May 5, 1936. H. E. MENDENHALL 2,039,655

METHOD OF OUTGASSING AND PURIFYING ELECTRICALLY CONDUCTIVE BODIES

Filed Oct. 20, 1934

FIG. 1

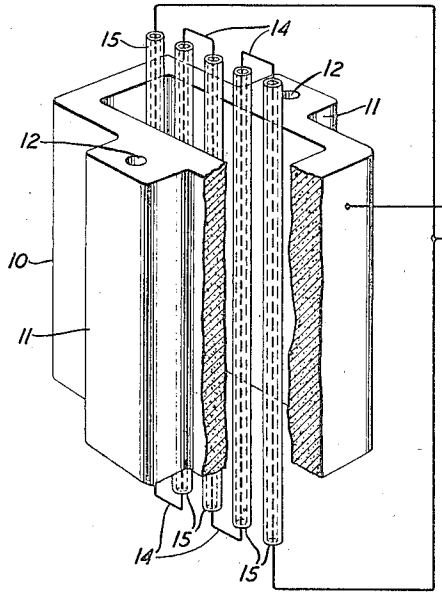
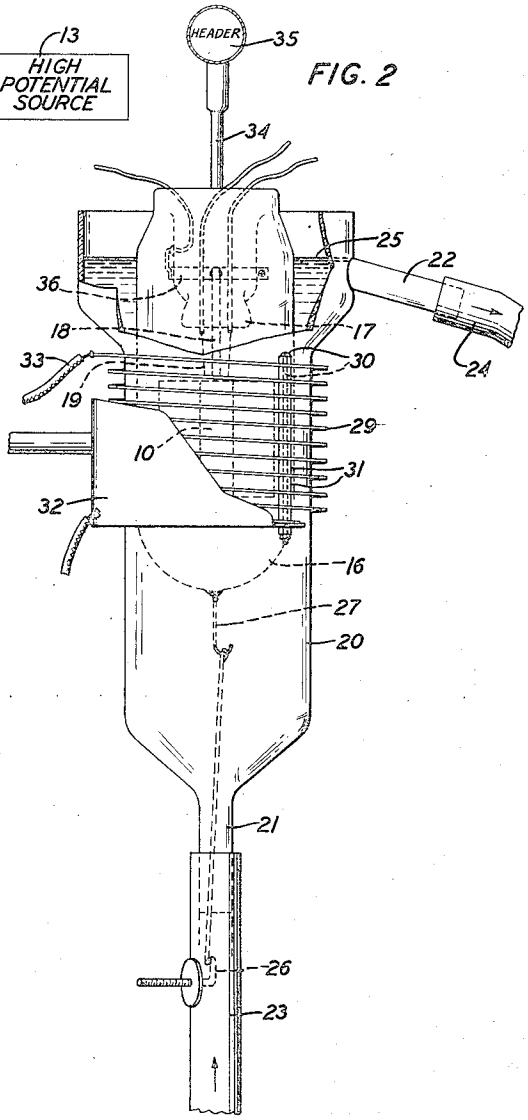


FIG. 2



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METHOD OF OUTGASSING AND PURIFYING ELECTRICALLY CONDUCTIVE BODIES

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2 Claims. (Cl. 250—27.5)

This invention relates to methods of outgassing and purifying electrically conductive bodies and more particularly to the fabrication and outgassing of electrodes for electron discharge devices.

One object of this invention is to remove occluded gases and foreign matter from electrodes, particularly non-metallic electrodes such as graphite anodes, for electron discharge devices.

Graphite electrodes, such as anodes, may be produced conveniently by machining graphite blocks to the desired configuration and size. It has been found, however, that as a result of such machining, the electrodes have thereon a quantity of minute loose graphite particles which can not be removed effectively by mechanical processes. In the operation of an electron discharge device including electrodes thus produced, the loose graphite particles are activated by the potentials extant between the electrodes of the device and form an objectionable coating upon other electrodes. For example, the particles may form a non-emitting coating upon the cathode of the device and thereby seriously impair the operation thereof.

Furthermore, graphite electrodes constitute black body radiators and hence must be heated to very high temperatures to remove occluded gases therefrom. If it were attempted to heat such electrodes to the necessary temperature within a vitreous enclosing vessel by a high frequency electromagnetic field, the enclosing vessel would become excessively heated and might collapse or give off water vapor which would deleteriously affect other electrodes, particularly the electron emitting cathode.

In accordance with this invention, these difficulties are overcome and graphite electrodes substantially free of occluded gases, loose graphite particles and other foreign matter are produced.

In order to remove the graphite particles and other foreign matter, a high poential is impressed between the electrode and an electrical conductor enclosed in an insulating member disposed in proximity to the electrode. Under the influence of this potential the graphite particles and other foreign matter are released from the electrode and deposited upon the insulating member.

The electrode thus treated may then be mounted in proper position within the enclosing vessel of an electron discharge device and subjected to a high frequency field which may be produced by a coil encompassing the enclosing vessel. In order to enable heating of the electrode to a degree sufficient to remove occluded gases substantially completely therefrom without unduly heating the enclosing vessel, a cooling jacket is provided about the enclosing vessel, the jacket being encompassed by the high frequency coil.

The invention and the manner of practicing it will be understood more clearly and fully from the following detailed description with reference to the accompanying drawing in which:

Fig. 1 shows one embodiment of the invention in a perspective view partly in cross-section of an electrode and apparatus associated therewith for removing foreign matter from the electrode; and

Fig. 2 is an elevational view partly in cross-section of an electron discharge device and apparatus associated therewith for outgassing an electrode of the device in accordance with this invention.

