Aug. 29, 1933. A. W. HULL 1,924,319

CATHODE STRUCTURE FOR THERMIONIC DEVICES

Filed Oct. 9, 1930

Fig. 1.

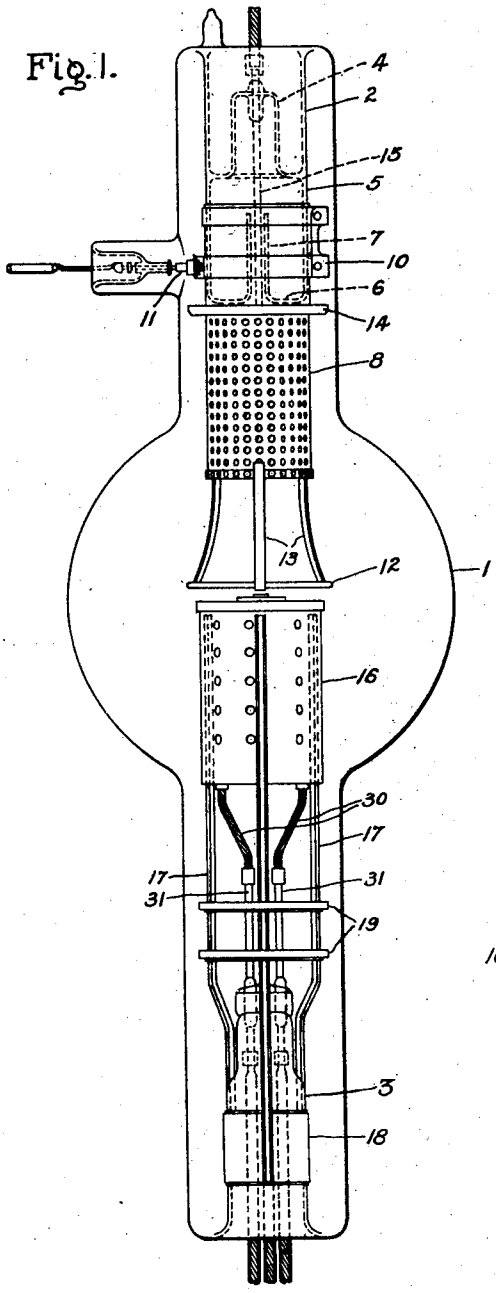


Fig. 3.

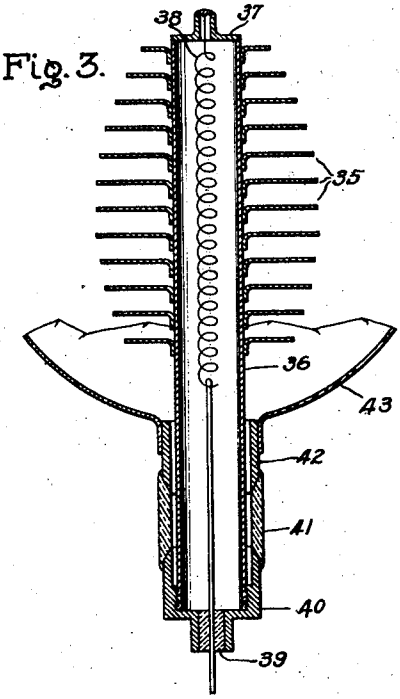
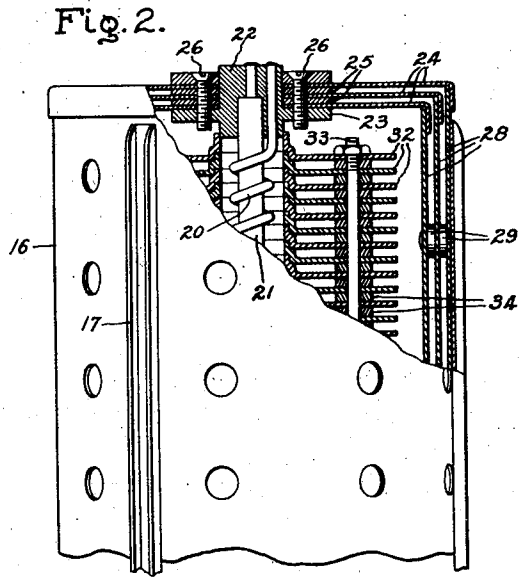


Fig. 2.



