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ELECTRON TUBE

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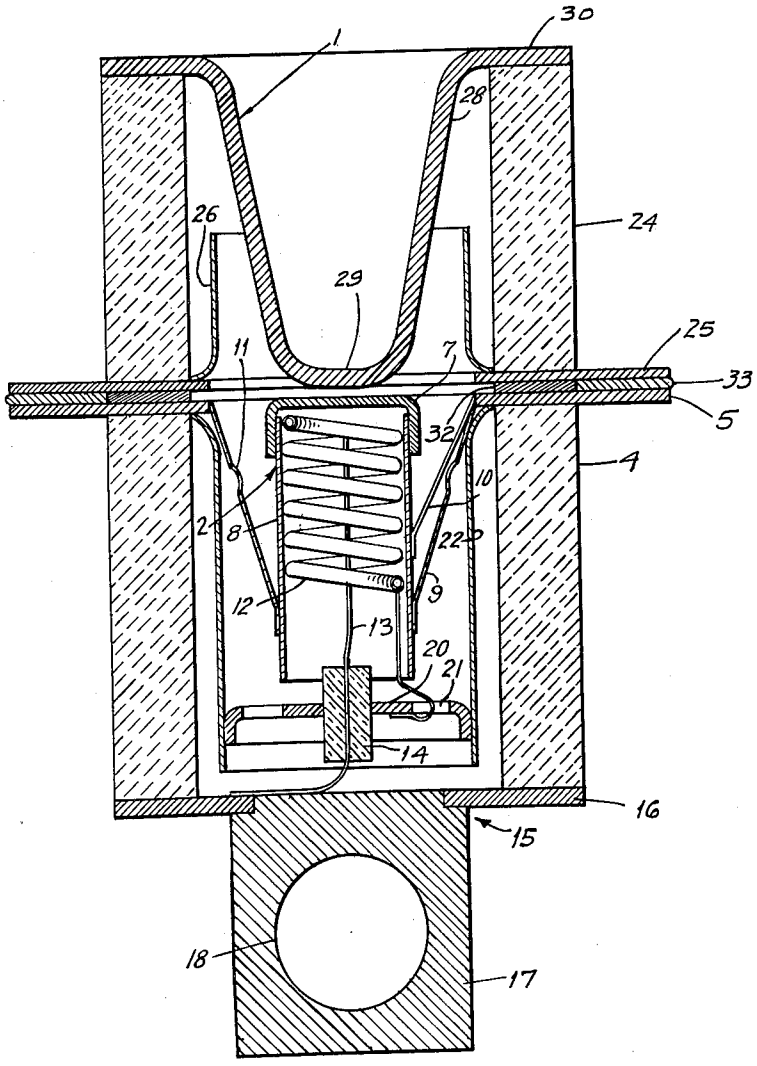

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ELECTRON TUBE

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This invention relates generally to electron tubes and more particularly to miniature size electron tubes having extremely close and accurately spaced electrodes.

It is a general object of the present invention to provide an electron tube in which the electrodes are closely and accurately spaced during manufacture, and in which the spacing is accurately maintained during operation.

It is another object of the present invention to provide a cathode structure which has good thermal efficiency.

It is another object of the present invention to provide a miniature size electron tube which includes a cylindrical ceramic envelope made in two sections with one of the sections supporting the cathode structure, and the other section supporting another electrode, the sections being joined to complete the envelope and give an accurate close spacing between the cathode and said other electrode.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description of the invention. It is to be understood that the invention is not to be limited to the disclosed species, as various embodiments thereof are contemplated and may be adopted within the scope of the claims.

The single sheet of drawing shows the invention embodied in a diode which has an anode indicated generally by the reference numeral 1, and a cathode designated generally by the reference numeral 2.

Essentially, the tube is made in two sections, a cathode section and an anode section, which sections are joined to form the electron tube. The cathode section comprises a cylindrical ceramic envelope portion 4 metallized at both ends by a known process, such as the molybdenum-manganese powder sintering process. A metal ring 5 of conductive material, such as Kovar, is brazed to one end of the ceramic cylinder 4 and serves as the terminal and lead-through for the cathode 2.

