July 30, 1957 G. H. ROBERTSON ET AL 2,801,360

TRAVELING WAVE TUBE

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FIG. 1

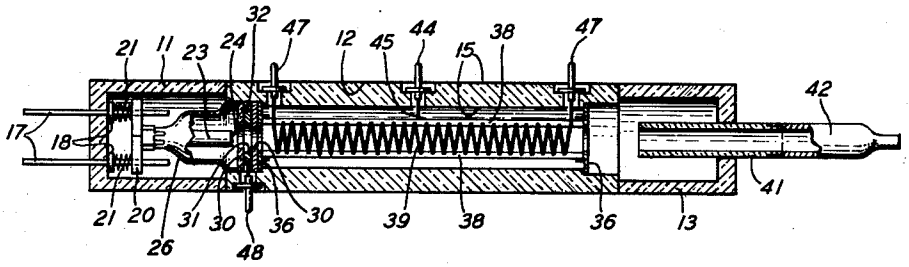
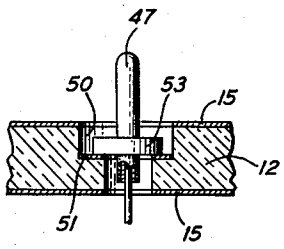


FIG. 2



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TRAVELING WAVE TUBE

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6 Claims. (Cl. 315—3.5)

This invention relates to electron discharge devices and particularly to such devices known as traveling wave tubes.

The envelope of such tubes has priorly generally been of glass, metal or a combination of ceramic and metal. Considerable advantages are attainable, however, if the envelope is entirely of ceramic, such advantages including the absence of objectionable oxides, thereby allowing the attainment of a much cleaner tube, the employment of higher bakeout or degassing temperatures, and, in accordance with this invention, ease of assembly of the various parts of the envelope and tube, and facility in sealing the terminals and leads to the envelope and the various portions of the envelope together. The problem of sealing has priorly been quite difficult and has, in part, prevented the attainment of some of these desirable characteristics. Sealing requirements have necessitated cumbersome seals and terminals even at frequencies where electrically much simpler terminals could be employed.

It is a general object of this invention to provide an improved traveling wave tube having an all ceramic envelope.

It is another object of this invention to enable the seals between the portions of the all ceramic envelope and between the envelope and the terminal pins to be made facilely and simply.

It is a further object of this invention to simplify the terminal pins and terminal pin seals.

It is a still further object of this invention to provide an improved tube structure that may be expeditiously and simply assembled.

These and other objects of this invention are attained in one specific illustrative embodiment wherein the envelope of the traveling wave tube comprises three ceramic sections, a gun cup member, a cylindrical body member, and a collector cup member, each of these sections having a thin metallic coating on both their inside and outside surfaces and on their end edges. The helix is supported on rods within the cylindrical body member, the rods being positioned by support members advantageously held against shoulders in the inner wall of the cylindrical body member. The ends of the helix are secured to terminals mounted in cup-like depressions in the outer surface of the body member. The bottoms of these depressions have metallic coatings thereon on which the shoulders of the terminal pins rest and to which they are sealed. Advantageously a terminal pin is provided adjacent the center portion of the helix to provide a direct current connection to the helix at the region of maximum attenuation along the helix.

The leads extending through the base of the gun cup member are similarly provided with shouldered terminals, the shoulders resting on and being sealed to the metallic coating on the inside of the base of the cup member. The terminal pins also support a spring loaded platform on which the cathode assembly is mounted, whereby the cathode assembly can be mounted in the stem as a unit. A cathode heat shield is carried by the cathode assembly and

when the tube is assembled the heat shield is guided into and aligned by the central bore of the central cylindrical portion of the envelope. The heat shield can thus transmit the spring pressure to an accelerating grid frame and its insulating spacer members to hold them in place.

The collector cup member advantageously comprises a ceramic exhaust tubing sealed in the base of the cup and having a metallic portion sealed to it exterior to the tube. By operating the accelerating grid at ground potential and applying a ground potential to the inner metallic coating of the tube, the inner metallic coating on the collector cup member can itself serve as the collector and a separate collector element is therefore not needed. Further, due to the geometry of the configuration and the ground potential applied to the collector metallic coating the need for a suppressor grid is also obviated.

It is therefore a feature of this invention that the envelope of a traveling wave tube comprise ceramic members having metallic coatings on their surfaces. Thus, it is a feature of this invention that the sealing together of the various ceramic members of the envelope be accomplished by these metallic coatings and that the coatings further serve to shield the electron system within the envelope from external electrical fields. Further the metallic coating will prevent electric charge from building up on the inner walls of the ceramic envelope.

It is a further feature of this invention that the metallic coating applied to the inner surface of the envelope be at ground potential so that that portion of the coating adjacent the end of the helix opposite the electron gun assembly can itself serve as the collector of the electron stream, thereby obviating the need for a separate collector element, for a suppressor grid, and for the supporting and cooperating members therefor.

