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CERAMIC ELECTRON TUBE

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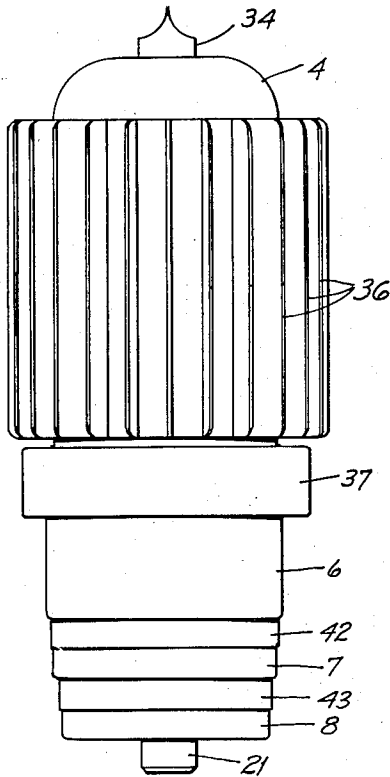


Fig. 1

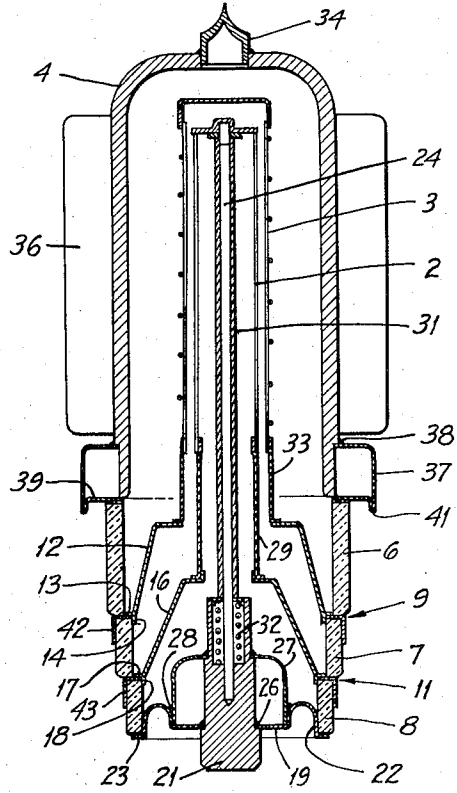


Fig. 2

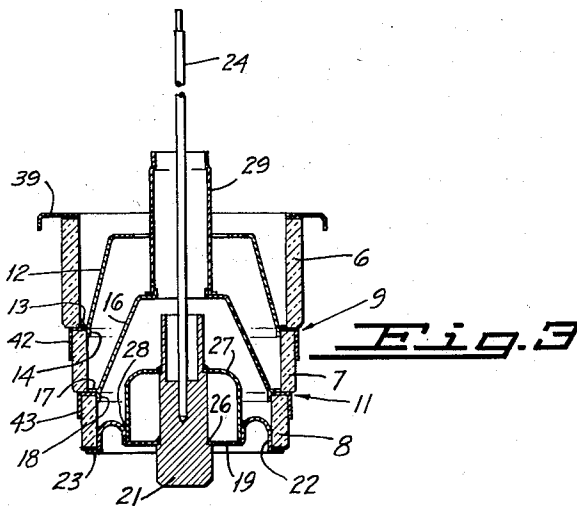


Fig. 3

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CERAMIC ELECTRON TUBE

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6 Claims. (Cl. 313—244)

My invention relates to electron tubes and more particularly to improvements in tubes employing ceramic in the envelope structure.

My improvements are especially suited for tubes in the transmitting or power tube category where anode dissipations of several hundred watts or more are encountered, it being among the objects of my invention to provide a structure which will deliver considerable power without forced cooling.

Another object of my invention is to provide a tube which is extremely rugged and has a simplified envelope comprising vertically stacked ceramic cylinders.

Another object is to provide improved means for self-jigging the ceramic cylinders.

Still another object is to incorporate such jigging means with an electrode mount so as to coaxially align the ceramic parts and simultaneously center the electrode mount in the envelope.