The cathode proper comprises a metal disc 7 having a planar electron emitting surface facing the anode 1. Preferably, the disc 7 is made of nickel and the emitting surface thereof is coated with a conventional alkaline earth carbonate mixture which is decomposed to provide the usual oxide coating. The disc 7 has a downward turned rim which fits over and is brazed to a support cylinder 8 of relatively thin metal, such as Kovar. The cylinder 8 is, in turn, supported by a frustro-conical support member 9, which is also made of relatively thin metal, such as Kovar, and is brazed at its small end to the support cylinder 8 at a location spaced from the disc, and at its large end to the inner periphery of the metal ring 5. In order to provide a complete evacuation of all areas within the tube during pumping, a number of small apertures 11 are provided in the support cone 9. A strip of getter material 10 such as zirconium may be brazed between the ring 5 and the cylinder 8.

The cathode is heated by means of a filamentary coil 12 received within the support cylinder 8. One lead 13 for the heater passes through a ceramic insulating plug 14 and is brazed to a metal end closure indicated generally at 15. The insulating plug 14 is supported on a downwardly turned dish 20 which is apertured 21 for evacuation. Dish 20 is, in turn supported by a cylindrical member 22 which is brazed to the inner periphery of the ring 5 and extends concentrically within the envelope portion 4. The end closure comprises a metal ring 16 brazed to the other end of the ceramic cylinder 4 and a plug 17 brazed to the center of the ring 16. The plug 17 may include a hole 18 extending transversely therethrough to facilitate holding the tube during manufacture thereof as well as to facilitate mounting the tube for operation.

The anode section of the tube comprises a cylindrical ceramic envelope portion 24 metallized at both ends by one of the known metallizing processes. A metal ring 25 of conducting material, such as Kovar, is brazed to one end of the ceramic cylinder 24. A cylindrical metal shield 26, preferably nickel, is brazed to the ring 25 and extends upwardly coaxially with the envelope section. The shield 26 serves to protect the ceramic cylinder from stray deposits of material which might be evolved by the cathode. Such deposits would create an r-f leakage path along the envelope wall if they were allowed to collect on the wall.

The anode itself is a drawn member, preferably copper. It has a frustro-conical side wall portion 28 terminating at its end in a disc portion 29. The disc portion might be said to provide an effective anode surface. The other end of the side wall portion 28 is provided with a flange 30 which is brazed to the other end of the ceramic cylinder 24.

In order to obtain the desired spacing between the planar cathode surface 7 and the planar anode portion 29, the surfaces are made coplanar with the metal rings 5 and 25, respectively. This is achieved by assembling the components in the sections and then lapping. Thus, the ring 5 and cathode button 7 are lapped coplanar in one lapping operation and the ring 25 and anode surface 29 in another lapping operation. By placing a spacer ring 32 between the rings 5 and 25, an exact spacing can be obtained between the opposed planar cathode and anode surfaces. A final seal may be made by employing brazing material 33 between the rings 5 and 25, for example.

The complete tube may be evacuated and the two sections sealed within an evacuated chamber in the manner described in Patent No. 2,713,532. Alternatively, the plug 17 may be replaced by a conventional exhaust tubulation and the tube sections seated together and the tube evacuated in a conventional manner.

Radial expansion of the tube parts as a result of heating during operation does not affect the spacing between the cathode and anode. However, axial expansion of the parts as a result of heating tends to alter the spacing. This effect can be minimized by selecting the material of cylinder 8 and the supporting cone 9 so that they have substantially the same linear coefficient of linear expansion. Thus, axial changes in length compensate one another and the spacing remains fixed.

Thus, it is seen that an improved electron tube is provided. The electrodes are closely and accurately spaced during manufacture. The conduction of heat from the cathode cylinder is minimized. The spacing is maintained during operation.

We claim:

1. An electron tube comprising a first section carrying a cathode and a second section having another electrode, a cylindrical ceramic envelope portion forming part of the envelope for said first section, a metallic lead-in ring secured to one end of said envelope portion and presenting an outwardly facing plane surface, means secured to said metallic lead-in ring for supporting a cathode within said ceramic cylinder, said cathode having a cathode emitting surface coplanar with said surface of said metallic lead-in ring, a second cylindrical ceramic envelope portion forming part of the envelope for said second section, a second ring secured to one end of said second cylindri-

cal ceramic envelope portion and presenting an outwardly facing plane surface, an electrode having a flange at one end, said flange being sealed to the other end of said second cylindrical ceramic envelope portion, said electrode extending downwardly into said second cylindrical ceramic envelope portion to form a planar surface which is coplanar with said surface of said second ring, spacer means having a thickness equal to the desired spacing of said electrodes, said spacer means being disposed between said rings, and means forming a seal between said ring portions to form an evacuated envelope.

