

Sept. 10, 1957

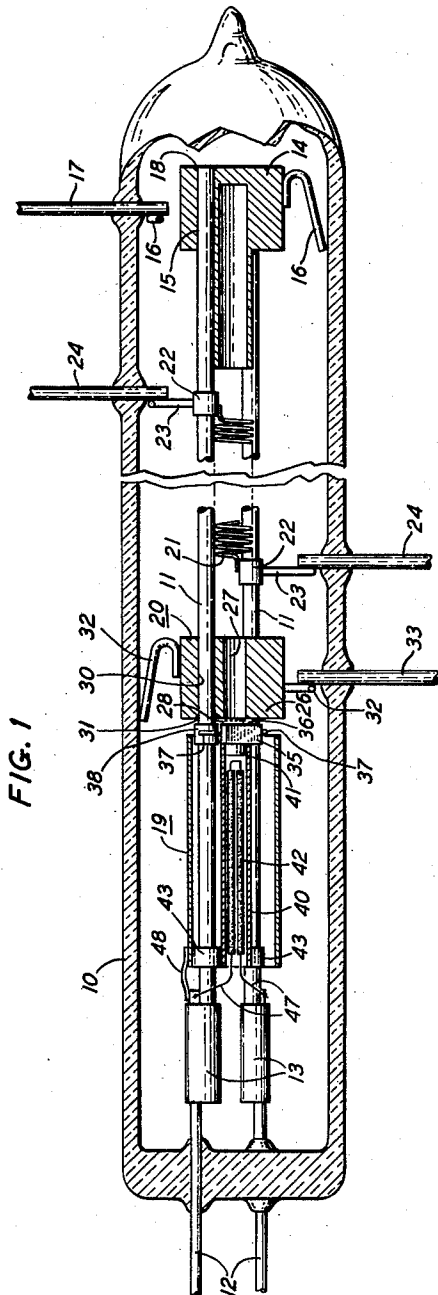
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2,806,169

ELECTRON DISCHARGE DEVICES

Filed Dec. 28, 1951

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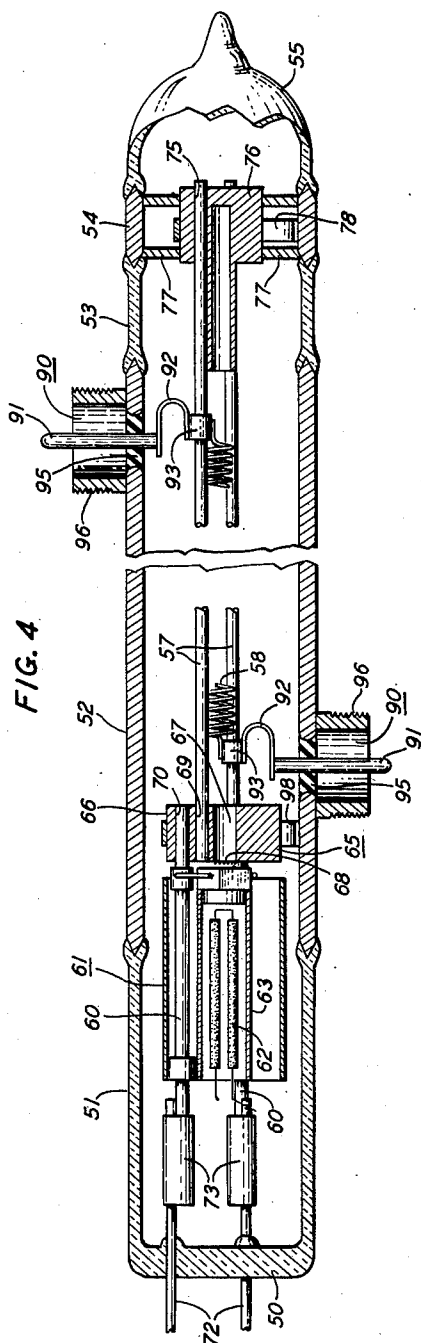
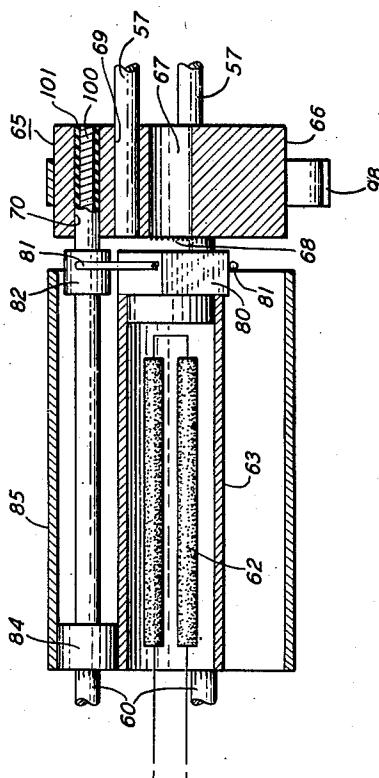


