

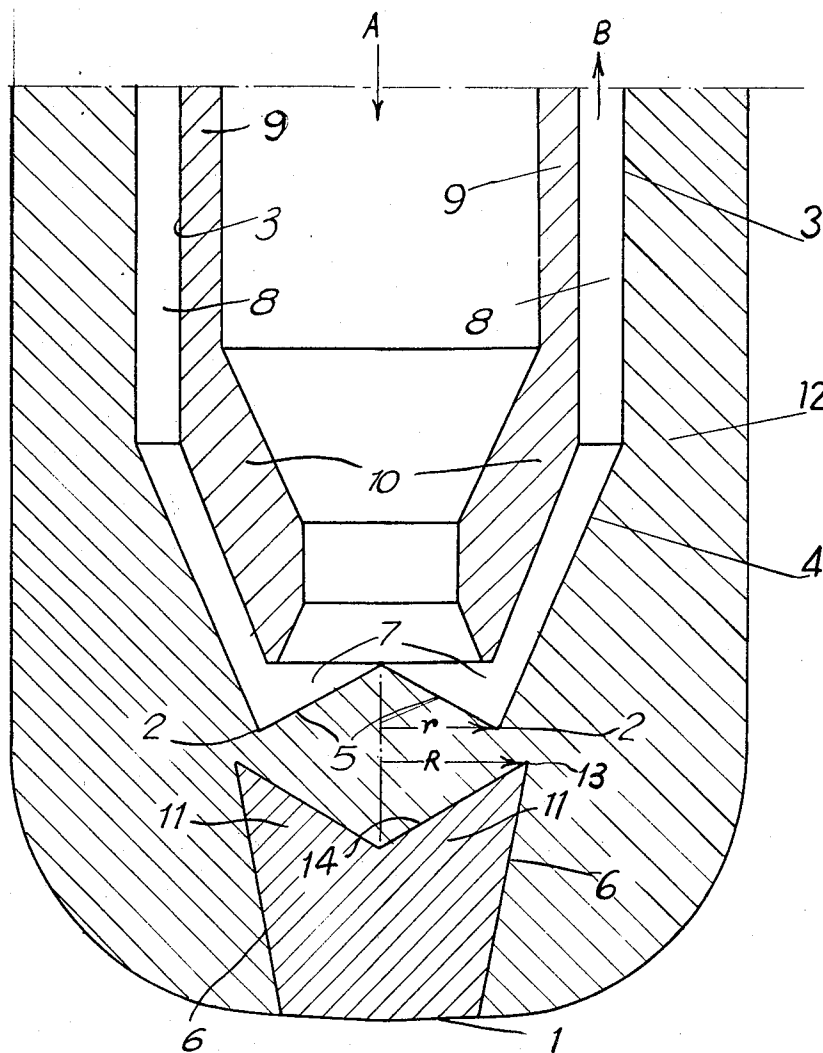
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COMPOSITE CATHODE FOR USE IN AN ARC PLASMA TORCH

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COMPOSITE CATHODE FOR USE IN AN ARC PLASMA TORCH

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ABSTRACT OF THE DISCLOSURE

Plasma-generating cathode with a generally cylindrical copper body having a rounded front end with a tungsten insert at its vertex, cooling water being axially admitted into the vicinity of this insert through an inner tube disposed in an axial bore of the body and defining therewith a flow channel having an inversion point near the insert, the cross-sectional area of the channel being less at the inversion point than in a cylindrical discharge portion beyond the inversion point whereby a turbulent flow is generated to increase the rate of heat removal from the copper body.

My present invention relates to a cathode structure to be used in the generation of a direct-current arc for a plasma torch, also known as a plasmotron.

In the operation of such a device, the applied voltage causes the emission of electrons at a point confronting an associated anode. The heat generated by the resulting arc discharge must be dissipated by a flow of cooling water through the electrode body.

The general object of this invention is to provide an improved water-circulation system for the cooling of such a cathode, more particularly a cathode where the emission of electrons takes place at a high-melting insert, preferably of tungsten, within a metallic body consisting for example of copper, this body being formed with an axial bore terminating short of the insert and accommodating a coaxial tube for the admission of the cooling water.

