April 13, 1954 L. J. CRONIN 2,675,498

CATHODE FOR ELECTRON DISCHARGE DEVICES

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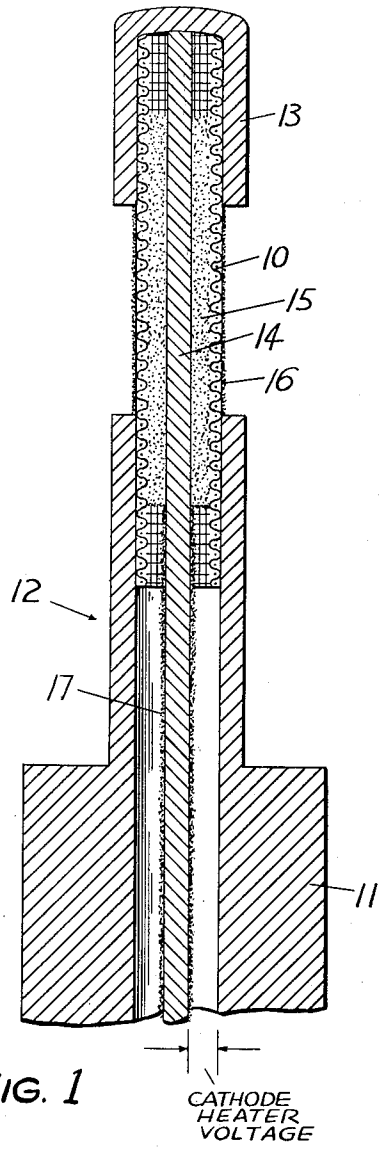

FIG. 1

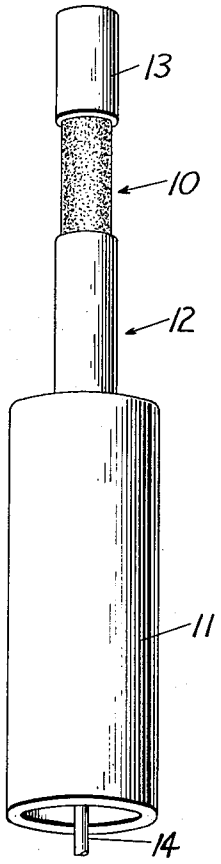

FIG. 2

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CATHODE FOR ELECTRON DISCHARGE DEVICES

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2 Claims. (Cl. 313—343)

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This invention relates to thermionic tube structure and more particularly to an improved form of cathode.

In high frequency power tubes such as magnetrons it is necessary that a cloud of electrons be available about the cathode of the device so that when the tube is pulsed a large current may be drawn with the resulting high power output.

Furthermore, as higher frequencies are used, the cathode of the device which is generally cylindrical in shape must be made smaller and smaller in diameter. It becomes extremely difficult to insert a heating coil in a cathode cylinder of the type described when the diameter of the cylinder becomes very small, for example, in the order of 50 thousandths of an inch in diameter.

Accordingly it is an object of this invention to provide a cathode structure wherein the necessity of a heating coil is eliminated.

It is a further object of this invention to provide a cathode which may be of very small diameter, and yet retain the ruggedness of a larger size cathode.

Yet another object of this invention is to produce a cathode which will operate over a wide range of temperature.

Still another object of this invention is to produce a cathode having a relatively low heating current.

A further object of this invention is to produce a cathode having a reservoir of electron emissive material for replacing material eroded from said cathode structure.

Other and further objects of this invention will become apparent as the description thereof progresses.

My invention will best be understood by referring to the accompanying drawings which illustrate one embodiment thereof, in which:

Fig. 1 is a longitudinal cross sectional view of the cathode and supporting structure; and

Fig. 2 is a view of the assembled cathode and structure.

Referring now to Fig. 1 there is shown a cylindrical member 10 which is fabricated from wire mesh. This mesh may be of any desired size and preferably is in the region of 100 meshes to the inch. This wire mesh should be made of some high refractory metal such as tungsten, tantalum, or molybdenum which will withstand temperatures up to above 2000° centigrade.

One end of the wire mesh cylinder 10 is inserted for a short distance into a hollow metal cylinder 11 and rigidly attached thereto by any

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desired means such as brazing or welding. This metal sleeve 11 is sufficiently strong to support the cathode structure and is suitably attached by any desired means to the base of the magnetron. As shown the cylindrical member 11 is necked down somewhat as at 12 at the end of the cylinder in which the wire mesh was inserted. The purpose of this is to insure adequate clearance from the anode structure of the magnetron.

The opposite end of the wire mesh is inserted for a short distance into a metallic sleeve 13, which may be called an end hat, and secured thereto by brazing or welding. The purpose of this end hat is to limit the area of electron emission to the wire mesh area between said end hat and the supporting cylinder 11.