A further object is to provide an envelope structure of the character described which can be brazed together in a single operation.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description of my invention. It is to be understood that I do not limit myself to this disclosure of species of my invention, as I may adopt variant embodiments thereof within the scope of the claims.

Referring to the drawings:

Figure 1 is a side elevation of an electron tube embodying my improvements; and

Figure 2 is a vertical sectional view of the same.

Figure 3 is a similar vertical sectional view showing the ceramic and associated portions of the envelope prior to mounting the electrodes.

In greater detail, my improvements are illustrated in a triode type of tube having coaxial electrodes including a filamentary cathode 2, grid 3 and external anode 4, the latter forming the upper portion of the evacuated envelope. The envelope is of generally cylindrical shape, and the body portion is made up of three vertically stacked ceramic cylinders 6, 7 and 8 joined along abutting ends. The abutting type of joint is particularly desirable because the ceramic sections can then be simple straight-wall cylinders without close tolerances on the dimensions. With the use of three side wall cylinders there are two such ceramic-to-ceramic joints provided, namely, an upper joint 9 and a lower joint 11.

The ceramic cylinders preferably have different diameters decreasing in size toward the lower end of the envelope so that the cylinders are offset at the joints as shown in Figure 2. The internal diameter of an upper cylinder in the stack is thus larger than that of an adjacent lower cylinder so that the upper edge of the lower cylinder provides an interior horizontal ledge adjacent a joint, the purpose of which will be hereinafter described.

The ceramic used in the wall cylinders is of a highly refractory kind, preferably alumina. In order to bond

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the ceramic to another ceramic section or to adjacent metal parts, the ceramic cylinders are first metalized at the ends in a suitable manner. Any of the known metalizing techniques may be used, such as the metal powder sintering process or the like. For example, the surface of the ceramic may be coated with a finely divided metal such as molybdenum, or a mixture of molybdenum and iron or manganese, and then fired in hydrogen to a temperature of about 1300° C. to sinter the metal powder to the ceramic.

Such metalized surface may then be brazed to another metalized ceramic part or to a metal member with a suitable high melting point brazing alloy such as copper-silver, copper-gold, or the like. The brazes are readily made by fitting the metalized parts together with rings of brazing wire adjacent the joints, and then elevating the temperature of the whole up to the melting point of the brazing material in a suitable furnace. Another metalizing technique is to coat the ceramic with titanium or zirconium hydride powders and fire in vacuum to about 1200° C.

An important feature of my invention concerns a unique structure for self-jigging the ceramic cylinders and simultaneously centering electrode mounts in the envelope. The grid mount 12 is of circular shape, preferably of conical formation, having, say, three legs supported from the ceramic side wall of the envelope. These legs have foot portions with a horizontal lip 13 engaging the upper surface of the ledge at joint 9 and a vertical lip 14 engaging the inner surface of ceramic cylinder 7. The diameter of the mount at the vertical lips 14 is substantially equal to the internal diameter of cylinder 7 so as to center the mount in the envelope. Likewise, the diameter of the mount at the horizontal lips 13 is substantially equal to the internal diameter of upper cylinder 6 so as to coaxially align the latter with lower cylinder 7 and with the electrode mount 12.

In a similar manner a filament mount 16 of like shape is supported at side wall joint 11 and has lips 17 and 18 for jigging the parts at the lower joint. Electrode mounts 12 and 16 are brazed to the metalized ceramic cylinders at the same time the latter are brazed together. Such structure is extremely easy to assemble, using simple parts, and insures coaxial alignment of all the elements. The resulting structure is very strong and rugged.

I prefer to use a metal wall member 19 at the lower end of the envelope, which member also incorporates the second filament terminal 21. Wall 19 of, say, copper is circular in shape fitted in the lower part of ceramic cylinder 8 and has a vertical flange portion 22 with a diameter substantially equal to the internal diameter of cylinder 8 so as to center the terminal member in the envelope. The metal wall also has a horizontal flange portion 23 overlapping the metalized lower end of ceramic cylinder 8 and brazed thereto. This butt brazing of the metal wall to the end of the ceramic cylinder produces an excellent joint which is easy to assemble and make.