Since copper is a better heat conductor than tungsten, a high-temperature zone tends to develop between the insert and the end wall of the bore where the thickness of the copper body is at a minimum. The heat barrier existing at that point leads to underutilization of the cooling capacity of the circulating water in areas remote from the insert while tending to create vapor locks in the vicinity of the insert which, by impeding heat dissipation near the electrode axis, may lead to early destruction of the cathode.

In order to improve the cooling action of the circulating water near the high-melting insert, I provide in a cathode according to this invention, in the vicinity of the rear edge of that insert, an inversion point of the cooling channel having a cross-sectional area less than that of an annular discharge portion of the channel defined by the peripheral wall of the bore of the electrode body and the feeding tube coaxially inserted into same.

More specifically, I prefer to provide the central bore of the electrode body with a cylindrical periphery spacedly surrounding the stem of the feeding tube, this cylindrical periphery being followed by a forwardly converging frustoconical transition zone terminating at a conical end wall with a rearwardly pointing vertex, the inversion point being located at the junction between this transition zone and the end wall. The feeding tube ends in a forwardly tapering head spacedly surrounded by the transition zone, the distance of this head from the end wall being so chosen as to form the passage of reduced cross-sectional area at the inversion point. The

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increase in channel width beyond the inversion point results in a turbulent flow with greatly improved heat transfer from the electrode body to the cooling water. In order to take full advantage of the cooling effect of this turbulent flow, the rearward edge of the high-melting insert should be disposed near the annular junction of the two conical surfaces of the central bore but at a distance from the axis exceeding the radius of that junction.

The invention will be described in greater detail with reference to the accompanying drawing, the sole figure of which shows, partly in elevation and partly in axial section, a portion of a cathode embodying the present improvement.

The cathode shown in the drawing comprises a generally cylindrical copper body 12 having a rounded front end with a tungsten insert 11 at the vertex 1 of that front end, this vertex representing the point of electron emission when the electrode is energized. Body 12 is formed with a central bore having a cylindrical periphery 3, a rearwardly converging frustoconical transition zone 4 and a rearwardly pointing conical end wall 5, the two conical surfaces 4 and 5 having an annular junction 2. A tube for the admission of cooling water (arrow A) has a cylindrical stem 9 surrounded by the wall 3 and a forwardly tapering head 10 confronting the transition zone 4, this head defining with the junction 2 a restricted annular passage 7 whose cross-sectional area is less than that of the annular channel portion 8 through which the water is discharged (arrow B) and which is bounded by the tube stem 9 and the cylindrical wall surface 3.

Insert 11 has a frustoconical, rearwardly converging peripheral surface 6 which meets, along the annular edge 13, the conically recessed rear face 14 of that insert. It will be noted that the radius r of annular junction 2 is less than the radius R of annular edge 13 so that the tungsten body 11 projects beyond the region of the restricted passage 7 into that part of body 12 which is intensely cooled by the turbulent flow existing in the diverging channel portion between wall 4 and head 10.

A cathode of this type can be driven at approximately twice the power admissible with conventional electrodes of like outer diameter.

I claim:

1. A plasma-generating cathode comprising a generally cylindrical metallic body with a rounded front end, an insert of higher-melting metal in said body at the vertex of said rounded front end, said body having an axial bore terminating short of said insert, and a tube disposed coaxially with said body within said bore in spaced relationship with the wall thereof for defining therewith a channel for a cooling fluid axially admitted through said tube, said channel having an inversion point in the vicinity of said insert and an annular portion between said tube and said wall beyond said inversion point, the cross-sectional area of the channel at said inversion point being less than that of said annular portion.

2. A cathode as defined in claim 1 wherein said bore has a cylindrical periphery, a conical end wall with rearwardly pointing vertex, and a rearwardly diverging frustoconical transition zone between said end wall and said periphery, said inversion point being located at an annular junction between said end wall and said transition zone.

3. A cathode as defined in claim 2 wherein said tube has a cylindrical stem terminating in a forwardly tapering head surrounded with clearance by said transition zone.

4. A cathode as defined in claim 3 wherein said tube is internally constricted in the region of said head.

5. A cathode as defined in claim 2 wherein said insert has a rearwardly diverging peripheral surface and a

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conically recessed rear face meeting along an annular edge close to said junction, the radius of said edge exceeding that of said junction.

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