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ELECTRIC DISCHARGE DEVICE

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Fig. 1.

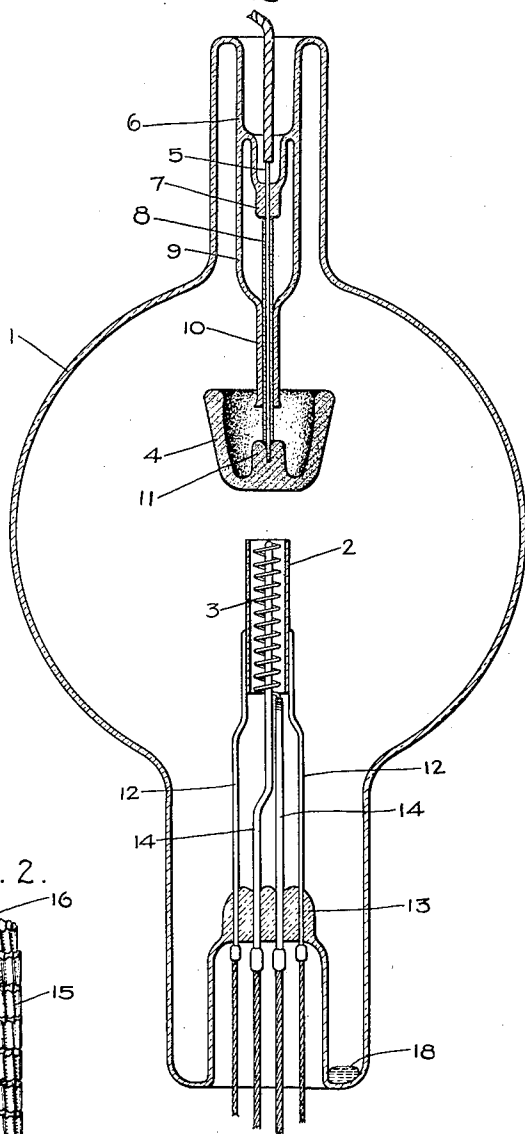
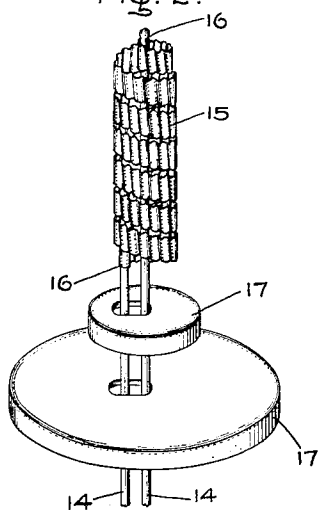


Fig. 2.



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UNITED STATES PATENT OFFICE

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ELECTRIC DISCHARGE DEVICE

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3 Claims. (Cl. 250—27.5)

My invention relates to electric discharge devices and has for its principal object the provision of improved electrodes adapted for use in such devices.

5 In the operation of discharge devices, such as hot cathode mercury vapor rectifiers for example, it is found that the magnitude of the rectified power is limited by arcing between the anode and the cathode at comparatively low potentials during the inverse part of a cycle. Such arcing generally takes place between the cathode and a sharp corner on the anode or between the cathode and the anode lead, the end at which the lead joins the anode or that at which it emerges from the glass seal being favorite places for the arc to strike.

According to one feature of my invention these difficulties are avoided by means of an anode provided with a surface which is so shaped that the potential gradient at all points of its surface is substantially uniform and is arranged to shield the supporting lead for the anode. Another novel feature consists in the employment of an improved cathode which is capable of producing large quantities of electrons at relatively low voltage to enable the device to transmit a rectified current of large magnitude.

My invention will be better understood from the following description when considered in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

In the drawing, Fig. 1 illustrates a cross section of a hot cathode discharge device including an improved form of anode and an equipotential cathode of ordinary construction, and Fig. 2 shows a cathode of improved construction.