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CATHODE STRUCTURE FOR THERMIONIC DEVICES

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Application October 9, 1930. Serial No. 487,533

5 Claims. (Cl. 250—27.5)

The present invention relates to electrical discharge apparatus and more particularly to thermionic devices of the power type. This application is a continuation in part of my application, Serial No. 226,276, filed October 15, 1927, Patent 1,790,153, entitled "Electrical discharge devices and method of operation."

In the application referred to, there are described, inter alia, various forms of cathode structures for electrical discharge devices of the arc type capable of handling large amounts of electrical energy. Devices of this sort contain an appreciable amount of gas or vapor at a pressure sufficient to support an arc-like discharge at the impressed potentials and have a negative volt-ampere characteristic in which the current is nearly independent of the voltage. The cathodes of these devices are usually indirectly heated and employ a heater positioned within a metallic member which serves as the cathode proper. The latter ordinarily is coated with an alkaline earth substance, such as barium oxide to increase the electron emission thereof.

The maximum amount of current that a device of this kind can carry is a function of the maximum electron emission from the cathode which, for a given emission per unit area, depends upon the total cathode area. It is desirable therefore, in the case of large current output to provide the cathode with the greatest amount of electron emitting surface, at the same time with the minimum bulk in order to facilitate the rapid heating thereof by avoiding undue heat radiation.

The object of the present invention is to provide an improved form of cathode in which the electron emitting area is enhanced without a proportional increase in cathode volume. This object is attained, in brief, by providing the cathode with a plurality of radially projecting discs or vanes which are rendered thermionically active.

For a more complete understanding of the invention reference should now be made to the drawing in which Fig. 1 represents an electrostatically controlled arc discharge device embodying the improved cathode; Fig. 2 is an enlarged view, partly broken away and in section, of the cathode shown in Fig. 1, while Fig. 3 is a fragmentary view, partly in section, of a modified form of cathode.

Referring to Fig. 1, numeral 1 designates the envelope of an electric discharge device which terminates in reentrant stems 2 and 3. The upper stem 2, as shown, is closed by an inverted stem and press 4 which terminates in an open-ended skirt portion 5. The interior of the latter has a transverse partition 6 provided with a tubular member 7 to exclude the glow discharge from the region of the press 4. A cylindrical control or grid member 8, fabricated preferably of perforated oxidized nichrome is fitted tightly over the skirt portion and rigidly secured thereto by a screw clamp 10 which carries a lead 11 to the exterior.

The end of the grid remote from the skirt portion is closed and has a starting ring 12 secured thereto by means of three equi-distantly spaced tie bars 13. The function of this ring is to lower the starting voltage of the tube, and claims on this feature are contained in the Pike application, Serial No. 487,541, filed Oct. 9, 1930, and assigned to the same assignee as the present application.

A metallic ring 14 is affixed to the outer surface of the grid member to prevent a discharge from forming in the annular space between the reentrant stem 2 and the interior of the envelope. Within the control member, there is a cylindrical graphite anode, (not shown), secured in place by a rod 15 which is sealed in the stem 4.

The cathode 16 which forms the subject of the present invention is supported by a plurality of channels 17 welded to a clamp 18 which tightly embraces the stem 3. There are two heat shields 19 affixed to the channels. The cathode illustrated in Fig. 1 is shown enlarged in Fig. 2. The heater member 20 may consist of tungsten wound as a spiral on a rod 21 of insulation, for example, alumina (Al_2O_3). The upper end of the heater and its insulation support are fixed into a metal hub member 22 which is provided with a radial flange 23. This flange supports a plurality of cap members 24 which are spaced by metal rings 25 and secured together by screws 26. The caps fit tightly over a corresponding number of open-ended perforated cylinders 28 which are held apart by a plurality of spacers 29 hung on rivets.