2. An electron tube comprising a first section carrying a cathode and a second section carrying an anode, a ceramic cylinder forming part of the envelope for said first section, a metallic lead-in ring secured to one end of said ceramic cylinder and presenting an outwardly facing plane surface, a cathode comprising a cylinder having a closure at one end thereof forming a planar emitting surface coplanar with said first named surface, a heater within said cathode cylinder, a support member attached to said cathode cylinder at a point spaced from said closure and extending towards said closed end in spaced relationship to said cathode cylinder, said support having its free end secured to said metallic lead-in ring, a second ceramic cylinder forming a part of the envelope for said second section, a second ring secured to one end of said second ceramic cylinder and presenting an outwardly facing plane surface, an anode having a flange, said flange being sealed to the other end of said second ceramic cylinder, said anode extending downwardly into said cylinder and having a surface coplanar with said surface of said second ring, a spacer having a thickness equal to the desired spacing of said electrodes, said spacer being disposed between said metallic lead-in ring and said second ring, and means sealing said rings to form an evacuated envelope.

3. An electron tube comprising a first section carrying a cathode and a second section carrying an anode, a ceramic cylinder forming part of the envelope for said first section, a metallic lead-in ring secured to one end of said ceramic cylinder and presenting an outwardly facing plane surface, a cathode comprising a cylinder having a closure at one end thereof to form a planar emitting surface coplanar with said first named surface, a heater having two terminals, a cylindrical member secured to said metallic lead-in ring and extending coaxially into said ceramic cylinder, a cup-shaped member secured to said cylinder, an insulating plug carried by said cup-shaped member, one terminal of said heater extending through said cup-shaped member at said plug, a lower sealing assembly, said one terminal being connected to said sealing assembly, the other terminal of said heater being electrically connected to said metallic lead-in ring, a support member attached to said cathode cylinder at a point spaced from said closure and extending towards said closed end in spaced relationship to said cathode cylinder, said support having its free end secured to said metallic lead-in ring, a second ceramic cylinder forming a part of the envelope for said second section, a second ring secured to one end of said second ceramic cylinder and presenting an outwardly facing plane surface, an anode having a flange, said flange being sealed to the other end of said second ceramic cylinder, said anode extending downwardly into said cylinder and having a surface coplanar with said surface of said second ring, a spacer having a thickness equal to the desired spacing of said electrodes, said spacer being disposed between said metallic lead-in ring and said second ring, and means sealing said rings to form an evacuated envelope.

4. An electron tube comprising a first section carrying a cathode and a second section carrying an anode, a ceramic cylinder forming part of the envelope for said first section, a metallic lead-in ring secured to one end of said ceramic cylinder and presenting an outwardly facing plane surface, a cathode comprising a cylinder having a closure at one end thereof to form a planar emitting surface coplanar with said first named surface, a heater having two terminals, a cylindrical member secured to said metallic lead-in ring and extending coaxially into said ceramic cylinder, a cup-shaped member secured to said cylinder, an insulating plug carried by said cup-shaped member, one terminal of said heater extending through said cup-shaped member at said plug, a lower sealing assembly, said one terminal being connected to said sealing assembly, the other terminal of said heater being electrically connected to said metallic lead-in ring, a support member attached to said cathode cylinder at a point spaced from said closure and extending towards said closed end in spaced relationship to said cathode cylinder, said support having its free end secured to said metallic lead-in ring, a second ceramic cylinder forming a part of the envelope for said second section, a second ring secured to one end of said second ceramic cylinder and presenting an outwardly facing plane surface an anode having a flange, said flange being sealed to the other end of said second ceramic cylinder, said anode extending downwardly into said cylinder and having a surface coplanar with said surface of said second ring, a cylindrical shield secured to the second ring and extending upwardly between the lower portion of the anode and the second ceramic cylinder, a spacer having a thickness equal to the desired spacing of said electrodes, said spacer being disposed between said metallic lead-in ring and said second ring, and means sealing said rings to form an evacuated envelope.

5. The method of forming an electron tube having accurately spaced cathode and anode surfaces which comprises the steps of forming a first tube section having a metallic lead-in ring and the cathode emitting surface lying nearly in the same plane, lapping the lead-in ring and cathode surface until they are coplanar, forming a second section which includes a second ring and the surface of the anode lying nearly in the same plane, lapping said second ring and anode surface until they are coplanar, assembling the first and second sections of said tube with a spacer of predetermined thickness between said rings whereby the cathode and anode surfaces are spaced a distance corresponding to the thickness of the spacer, and joining said rings.

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