With the filamentary cathode shown, using vertical wires of thoriated tungsten, I provide a center rod 24 supported from the terminal stud 21. The latter is brazed at 26 to wall 19 and is also preferably reinforced by a cup-shaped button 27 brazed at 28 to the reentrant portion of the wall. This provides a rigid terminal and end wall structure. The lower ends of the filament wires are supported from a tubular extension 29 on mount 16, and the upper ends are supported by center rod 24. A pusher sleeve 31 pressed by a spring 32 is provided for tensioning the filament.

Grid 3 which may be of the conventional wire cage type is supported from a tubular extension 33 on upper mount 12. The filament and grid are thus coaxially

arranged in the envelope and are provided with adequate support for purposes of rigidity.

Anode 4 which forms the upper portions of the envelope is cup-shaped, preferably of copper, and carries a metal exhaust tubulation 34 as well as suitable cooling fins 36. The latter are preferably simple vanes brazed directly to the anode because the tube is able to operate in a unique manner as hereinafter described. The fins are preferably of copper and are brazed to the anode with a high melting point brazing alloy such as copper-gold, so that the fins are formed as a structurally integral part of the anode.

The anode support comprises a downwardly extending metal flange 37 brazed at 38 to the anode and encircling the upper ceramic cylinder 6. A metal sealing ring 39 is fitted into anode flange 37 and has an intumed flange portion overlapping the metalized upper end of cylinder 6 and brazed thereto. As a final assembly step the registering edges of the metal flanges are welded together at 41. When so assembled the projecting lower end of the anode preferably abuts the ceramic envelope structure as shown in Figure 2 to take the thrust when the envelope is evacuated and thus remove the stress from the sealing flanges.

Figure 3 illustrates the ceramic body portion of the envelope prior to mounting the electrodes. All of the parts shown in this view are assembled and brazed together in one operation in a brazing furnace. This is possible because all the parts are self-aligning and self-supporting and can be assembled together with the necessary brazing rings for delivery to the brazing furnace.

Grid and filament terminals 42 and 43 are provided on the ceramic envelope and are connected to the grid and filament mounts 12 and 16 through the metallic bonds at joints 9 and 11. Electrode terminals 42 and 43 are preferably formed in a simple manner by metalizing the desired areas on the ceramic cylinders, which metalized areas may be electroplated with nickel or copper if a smoother terminal surface is desired.

The tube illustrated was designed for an anode dissipation of 450 watts without forced cooling. As constructed for such rating the tube has an anode diameter of about two inches and an overall height of about six inches. Since the ceramic envelope parts and all joints will withstand high temperatures, the tube is capable of operation without forced cooling of any kind, either on the anode or on the envelope, which was one of the reasons for brazing fins 36 directly to the anode without the usual soft solders employed with conventional forced air cooled structures.

It is thus seen that, since the temperature of the entire tube can rise considerably without danger to the seals or envelope, it is possible to generate fairly large orders of power without forced cooling and relying merely upon convection and radiation of heat from the external anode. In actual operation at 450 watts anode dissipation the measured temperature at anode seal 37 was 400° C. and at the middle of ceramic cylinder 6 was about 350° C. This manifestly would not be possible with the conventional glass tubes where seal temperatures have to be held down to about 175° C. With the addition of forced cooling my tube, of course, is capable of considerably higher ratings than would be possible with conventional tubes.

While operation at higher temperatures is one of the advantages of my tube structure, it is understood that other features already mentioned are very important, such as ease of fabrication and improved mechanical support for the electrodes.

I claim:

1. An electron tube having an envelope comprising vertically stacked ceramic cylinders joined along abutting ends, the internal diameter of an upper cylinder in the stack being larger than that of an adjacent lower cylinder with the upper edge of the lower cylinder pro-

viding an interior horizontal ledge adjacent the joint, said ceramic cylinders having metalized ends metallurgically bonded together at the joint, and a circular metal electrode mount supported from the envelope and having a horizontal lip engaging the upper surface of said ledge and having a vertical lip engaging the inner surface of the lower cylinder, the diameter of said mount at the vertical lip being substantially equal to the internal diameter of the lower ceramic cylinder to center the mount within the envelope, and the diameter of the mount at the horizontal lip being substantially equal to the internal diameter of the upper ceramic cylinder to coaxially align the latter with the lower cylinder and with said mount.