FIG. 5



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ELECTRON DISCHARGE DEVICES

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Application December 28, 1951, Serial No. 263,735

4 Claims. (Cl. 315—3.5)

This invention relates to electron discharge devices and more particularly to such devices of the traveling wave tube type.

In such devices, it is eminently advantageous to align accurately the cathode, helix and anode or collector and to attain parallelism between the surfaces of the cathode and the grid adjacent thereto. Further it is advantageous that the alignment and parallelism be undisturbed during the operation of the device. Additionally, these desiderata should be attained in a device that is facile to manufacture and characterized by simplicity in its lead-in connections and over-all structure.

It is one object of this invention to align the internal elements of a traveling wave tube in a facile manner.

Another object of this invention is to provide simple lead connections from terminals on the envelope to the internal elements of a traveling wave tube.

A further object of this invention is to attain parallelism between the cathode and the grid adjacent thereto. More specifically, it is an object of this invention to prevent misalignment or distortion in this parallelism during the operation of the device.

A still further object of this invention is to facilitate the fabrication of traveling wave tubes.

In one illustrative embodiment of this invention, the helix support rods extend the length of the device and the elements of the device are supported by these rods, which in turn may be directly connected to lead-in terminals on the base of the device. Thus, in this specific embodiment the cathode, accelerating grid, helix and electron collector are each directly supported by the support rods.

Further, in one specific embodiment of the invention, the cathode comprises a button secured to one end of a tubular sleeve and also secured at that one end to a plurality of rings affixed to the support rods. The heater element for the cathode fits within the sleeve which is secured at its other end to rings slidably positioned on the support rods, so that expansion of the cathode and cathode sleeve will cause the other end of the sleeve and the slidable rings to move along the support rods without causing distortion of the cathode surface, the loss of parallelism between the cathode surface and the accelerating grid adjacent thereto, or alteration of grid to cathode spacing.

In another specific embodiment of this invention wherein the cathode is supported as described above but the internal helix diameter is very small, the accelerating grid comprises a cylindrical block into which the helix support rods extend. A second group of support rods spaced on a larger diameter circle than that of the helix support rods also extends into the accelerating grid and the cathode assembly is secured thereto. The accelerating grid in this specific embodiment thus serves as a mechanical transformer to transform the internal spacing of the support rods while still enabling the cathode assembly, accelerating grid, helix and electron collector to be accurately aligned by support rods extending the length of the device.

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In these embodiments in accordance with this invention, one or more of the support rods may be of metal with an insulating coating thereon and electrical connections to the cathode, accelerating grid, or suppressor electrode if employed, may be made directly from the terminals in the base of the device by the support rods themselves.

It is one feature of this invention that the various elements of a traveling wave tube all be directly supported by support rods extending lengthwise of the device. In accordance with this feature of the invention, the supports may be each a single rod extending the length of the device or be composed of two rods, the two groups of rods being located on circles of different diameters and each group extending into a ring element serving thus as a mechanical transformer. Further it is a feature of this invention that the accelerating electrode be a ring member into which these two groups of rods may be inserted, the accelerating electrode thus serving as the mechanical transformer to transform the diameter of the circle on which the rods are located.

It is a further feature of this invention that the cathode be permanently affixed to the support rods and have a cathode sleeve attached thereto which is slidably affixed to the support rods at its end away from the cathode surface, so that expansion of the cathode and cathode sleeve will cause movement of the cathode sleeve along the support rods but will not interfere with the accurate alignment of the cathode or with the spacing between the cathode and the accelerating grid.