It is a still further feature of this invention that the terminal pins each comprise a shoulder portion adjacent a metallic coating on the ceramic envelope and that the seal between the terminal pins and the ceramic envelope be made by the shoulders and the metallic coatings. More specifically it is a feature of this invention that certain of the terminal pins be positioned in cup-shaped depressions in the ceramic envelope, the base of these depressions having a metallic coating thereon for sealing to the pins and the side portions of these depressions being uncoated to insulate the terminal from the major portion of the metallic coating.

It is a still further feature of this invention that a spring loaded platform be supported by certain of these terminals, the cathode assembly be mounted on the platform, and the accelerating grid assembly be positioned and held by a heat shield member spring biased by the platform.

It is a still further feature of this invention that a separate terminal be provided for connection to the helix at a point along its length to apply a direct current bias to the helix. Advantageously the direct current bias of the helix with respect to the cathode can then be introduced at the point where the attenuating medium on the helix is a maximum with a minimum of disturbance of the high frequency alternating current path.

A complete understanding of this invention and of the above noted and other features thereof may be gained from consideration of the following detailed description and the accompanying drawing, in which:

Fig. 1 is a sectional view of a traveling wave tube in accordance with one specific illustrative embodiment of this invention; and

Fig. 2 is an enlarged sectional view of one of the terminals of the embodiment of Fig. 1.

Turning now to the drawing, the traveling wave tube depicted in Fig. 1 has an all ceramic, for example steatite, envelope comprising a gun cup member 11, a cylindrical

body member 12, and a collector cup member 13. A metallic coating 15 covers all surfaces of each of the ceramic members, except as indicated below, and advantageously may comprise a layer of molybdenum and iron particles. A thin nickel layer or a copper layer may cover the molybdenum and iron coating; further, other metallic coatings may be employed. By means of this metallic coating a butt seal is made between the edges of each of the cup members 11 and 13 and the central cylindrical member 12. By employing a metallic coating on the ceramic envelope portions the sealing together of the various portions is considerably simplified and the advantages of a ceramic envelope are retained while providing an electrostatic shield around the tube.

Extending through the base of the gun cup member 11 are a number of terminal pins 17 of which only two are shown in Fig. 1 but which may include two heater terminal pins, a cathode terminal pin, and two getter terminal pins. Each of the pins 17 has a shoulder portion 18 which abuts a portion of the metallic coating 15 on the inner surface of the gun cup member 11 which is insulatingly separated from other portions of the metallic coating. The shoulder 18 is sealed to the distinct portion of the metallic coating 15 by a butt type seal, the pin advantageously being of a nickel-cobalt-manganese-iron alloy known as Kovar. A platform 20 is supported on the terminal pins 17 and mounted therefrom by a plurality of springs 21. The platform supports the cathode assembly which comprises a tubular cathode member 23 having an electron emissive plate member 24 at the end thereof adjacent the helix. The platform also supports a cathode heat shield 26 which is attached to the tubular cathode member 23. The heat shield 26 fits into the central bore of the cylindrical ceramic envelope member 12 and abuts the accelerating grid assembly which comprises a pair of insulating washers 30 positioned to either side of a ring-like accelerating electrode 31 and an annular insulating ring 32 around the electrode 31 and between it and the metallic coating 15 on the inside of the envelope wall.

The accelerating grid assembly is held in position by the spring biased heat shield 26 which presses the assembly against a helix rod support member 35 which may itself abut a shoulder on the inner bore of the central cylindrical envelope member 12 or may be brazed to the metallic coating 15 thereon. This support member 35 together with a similar support member 36 at the other end of the cylindrical member 12 supports the helix assembly which comprises the helix support rods 38 and the wire helix 39.

The metallic coating 15 on the inner wall of the collector cup member 13 advantageously, in accordance with our invention, itself serves as the collector electrode for the electron system of the traveling wave tube so that no other elements or suppressor grids are required. Additionally a metallized ceramic tube 41 extends through the base of the collector cup member 13 and defines the inner portion of an exhaust tabulation for evacuating the envelope of the tube. A metallic tube 42, such as of Kovar or of Kovar sealed to copper, is sealed to the tube 41 and is closed off after evacuation of the envelope.

In accordance with our invention a terminal pin 44 is advantageously provided adjacent the center of the cylindrical envelope member 12 and connected, as by a lead 45, to the attenuating medium, which may advantageously be carbon, coated onto the central portions of the helix 39 and support rods 38. By this terminal a direct current bias is applied to the central portion of the attenuation to bias the helix with respect to the cathode. By connecting the direct current bias to the middle of the attenuation where it is advantageously a maximum, a minimum of disturbance of the alternating current path is introduced, thus obviating discontinuities or reflection of energy caused thereby.

Each of terminal pin 44, terminal pins 47 connected to the ends of the helix 39, and terminal pin 48 connected to the accelerating grid 31 advantageously, in accordance with our invention, are positioned in a cup-shaped depression 50 in the outer wall of the envelope. As best seen in Fig. 2 the base of this cup-shaped portion has a metallic coating 51 thereof which may advantageously be identical with the metallic coating 15 and each of the terminals has a shoulder member 53 which sits onto this coating 51 and is sealed thereto. Advantageously the side walls of this cup-shaped depression 50 are not metallized so that the metallic coating 51, and hence the terminal itself, is insulated from the metallic coating 15, which is advantageously at ground potential. If it is desired to operate the accelerating grid at ground potential, its terminal 48 and the annual insulating ring 32 may be omitted and the accelerating grid 31 electrically connected directly to the metallic coating 15 with the envelope portion 12.