Referring now to the drawing there is shown in Fig. 1 an electrode including a hollow rectangular body 10 provided with oppositely disposed flange portions 11 having longitudinal bores 12 therethrough for receiving supports for the electrode. The electrode may be utilized as the anode of an electron discharge device and may be machined in one piece from a block of graphite. As a result of the machining process, the inner and outer surfaces of the electrode have thereon minute particles of graphite and also other foreign matter which cannot be removed expeditiously by mechanical processes. During the operation of an electron discharge device in which the electrode may be incorporated, these particles are activated by the potentials extant between the electrodes of the device and may deposit upon a cathode and form a black non-emitting coating thereon which would seriously impair the operation of the device.

In accordance with this invention, graphite particles and other foreign matter upon the surfaces of the electrode are removed therefrom by impressing a high potential, which may be obtained from a suitable source 13 and may be constant or high frequency, between the electrode and a conductor 14. The conductor 14 may be a continuous wire forming a closed loop as shown, which is threaded through a plurality of insulating members 15, such as glass tubes, disposed within the body portion 10 of the electrode and in proximity to the inner surface thereof. The insulating members serve as a barrier between the wire loop and the graphite anode to prevent the establishment of an arc which would produce "pitting" or puncturing of the anode. Preferably the insulating members or glass tubes 15 extend beyond the ends of the body portion 10.

Under the influence of the fields produced by the high potential, the graphite particles and other foreign matter upon the surfaces of the electrode are liberated from the electrode and deposited upon the insulating members or glass tubes 15.

Although the insulating members or glass tubes 15 are shown within the body 10 of the electrode in Fig. 1, it will be understood, of course, that they may be disposed in proximity to the outer surfaces of the electrode if it is desired to remove graphite particles and other foreign matter from the outer surfaces more completely.

After the electrode has been treated as above described, the insulating members or glass tubes 15 may be removed and the electrode mounted in proper position within an enclosing vessel 16 of an electron discharge device as shown in Fig. 2. For example, it may be supported from a stem 17 of the enclosing vessel 16 by a plurality of supports or rods 18 extending from a collar 36 secured about the stem 17 and entering the bores 12 in the flanges 11. The electrode or anode may encompass a filamentary cathode 19 also supported from the stem 17.

The enclosing vessel 16 is disposed within and spaced from the inner walls of a jacket 20, which may be of a glass having high heat resisting qualities, the jacket 20 being provided at one end with an inlet 21 and at the other end with an outlet 22. Suitable hose connections 23 and 24 are coupled to the inlet and outlet, respectively for associating the jacket with a fluid circulating system. The jacket 20 is sealed at its upper end by a resilient closure member 25 in which one end of the enclosing vessel 16 is fitted and held. The enclosing vessel 16 may be held in proper position within the jacket 20 by a metallic hook member 26 carried by the hose 23 and engaging a metallic hook member 27 sealed in one end of the enclosing vessel 16. The hook member 27 may serve as a leading-in conductor for a grid electrode, not shown, so that suitable potentials may be applied to the grid electrode during the evacuation treatment of the device.

The jacket 20 is encompassed by a coil 29, through which a high frequency current may be passed, the coil being positioned to encompass the anode 10 and substantially coextensive therewith. The coil 29 may comprise a plurality of ribbon-like turns insulated from each other and held in spaced relation by a rod 30 carrying insulating spacers 31. One end of the coil 29 may be electrically connected to a metallic support 32 and the other end may be connected to a conductor 33.

In the fabrication of the electron discharge device, the enclosing vessel 16 is coupled by a tubulature 34 to a header 35 constituting a part of the evacuating system. The cathode 19 and the grid may be denuded of occluded gases in a manner well-known in the art. By passing high frequency current through the coil 29, high frequency current will be induced in the anode, thereby degassing it by the heating effect. Inasmuch as the anode, if of graphite, constitutes a black body radiator, it will be appreciated that it must be heated to a very high temperature to effectively denude it of occluded gases. Such a temperature may be reached, of course, by passing a current of sufficient magnitude through the coil 29. However, because of the high radiating properties of the anode, the enclosing vessel 16 may become heated to an excessively high temperature so that it may give off water vapor, which would deleteriously affect the cathode and grid, or the glass vessel may collapse. In accordance with this invention, these disadvantages are overcome and the heating of the anode to a sufficiently high temperature is made possible by passing a cooling fluid through the jacket 20 during the outgassing treatment of the anode. The cooling fluid maintains the enclosing vessel at a safe temperature irrespective of the degree to which the anode may be heated. During the heating of the anode the gases released may be removed from the enclosing vessel 16 by the evacuating system, and at the desired time in the evacuation process the tubulature 34 may be sealed and disconnected from the header 35.

Although the invention has been described with reference to an electron discharge device of a particular construction including an anode of a particular form, it will be understood, of course, that it is equally applicable to devices of a different construction and including electrodes of various forms, and that modifications may be made in the apparatus and methods described without departing from the scope and spirit of this invention as defined in the appended claims.

What is claimed is:

1. The method of treating a hollow graphite anode for electron discharge devices which comprises disposing a plurality of insulating tubes having electrical conductors therein within said anode, and applying a high potential between said anode and said conductors.

2. The method of treating a hollow graphite anode of the machined type which comprises placing an insulating tube within said anode, threading a conductor through the tube, connecting the ends thereof to form a loop, and establishing an electrostatic field of high potential between the loop and said anode, whereby residue particles of graphite and foreign matter are liberated from the surface of said anode and deposited on said insulating tube.

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