Thorpe.

In said patent, brief reference is made to the initiation of an arc between the two electrodes forming a part of the circuit of the electric torch. Essentially, a high frequency, high voltage discharge may be provided to establish the ionization level required to initiate the main arc. Such a source of ionization may also consist of a high-voltage capacitor discharge across the space separating the electrodes, which then defines the initial path of the main, high current arc used to heat gases supplied under pressure to the torch. The general techniques and theory of operation of such devices are described in detail in the Thorpe patent referred to above.

It is most important that the arc-starting action be reliable and consistent. In prior art devices, either excessively high potentials must be provided, or the electrodes must be closely spaced if the initial arc is to be struck with desired reliability. In the former case, the apparatus may be unwieldy, expensive, or dangerous. In the latter case, the close spacing of electrodes is objectionable in that the flow of gas may be inhibited to a degree seriously impairing efficient torch operation.

It is, accordingly, a principal object of our invention to provide improved means for the initiation of arcs in electric torches.

It is another object of our invention to provide electrodes between which ionization levels may be reached wherein limitations dictated by spacing or voltage levels or both are minimized.

It is a further object of our invention to achieve the foregoing objects simply, inexpensively, and with a minimum modification of prior art devices.

These and other objects and advantages of our invention will be better understood from the following detailed description and the accompanying drawing, in which,

FIGURE 1 is a simplified schematic diagram of an electric torch showing those components which are germane to the invention;

FIGURE 2 is an enlarged detail of the space region between the electrodes of the device of FIGURE 1, with the addition of one embodiment of the inventive concept;

FIGURES 3, 4, and 5 are modifications of electrode geometry utilizing the invention.

Referring now more particularly to FIGURE 1, current is supplied by source 10. Electrons flow through lead 11 to the cathode 12, from the tip of which they are emitted to form an arc column 16. The column 16 passes part way down a nozzle passage 18 defined in an anode 15. The electrical circuit is completed through a lead 21. It will be seen that electrode 12 is electrically insulated from

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electrode 15 by the insulating section 14. End piece 13 supports electrode 12 in spaced relation to electrode 15.

Gas of a suitable nature is introduced under pressure through aperture 19, and it flows around the cathode 12, through space "e" and down the passage 18. The gas acts to constrict and force the arc column 16 at least part way down the passage 18 as shown. In so doing, and by intimate contact with the arc, the gas is heated to form a useful plasma stream. The mechanism of this phenomenon fully discussed in Thorpe Patent 2,960,594.

What is shown in FIGURE 1 is a torch with the main arc stream already established. Before this can be accomplished, an ionized path between electrodes 12 and 15 must be provided. This is so because the electrical pressures employed to maintain the relatively high amperage, low voltage arc is too low to strike or initiate an arc in the first instance. Therefore, a high frequency, high voltage source 17 may be provided to strike the initial arc. It has been found to reliably start the arc with electrodes of conventional configuration the spacing "e" must often be made very small. Gas flow characteristics under such a condition are then seriously impaired.

In addition, too small a spacing "e" leads to failure of electrodes due to the undesired persistence of the main arc across this narrow gap. It is essential to successful operation that the main arc be gas-stabilized and forced down into the passage 18 as shown in FIGURE 1.

Smooth surfaces in the area of minimum electrode spacing result in unreliable arc initiation. It has been found that by forming the electrodes with roughened surfaces, as at 22 and 23 in FIGURE 2, the initial arc is readily struck, thus providing an ionized bridge between the electrodes to establish the main arc. The slight surface discontinuities at 22 and 23 permit a greater spacing at "e" while at the same time increasing the ease and reliability with which the initial arc is struck.

The discontinuities may be very slight and yet produce the desired effect without significantly affecting gas flow geometry in any adverse way. We have used grit blasting as one good method which produces minute sharp protrusions terminating as points. The electrical fields established at these points are conducive to electrical discharge phenomena upon which the initiating of the arc depends.

We have found that other forms of surface discontinuity are also effective in achieving the purposes of our invention. Thus, in FIGURE 3, we provide a sharp annular ridge 25 at the intersection of two conical surfaces. In FIGURE 4, a ridge 28 may be formed in the anode piece 15. In some instances, a similar ridge may be provided in both the anode piece and the cathode piece, said ridges being preferably opposite each other.

Where pointed cathodes are used, as is often the case in torches of this general type, the cathode tip provides the logical area for the starting electrical discharge. However, the point is usually too far from the nearest anode surface for this to occur. We therefore provide a shallow but preferably sharp edged groove as at 26 in FIGURE 5. The groove 26 defines a sharp annular ridge relatively close to the anode. Thus the spacing between the electrodes may be increased with the attendant advantages set forth above.

While a torch using a wholly contained, or non-transferred, arc has been shown, the principles of our invention are equally applicable to torches in which the main arc extends beyond the opening in passage 18. Such modes of operation are termed "transferred" in that the main arc extends to a workpiece which then becomes a part of the electrical circuit.

Furthermore, we have shown a torch using what may be called direct polarity; that is, where the electrode 12 is the electron emitting member. Here again our invention

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may be used with equal effectiveness where polarity is reversed, or where alternating currents are used between the electrodes to maintain the main arc.

The important and essential features of our invention is the provision of surface features on one or both electrodes conducive to the striking of the initial arc with maximum reliability and with maximum permissible electrode spacing in the area where other considerations so dictate. It is clear, therefore, that variations and modifications within the spirit and scope of the following claims may occur to persons skilled in the art.

We claim:

1. In a torch of the type described, having at least two electrodes between which an arc is to be struck and maintained, the improvement comprising a surface discontinuity on at least one of said electrodes on that portion of said electrode closest to the other of said electrodes.

2. An electric torch, comprising a first electrode, a second electrode in spaced relationship to said first electrode, means for establishing an arc between said electrodes, and a roughened surface on at least one of said electrodes on that portion of said electrode closest to the

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other of said electrodes, said surface providing discontinuities conducive to the establishment of said arc.

3. An electric torch comprising a first nozzle-like electrode having an arc passageway therein, a second conically shaped electrode in spaced relationship to said first electrode and extending part way into said passageway, and a sharp groove formed on the surface of said first electrode where said electrode enters said passageway.

4. A torch as described in claim 1 in which said discontinuity consists of a sharp shallow groove in at least one of said electrodes.

5. A torch as described in claim 2 in which said roughened surface consists of a grit blasted area on at least one of said electrodes.

6. A torch as described in claim 1 in which the surface discontinuity on said first electrode is in the form of a sharp ridge.

#### References Cited in the file of this patent

#### UNITED STATES PATENTS

1,002,721 Mathers ----- Sept. 5, 1911