A metallic rod 14 passes through a center of the cylinders 10, 11 and 13 coaxially therewith. This metallic rod is of considerably smaller diameter than the hole existing in said cylinders. The rod is attached to the mesh and end hat at the outer end thereof by heating all three at that point until they fuse into a solid mass. Obviously this attachment could be accomplished in other ways. The space 15 between the sleeve and the cylinder and surrounding metallic rod is filled with thoria such that it extends slightly through the openings in the mesh and covers the outer surface of the screen 10 with an electron emitting surface 16. This may be done in any desired manner, for example, by forming the thoria into a paste and working it into the space between the rod 14 and the mesh 10 with the fingers and allowing the mass of thoria to harden and by the application of heat, whereupon the mass of thoria becomes rigid and strong. The portion of the metallic rod 14 which extends through the cylinder 11 is insulated therefrom by any desired means such as spacers, or as in the present case by a coating of alundum 17 which may be sprayed onto the rod 14.

Thus it may be seen that due to the cementing action of the thoria there is produced an extremely rigid cathode structure. Further there is no thin filament of a heater coil to be jarred and broken.

Now by suitably applying a potential between the rod 14 and the cylinder 11 current is caused to flow through the wire mesh 10 from the end hat 13 to the sleeve 11 since the thoria is a relatively good insulator and little current will pass therethrough. Since this wire mesh is made up of relatively small diameter wire a substantial resistance exists between the ends thereof, and the current passing therethrough will create heat.

In the present case where a cylindrical mesh of approximately fifty thousandths of an inch in diameter and roughly ½" long is used, a potential of 3 volts between the cylinder 11 and the rod 14 will draw a current of approximately 10 amperes through the wire mesh with the resulting 30 watts of heating capacity in the cathode structure. The thoria upon being heated emits electrons which are then used to generate high frequency power in the tube in a well-known manner. This construction will allow a range of temperature of from approximately 1200° to 2000° centigrade under which suitable electron emission will occur with the operating temperature prevailing being about 1600° centigrade.

As the upper temperature is approached evaporation of the thoria material from the surface of the mesh increases until at a temperature above 2000° centigrade it becomes objectional and will lessen the life of the cathode considerably. On the other hand if the temperature becomes too low, for example, below 1200° centigrade, insufficient quantities of electrons will be emitted to adequately operate the device.

It may be seen that, as material is eroded from the surface of the wire mesh, more material from the inside of the mesh cylinder will diffuse through the holes in the mesh thus replacing the material on the outside with the resultant lengthening of cathode life. Further, due to the fact that the material is held onto the surface of the wire mesh by extending partially through the meshes, it will not be readily dislodged therefrom by ionic bombardment. Therefore, a considerable amount of this positive ion bombardment can be tolerated with its attendant increase in electron emission due to secondary emission phenomena.

Thus it may be seen that this cathode is well suited to operation in a magnetron device which contains a certain amount of gaseous material due to the absence of a getter. Furthermore, the diameter of this type of cathode structure may be made extremely small with relative strength since it is a solid mass rather than one containing spaces or voids.

Since the heating current passes through the wire mesh, and the mesh is covered by thoria so it will not erode away, the heating current required will remain constant anent the life of the tube. Further, deterioration of the electron emissive material, due to the "thermal shock" of stopping and restarting the discharge device after the cathode has cooled down, is considerably less than in the type of cathode where the heating current flows directly through the electron emissive material.

While there is herein described one embodiment of the invention other modifications will be apparent to those skilled in the art. For example, the circular rod 14 could be eliminated and two supporting cylinders 11, one on each end of the mesh 10, could be used with the potential applied between them, or, if desired, a section of heater coil could be substituted for the rod on the inside of the mesh 10 and then surrounded with thoria.

Therefore, I do not wish to be limited to the embodiment of the invention herein described but rather desire a broad interpretation of the appended claims commensurate with the scope of the invention within the art.

What is claimed is:

1. A cathode comprising a substantially cylindrical wire mesh, a portion of said mesh comprising an exposed surface, a rod passing through the inside of said cylinder parallel to the axis thereof and attached to one end of said cylinder and a mass of thoria fused to said mesh and substantially filling the space between said rod and said cylinder, said mesh being of sufficiently open weave to expose a substantial amount of said thoria.

2. A cathode comprising a substantially cylindrical wire mesh, a portion of said mesh comprising an exposed surface, a rod passing through the inside of said cylinder parallel to the axis thereof and attached to one end of said cylinder and a mass of thoria filling the space between said rod and said cylinder and fused to said wire mesh.

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