The lower ends of the cylinders are closed by metal members and have secured thereto a pair of flexible conductors 30 (Fig. 1) which are joined to stiff wires 31 sealed in the lower press. A similar combination of flexible and stiff wires is taken from the lower end of the heater member. Within the cylinders 28 (Fig. 2), there are a plurality of metal discs 32 in addition to the heater 20 referred to. These discs may be formed with a stepped upset inner lip having a configuration such that the projection of one disc fits snugly within the recess of the adjacent disc. The discs are rigidly secured together by a number of equi-distantly spaced bolts 33 which also serve to hold

the spacers 34 in place. When the discs are fitted together and bolted, the cathode takes on a rigid self-supporting structure. The feature of providing discs with interlocking projections is described and claimed in the Pike application, Serial No. 487,541, referred to hereinbefore.

The cylindrical members 28 serve as shields to conserve the heat energy while the perforations therein allow ready egress for the electrons emitted by the discs 32. The latter are preferably coated with a substance of low work function such as barium oxide which emits electrons readily. The envelope 1 may be either highly evacuated or contain inert gas or vapor, for example, mercury vapor, at a pressure, for example, 1 mm. mercury, sufficiently high to neutralize space charge effect thereby to support an arc discharge at practical voltages.

The operation of a tube of this kind is well known and it is sufficient to state that when alternating voltage is applied between anode and cathode, the grid member may be biased by alternating or direct current to control the average rectified current in the output circuit. The control member may obviously be omitted, in which case the device performs the function of a simple rectifier. It has been found during operation that a cathode provided with laterally extending discs gives adequate electron emission for an exceedingly large current. Furthermore, the increase of electron-emitting surface in the improved cathode over the prior art cathodes is attained without unduly increasing its mass or metal content so that the time taken by the cathode in reaching its normal operating temperature is not unduly long.

Fig. 3 shows a modified form of cathode in which the discs 35 are spun over at their inner edge to form a surface which may be readily welded or otherwise secured to a metal cylinder 36. The cylinder is closed at the top by a metal member 37 to which is fixed one end of a spiral heater 38. The other end of the spiral is attached to a metal rod fused in a glass insulator 39. The lower end of the metal cylinder 36 may be threaded into a metal cap 40 which carries the glass insulator and is sealed to a ring of glass 41. This ring is fused to a metal cylinder 42 which fits within the flanged mouth of an envelope 43. Inasmuch as the filament is completely insulated from the envelope by the glass ring 41, the envelope may be made of metal and the cylinder 42 welded thereto. The envelope construction may take the form of a large size iron tank capable of handling power currents of magnitude. The cathode structure is exceedingly rugged and for a given mass presents a large electron emitting surface to the anode by reason of its disc construction. It is apparent that, if desired, heat shielding cylinders may be provided as in the previous figure, further to enhance the operating efficiency of the cathode.

Broad claims to the hollow or cavity cathode construction disclosed herein appear in my copending application, Serial No. 156,713, filed Dec. 23, 1926. That application also contains claims relating to the combination of a cathode and heat shielding means. The claims in the present application, therefore, are limited to improvements over the invention described and claimed in the prior application referred to above.

Claims directed to a hollow cathode provided with longitudinal vanes for increasing the electron emitting surface appear in the Hull and Ruggles application, Serial No. 268,976, filed April 10, 1928.

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

1. A cathode for an electrical discharge device comprising a heater member enclosed within a metal casing, said casing being provided with a plurality of discs extending transversely therefrom and adapted to emit electrons, the size of the discs in said transverse direction being considerably greater than that of the casing.

2. A cathode for an electrical discharge device comprising a heater member enclosed within a metal casing, said casing being provided with a plurality of discs which extend normal to the surface of the casing and coated with an electron emitting substance, the size of the discs in said normal direction being considerably greater than that of the casing.

3. A cathode for an electrical discharge device comprising a heater member enclosed within a metal casing, discs secured to said casing and extending transversely therefrom, and one or more heat shields surrounding said discs.

4. A cathode for an electrical discharge device comprising a heater member enclosed within a metal casing, discs secured to said casing and extending transversely therefrom and one or more perforated cylinders surrounding said discs.

5. A cathode for an electrical discharge device comprising a heater member enclosed within a cylindrical metal casing, a plurality of circular electron-emitting discs secured directly to the casing, said discs extending normal to the surface of the casing and having diameters at least several times the diametral size of the casing.

ALBERT W. HULL.