The invention is embodied in a rectifier which comprises an evacuated glass vessel 1, a cathode 2 including a heated filament 3 and an anode 4.

40 The anode 4 is supported by a stiff lead 5 sealed into the glass stem 6 by means of a pressed seal 7. The lead 5 is covered by an insulating tube 8 extending the full length of the lead 5 between the seal 7 and the anode 4. A glass sleeve 9 is fused to the stem 6 and surrounds seal 7. It extends below the seal 7 and joins a sleeve 10 of smaller diameter which snugly fits over tube 8.

50 The anode 4 which preferably consists of carbon is cup-shaped, having its edges well rounded and its outer convex surface presented to and arranged to cooperate with the cathode 2 which is illustrated as a unipotential cathode but may be of any suitable construction. In the type of discharge device illustrated no ionization is encountered during the inverse voltage cycle. In

order to obtain the highest break down potential for such a device, it is necessary to eliminate the high potential gradient points on the anode, at which the device tends to break down, and distribute this gradient, and the electrostatic field intensity, uniformly over the active surface of the anode. In order to accomplish this distribution it is necessary to provide a continuous surface, eliminate all sharp corners therefrom, and further shape it so that it approximates one of the theoretical equipotential surfaces in the electrostatic field between the anode and cathode. The actual curvature thereof will depend upon the potential for which the device is designed and will approximate a spherical surface at comparatively high potentials.

As mentioned above, the places for possible flashovers within the discharge devices are first, from the cathode to sharp corners on the anode; second, from the cathode to the anode lead at the point where it joins the anode; and third, from the cathode to the anode lead at the point at which it emerges from the pressed seal. In accordance with my invention, the anode 4 is made hollow and the lead 5 is threaded into a boss 11 which is only slightly raised above the bottom or concavity of the anode. In this manner the lead 5 enters the anode material at a point electrostatically shielded by the walls of the anode.

The end of the sleeve 10 is also extended below the upper edge of the anode wall so that its opening is within the shielded area and protects the seal end of the lead-in conductor. In cases where the anode is operated at high temperatures, it is advisable to raise the end of sleeve 10 above the shielded space within the anode. In such cases it is important to have this sleeve snugly fit over tube 8.

Due to the use of an anode as described, the breakdown points above mentioned are eliminated and the breakdown potential of the device during the inverse part of a cycle is increased to the breakdown potential characteristic of the vapor contained in the device. The potential that can be safely applied to a device provided with an anode in accordance with my invention is therefore much greater than that which can be applied to devices provided with the usual anodes, and the load capacity thereof is substantially increased.

The cathode 2 may consist of a metallic cylinder, preferably of nickel, coated on one or both surfaces with a substance which emits electrons effectively at a relatively low temperature e. g.

alkaline earth material. Leading-in conductors 12, may be taken through the press 13 and connected in parallel to one terminal of the exterior energizing circuit (not shown) of high voltage, the other terminal of the circuit being connected through the load to the anode. The filamentary member 3 comprises a helix supported in any suitable manner by the leading-in conductors 14, and supplied with current of relatively low voltage. It will be evident that the cylinder 2 in addition to performing the function of an equipotential cathode also serves to reduce heat loss by radiation thereby to increase the electron emission for a given projected filament area.

In certain cases I may dispense entirely with the heat shield 2 and may modify the surface of the filament in such a manner that the heat is constrained to the region of the cathode by reason of the configuration. Thus in Fig. 2 there is shown a cathode consisting of crimped metal ribbon 15 preferably of nickel, and wound in convolute fashion i. e. as a helix of uniform diameter, the upper extremity of which extends vertically away from the press, although it is to be understood that the ribbon may also take the form of a horizontal helix, spiral or any other suitable shape. The ends of the convolute member may be affixed to the leading-in conductor 14, by forming the extremities into tight fitting sleeves 16 which embrace the conductors and are welded thereto. The crimps or projections conveniently may be formed by passing the ribbon between loosely meshed gears adapted to rotate. In order to facilitate bending of the ribbon into the helical shape, it is desirable to form the crimps slightly angular with respect to the transverse axis of the ribbon, the amount of angularity depending upon the pitch of the convolute so that the corrugations will fall substantially in a vertical line, as shown.