By providing a metallic coating over the ceramic envelope surface and employing terminal pins having shoulders which rest on the coating, the sealing of the metal terminals to the ceramic envelope is considerably simplified and traveling wave tubes having ceramic envelopes can be facilely constructed.

In the construction of a traveling wave tube in accordance with this invention the gun cup member 11 may be fabricated first with the cathode assembly therein, the collector cup member 13 and the central portion 12 with the helix assembly therein similarly separately assembled and the tube then constructed simply by joining these portions together. Advantageously each of the seals may be of the type described in A. J. Chick-L. J. Speck application Serial No. 220,575, filed April 12, 1951, now Patent 2,708,787, issued May 24, 1955.

It is to be understood that the above-described arrangements are illustrative of the application of the principles of the invention. Numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. A traveling wave tube comprising a ceramic envelope having metallic coatings on its exterior and interior surfaces, a helix positioned within said envelope, an electron gun opposite one end of said helix for projecting a stream of electrons therealong, said electrons impinging on and being collected by a portion of said metallic coating opposite the other end of said helix, and a plurality of terminal pins electrically connected to said helix and said electron gun and extending through said ceramic envelope, each of said pins having a shoulder portion resting on and sealed to a distinct portion of one of said coatings insulatingly separated from other portions of said coatings.

2. A traveling wave tube comprising a ceramic envelope having a plurality of cup-shaped depressions in its outer surface and having metallic coatings on both its inner and outer surfaces, a wire helix positioned within said envelope, an electron gun positioned within said envelope opposite one end of said helix for projecting a stream of electrons therealong, and a plurality of terminal pins electrically connected to said helix and said electron gun and extending through said ceramic envelope, each of said pins having a shoulder portion resting on and sealed to a distinct portion of one of said coatings insulatingly separated from other portions of said coatings and at least certain of said shoulders resting on the bases of said cup-shaped depressions.

3. A traveling wave tube comprising a ceramic envelope comprising a pair of cup-shaped base portions and an intermediate cylindrical portion, each of said portions having metallic coatings on its inner and outer surfaces, a wire helix within said cylindrical portion, an electron gun within one of said base portions for projecting a stream of electrons along said helix, said electrons impinging on and being collected by a portion of the metallic coating on the other of said base portions, and a plurality of

terminal pins electrically connected to said helix and said electron gun and extending through said ceramic envelope, each of said pins having a shoulder portion resting on and sealed to a distinct portion of one of said coatings insulatingly separated from other portions of said coatings.

4. A traveling wave tube comprising a ceramic envelope comprising a pair of cup-shaped base portions and an intermediate cylindrical portion having a plurality of cup-shaped depressions in its outer surface, each of said portions having metallic coatings over substantially its entire surface, a wire helix within said cylindrical envelope portion, an electron gun opposite one end of said helix and positioned in one of said base envelope portions for projecting a stream of electrons along said helix, said electrons impinging on and being collected by a portion of said metallic coating on the other of said base envelope portions opposite the other end of said helix, and a plurality of terminal pins extending through said envelope and electrically connected to said electron gun and said helix, each of said pins having a shoulder portion resting on and sealed to a distinct portion of one of said coatings insulatingly separated from other portions of said metallic coatings and at least certain of said shoulders resting on the bases of said cup-shaped depressions.

5. A traveling wave tube in accordance with claim 4 wherein one of said terminals extending through said cylindrical envelope portion is adjacent the middle portion of said helix for applying a bias to said helix with respect to said electron gun.

6. A traveling wave tube comprising a ceramic envelope comprising a pair of cup-shaped portions and an intermediate cylindrical portion having in its outer surface a plurality of cup-shaped depressions having bases, each of said portions and cup-shaped depressions having a metallic coating over its outer and inner surfaces and over its edges adjacent the other of said portions, a wire helix within said cylindrical envelope portion, an electron gun opposite one end of said helix and within one of said cup-shaped envelope portions for projecting a stream of electrons along said helix, said electrons impinging on and being collected by a portion of said metallic coating on the other of said cup-shaped envelope opposite the other end of said helix, a plurality of terminal pins extending through the base of said one-cup shaped portion, each of said pins having a shoulder portion resting on and sealed to a distinct portion of the metallic coating on the inner surface of said cup-shaped envelope portion insulatingly separated from other portions of the metallic coating, a platform member located on said pins and supporting said electron gun, said gun including a heat shield member extending into said cylindrical envelope portion, spring means on said pins biasing said platform and said heat shield member towards said cylindrical envelope portion, and a second plurality of terminal pins extending through the cup-shaped depressions in said cylindrical envelope portion, each of said second plurality of pins having a shoulder portion resting on the metallic coatings on the bases of said cup-shaped depressions.

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