It is a still further feature of this invention that electrical connections to certain of the elements of the device may be made directly through the support rods which may be of metal with an insulating coating thereon.

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

Fig. 1 is a side view, partly in section, of an electron discharge device illustrative of one specific embodiment of this invention;

Fig. 2 is an enlarged side view, partly in section, of the cathode assembly of the device of Fig. 1;

Fig. 3 is a plan view along the line 3—3 of Fig. 2;

Fig. 4 is a side view, partly in section, of an electron discharge device illustrative of another embodiment of this invention; and

Fig. 5 is an enlarged side view, partly in section, of a portion of the device of Fig. 4 showing particularly the cathode assembly and accelerating electrode thereof.

Turning now to Fig. 1, the illustrative embodiment of this invention there depicted comprises an elongated envelope 10, as of glass, in which extend a plurality, as three, support rods 11. These rods 11 may be advantageously of ceramic or of a conducting material with an insulating or ceramic coating thereon, as described further below. The rods are secured at the one end of the envelope 10 to terminals 12 extending through the envelope, as by sleeves 13. At the other end of the envelope, the rods 11 are positioned by a plurality of spring wires 16 bearing against the side wall of the envelope and against the cup-shaped electron collector 14 having apertures 15 therethrough into which the rods extend and in which they are secured by a glaze 18. One of the spring wires 16 is secured to a terminal 17 extending through the envelope 10 to enable application of the desired potential to the electron collector 14.

The rods 11 thus extend substantially the length of the envelope 10 and are positioned therein. Further, these rods 11 support each of the elements of the device directly. Thus, besides the electron collector 14 supported at the end of the rods, the cathode assembly

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19, accelerating electrode 20 and helix 21 are directly supported by the rods 11. The helix 21 is advantageously secured to the rods 11 by a glaze and may have attenuation or loss deposited thereon, as is known in the art. Each end of the helix is connected to a ring 22 positioned on one of the rods 11. Electrical connection is made from the rings 22 to terminals 24 in the side wall of the envelope 10 by connecting leads 23. Advantageously, a hollow metal cylinder, not shown, encompasses the envelope 10 to provide shielding for the electron beam and a ground connection around the terminals 24.

The accelerating electrode 20 comprises a cylindrical metallic block 26 having a central aperture 27 therethrough. A grid 28 composed of a plurality of fine wires advantageously extends across the aperture 27 adjacent the cathode assembly 19. The block 26 also has a plurality of apertures 30 extending therethrough parallel to the central aperture 27 and around the periphery of the block. In each of the apertures 30 a rod 11 extends, the rods being preferably secured to the block 26 as by a glaze 31 in a bevelled end portion of the apertures 30. Spring wires 32, similar to spring wires 16, may be positioned between the accelerating electrode 20 and the wall of the envelope 10 to aid in positioning the rods 11 along the length of the envelope, one of the wires 32 being secured to a terminal 33 extending through the envelope 10 for applying an accelerating potential to the electrode 20.

The cathode assembly comprises a button member 35 having an electron emissive surface 36 directly adjacent the grid 28 of the accelerating electrode 20. The surface 36 is advantageously shaped in the form of an equilateral triangle with truncated corners across which short wires 37 extend. The wires 37 are secured to rings 38 permanently affixed to the rods 11 and thus support the button member 35 from the rods 11. An inner cylindrical cathode sleeve 40 fits onto a cylindrical back portion 41 of the button member 35, to which it is secured, and within the rods 11. A heater element 42 fits within the sleeve 40. The lower end of the sleeve 40 away from the cathode button member 35 is secured to rings 43 slidably positioned on the rods 11. An outer cylindrical sleeve or heat shield 45 encompassing the rods 11 is also secured to the rings 43. Expansion of the cathode button 35 and the sleeves 40 and 45 thus causes the rings 43 to slide along the rods 11 and does not disturb the alignment of the cathode with the other elements of the device, the parallelism of the cathode surface 36 and the grid 28, or the grid to cathode spacing, as attained by supporting each of the elements directly from the support rods 11, in accordance with this invention.

Electrical connections to the heater element 42 may advantageously be provided by leads 47 each connected to a terminal 12, one of the terminals also serving as a cathode terminal and being connected to the outer cathode sleeve 45 by a flexible wire 48.