As in the case of the equipotential cathode, of Fig. 1, an alkaline coating may be applied to the surfaces of the ribbon to augment the electron emission whereby large amounts of current may be transmitted between the anode 4 and cathode 15. It is evident that if the crimps are located close together and dimensioned properly the heat rays emanated by one surface of a trough will strike the adjacent surface of that trough and be reflected back in substantial degree which action takes place in recurrent manner so that the heat which normally would be dissipated is constrained in large measure to an envelope defined by the outermost diameter of the crimped surface. The heat is thus conserved as in the embodiment previously described without however, necessitating a heat obstruction. It is also apparent that a ribbon cathode of this kind is of a rugged, self-supporting construction and that the crimping adds to the strength of the member. Moreover, the strip construction lends itself readily to a large cross sectional area and hence large current carrying capacity without affecting the ease with which the cathode may be fabricated. Due to the fact that the cathodes illustrated in Figs. 1 and 2 have a comparatively large surface area, the danger of break down due to loss of active material at one spot is minimized.

In order to minimize heat loss at the lower end of the convolute thereby to maintain the stem 13 below fusing temperature, it may be desirable to

affix a plurality of parallelly disposed disks 17, preferably of metal to one of the leading-in conductors. These discs preferably are of concave construction with peripheral flanges extending downwardly toward the stem and are of a size depending upon the respective distances from the heat radiating member. The disks may conveniently be supported by sleeves (not shown) which are welded to the same conductor.

While the cathode illustrated in Fig. 2 employs laterally disposed crimps or projections, it is evident that corrugations of any shape may be formed lengthwise of the ribbon provided the adjacent surfaces are at the proper angle and distance apart effectively to reflect heat rays.

In order to pass considerable current through the rectifier, it is necessary to reduce space charge effect and this conveniently may be accomplished by placing within the tube during manufacture, a small globule of mercury 18 which provides under operating conditions, a positive-ion-producing vapor for neutralizing space charge. A device of the kind described has been found to be capable of furnishing rectified current of the order of 5 to 25 amperes with a voltage drop of less than 20, the peak inverse voltage being in the neighborhood of 30,000, without danger of breakdown.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. An electric discharge device including an evacuated vessel, a cathode and an anode enclosed within said vessel, said anode being formed into a substantially equipotential gradient surface with respect to said cathode and forming an electrostatically shielded space in said vessel, a support for said anode including an insulated metallic rod sealed into said evacuated vessel and joined to said anode at a point within said shielded space, and a sleeve surrounding said seal and extended to have its opening within said shielded space.

2. A vapor electric device including an evacuated vessel, a cathode and an anode enclosed within said vessel, said anode being formed into a substantially equipotential gradient surface with respect to said cathode and forming an electrostatically shielded space within said vessel, a support for said anode including an insulated metallic rod sealed into said evacuated vessel and joined to said anode at a point within said shielded space, and a sleeve surrounding said seal and closed at one end by said insulated support.

3. An electric discharge device including an evacuated vessel, a cathode and an anode mounted within the vessel, said anode being provided with an active surface the electrostatic field intensities of all points of which are substantially equal, said anode being cup-shaped with its convex surface presented to the cathode and its interior open to the interior of the vessel, a conductor joined to said anode within the cup-shaped interior at a position intermediate the length of the anode whereby the joint is shielded from the electric forces about said anode, said conductor terminating in the material of the anode, a tube of insulating material surrounding said conductor and terminating at the joint between the conductor and the anode.

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