2. An electron tube having an envelope comprising vertically stacked ceramic cylinders joined along abutting ends, the internal diameter of an upper cylinder in the stack being larger than that of an adjacent lower cylinder with the upper edge of the lower cylinder providing an interior horizontal ledge adjacent the joint, said ceramic cylinders having metalized ends metallurgically bonded together at the joint, a circular metal electrode mount supported from the envelope and having a horizontal lip engaging the upper surface of said ledge and having a vertical lip engaging the inner surface of the lower cylinder, the diameter of said mount at the vertical lip being substantially equal to the internal diameter of the lower ceramic cylinder to center the mount within the envelope, and the diameter of the mount at the horizontal lip being substantially equal to the internal diameter of the upper ceramic cylinder to coaxially align the latter with the lower cylinder and with said mount, the mount being metallurgically bonded to the metalized ceramic, and a terminal on the envelope connected to the mount through the metallic bond of said joint.

3. An electron tube having an envelope comprising vertically stacked ceramic cylinders joined along abutting ends, the internal diameter of an upper cylinder in the stack being larger than that of an adjacent lower cylinder with the upper edge of the lower cylinder providing an interior horizontal ledge adjacent the joint, said ceramic cylinders having metalized ends metallurgically bonded together at the joint, a circular metal electrode mount supported from the envelope and having a horizontal lip engaging the upper surface of said ledge and having a vertical lip engaging the inner surface of the lower cylinder, the diameter of said mount at the vertical lip being substantially equal to the internal diameter of the lower ceramic cylinder to center the mount within the envelope, and the diameter of the mount at the horizontal lip being substantially equal to the internal diameter of the upper ceramic cylinder to coaxially align the latter with the lower cylinder and with said mount, the mount being metallurgically bonded to the metalized ceramic, and a terminal on the envelope connected to the mount through the metallic bond of said joint, said terminal comprising a metalized area on the ceramic.

4. An electron tube having an envelope comprising a ceramic side wall cylinder metalized at the lower end, and a circular metal member fitted in the ceramic cylinder and forming the bottom wall of the envelope, said wall having a central disk-shaped portion and, adjacent its periphery, an annular inverted U-shaped channel, the outer leg of the U-shaped channel having an external diameter substantially equal to the internal diameter of the ceramic cylinder to center the wall in the envelope, and an outturned flange portion on the bottom of said outer leg of the U-shaped channel, said flange portion overlapping the lower end of the ceramic cylinder and metallurgically bonded thereto, and a central electrode terminal stud passing through and bonded to said disk-shaped portion of said bottom wall.

5. An electron tube having an envelope comprising a ceramic side wall cylinder metalized at the upper end, a

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metal external anode forming the upper portion of the envelope and a pair of flexible cup-shaped members, each having a lip adapted to interfit with the lip of the other cup-shaped member, one of said cup-shaped members being secured to said anode at a point intermediate its ends, the other of said cup-shaped members being connected to said ceramic cylinder, a portion of said anode extending within said one cup-shaped member to contact the other cup-shaped member so as to maintain said two lips in position adjacent each other, said lips being hermetically sealed by a metallic bond.

6. An electron tube having an envelope comprising a ceramic side wall cylinder metalized at one end, a metal member forming the portion of the envelope adjacent said metalized end of the ceramic cylinder, a first cup-shaped member on said metal member adjacent the metalized end of said ceramic cylinder, and a second cup-shaped member fitted into said first cup-shaped member, said first and second cup-shaped members having lips thereon, said metal member extending to contact said second cup-shaped member so as to maintain said

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two lips in a position adjacent each other, said two lips being hermetically sealed to each other by a metallic bond.

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