In the fabrication of the specific embodiment of this invention illustrated in Fig. 1, the helix 21 is advantageously first secured to the rods 11, as by a glaze, and then each of the other elements is positioned on the rods 11. Thus the electron collector 14 is slid onto the rods 11 on one side of the helix 21, so that they extend through the apertures 15 in the collector, and then secured to the rods by the glaze 18. On the other side of the helix 21 the accelerator electrode 20 is slid onto the rods 11 so that they extend through the apertures 30 and secured to the rod 11 as by the glaze 31. The rings 38 may then be affixed to the rods 11 and the cathode assembly 19 including the rings 43 slidably positioned on the rods 11 attached to the rings 38. The rods 11 may then be attached to the terminals 12. The device, in accordance with this invention, is thus assembled by merely affixing each of the elements to the rods 11 whereby they are positioned in accurate alignment.

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Referring now to Fig. 4, the specific illustrative embodiment of our invention there depicted, comprises an elongated envelope advantageously having a glass base 50 and bottom side portion 51, a long metallic sleeve portion 52, a short glass sleeve portion 53, a short metallic sleeve portion 54, and an end portion 55, preferably of glass. A support rod structure extends the length of the envelope and includes two sets of support rods positioned on the circumferences of concentric circles of different diameters. Each set advantageously comprises three rods. The one set comprises rods 57 positioned on a circle of a small diameter in order that the helix 58 supported by the rods 57, as by being glazed thereto, may have a small inner diameter. The other set comprises the support rods 60 positioned on a circle of larger diameter in order that sufficient room may be provided to locate the heater assembly 62 and the inner sleeve 63 of the cathode assembly 61 within the rods 60. The two sets of rods are connected together by the accelerating electrode 65 which comprises a cylindrical metal block 66 having a central aperture 67 therethrough across which the grid 68 extends, a first plurality of apertures 69 parallel to the central aperture 68 and a second plurality of apertures 70 parallel to the central aperture and located on a circle of larger diameter than the circle on which apertures 69 are located. The rods 57 extend into the apertures 69 and the rods 60 into the apertures 70.

The other end of each of the rods 60 is supported by a terminal 72, extending through the base 50 of the envelope, to which it is secured as by a sleeve 73. The other end of each of the rods 57 extends through an aperture 75 in a collector electrode 76 to which it is secured. The collector electrode 76 is itself secured to the short metallic sleeve 54 of the envelope as by tubing 77 which may be of metal or ceramic. A connecting finger 78 extends from electron collector 76 to the sleeve 54 to provide a good electrical connection therebetween, the sleeve 54 comprising the terminal for the electron collector.

In this specific embodiment of this invention, the support rod structure extending the length of the envelope and by which each of the elements of the device is positioned thus comprises the rods 60 and 57 connected together by the accelerating electrode 65 and supported at its one end by the terminals 72 and its other end by the electron collector 76.

The cathode assembly 61 is similar to that of the prior embodiment of Fig. 1 and includes, in addition to the heater assembly 62 within the inner sleeve 63, a button member 80 to which the inner sleeve 63 is attached, support wires 81 supporting the button member 80 from rings 82 rigidly affixed to the rods 60, and rings 84 slidably positioned on the rods 60 and attached to the lower end of the inner sleeve 63 and the outer sleeve 85.

The signal may advantageously be applied to the helix 58 by coaxial input and output leads 90 each comprising an inner conductor 91 attached to a strip 92 in turn attached to rings 93 on the rods 57. The ends of the helix 58 are secured to the rings 93. The conductors 91 extend through insulating discs 95 positioned in apertures in the metallic envelope sleeve 52 to which sleeve the outer conductor 96 of the coaxial lead is connected. The metallic envelope sleeve 52 thus both shields the interaction space of the device, wherein the signal traveling along the helix interacts with the electron beam, and also provides a ground connection for the outer conductor of the coaxial input terminals. A ring condenser element may advantageously be positioned between the metallic envelope portion 52 and the portion 54, defining the electron collector terminal, in lieu of the glass sleeve 53 to provide a high frequency path to ground from the collector 76. Or advantageously, the glass sleeve 53 may

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be omitted and metallic envelope portions 52 and 54 form portions of a single integral member.

One advantageous manner of operation of the specific embodiment of Fig. 4 comprises maintaining the accelerating electrode 65 at ground potential and applying a negative voltage to the cathode button member 80. Thus a metallic strip 98 may advantageously be connected between the accelerating electrode 65 and the metallic envelope portion 52. Further in accordance with this invention, one or more of the rods of the support rod structure may provide a lead connection to one or more of the internal elements of the device. Thus in the specific embodiment disclosed, as best seen in Fig. 5, one of the rods 60 is formed of a metallic inner rod 100 and an insulating, such as a ceramic, coating 101 therearound, the coating 101 being shown greatly enlarged in Fig. 5. Electrical connection to the cathode button member 80 in this specific illustrative embodiment is made by the ring 82 which is affixed to the rod 60 at a portion where the ceramic coating 101 has been removed so that the ring 82 is in electrical contact with the inner rod 100. It is to be understood, however, that the employment of metallic support rods having insulating coatings thereon is not limited to the provision of electrical lead connections for the cathode but may be utilized for lead connections for other electrodes within the device, such as the accelerating electrode, as when the metallic envelope portions 52 and 54 are integral portions of a single member, suppressor electrode, if one is employed adjacent the collector, or the collector itself.

It is to be understood that the above-described arrangements are merely illustrative of the application of the principles of this invention and that the support rod structure of the one embodiment may be employed in the envelope of the other and vice versa. Similarly, this invention is not limited to the employment of insulation coated metallic support rods for electrical connection to the cathode or any particular electrode, but such rods may be employed in accordance with this invention for connection to any of such electrodes. Numerous other arrangements may be devised in accordance with the teaching of this invention 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 an elongated envelope, an accelerating electrode within said envelope, said accelerating electrode comprising a metallic block having a central aperture therethrough and a plurality of apertures therethrough located on the circumference of two coaxial circles centered at the center of said central aperture, said plurality of apertures being parallel to said central aperture, a first set of support rods extending into the apertures located on the outer of said circles and terminating within said block, means supporting said first rods from the base of said envelope, said means comprising a plurality of terminals extending through said base and means rigidly securing said first rods to said terminals, a cathode assembly supported by said first rods, said assembly comprising a button member having an emissive surface, a first plurality of rings rigidly attached to said first rods, means supporting said button member from said first rings, a cathode sleeve

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within said first rods and secured to said button member, heater means within said sleeve, and a second plurality of rings slidably positioned on said rods and secured to the other end of said sleeve removed from said button member, a second set of support rods extending into the apertures located on the inner of said circles, said second rods being terminated within said block, an electrical conductor helix supported by said second set of support rods, a collector electrode to the other side of said helix than said cathode assembly and supported by said second set of support rods, said collector electrode comprising a cup-shaped member having a cup-shaped depression positioned within said rods and a plurality of apertures therein, said second rods extending into said apertures, means cooperating with said collector assembly and said envelope to support said second support rods from said envelope, and means for applying a signal to said helix.

2. A traveling wave tube comprising an elongated envelope, a plurality of support rods extending in said envelope and remote from the walls thereof, means supporting said rods from one end of said envelope and comprising terminal means extending through said envelope, a cathode button having an emissive surface, a first plurality of rings rigidly affixed to said rods, means supporting said cathode button from said first rings, a cathode sleeve extending within said rods and secured to said cathode button, heater means within said sleeve, a second plurality of rings slidably positioned on said rods and secured to the other end of said sleeve remote from said cathode button, an electrode block adjacent said cathode button, said block having a plurality of apertures therethrough and said support rods extending into said apertures, an electrical conductor helix adjacent said block electrode and supported by said rods, a cup-shaped collector electrode having apertures therein, said support rods extending through said apertures and supporting said collector electrode, and spring elements between said collector electrode and said envelope and said electrode block and said envelope to mount said support rods within said envelope.

3. A traveling wave tube in accordance with claim 2 wherein said support rods extend integrally from said cathode button to said collector electrode.

4. A traveling wave tube in accordance with claim 2 wherein said support rods are in two sets, the first set extending from said one end of said envelope to said electrode block and being positioned on the circumference of a first circle and the second set extending from said electrode block to said collector electrode and being positioned on the circumference of a second circle, concentric with but of smaller diameter than said first circle.

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