April 23, 1957 M. E. HINES ET AL 2,790,105

TRAVELING WAVE TUBES

Filed Nov. 1, 1951

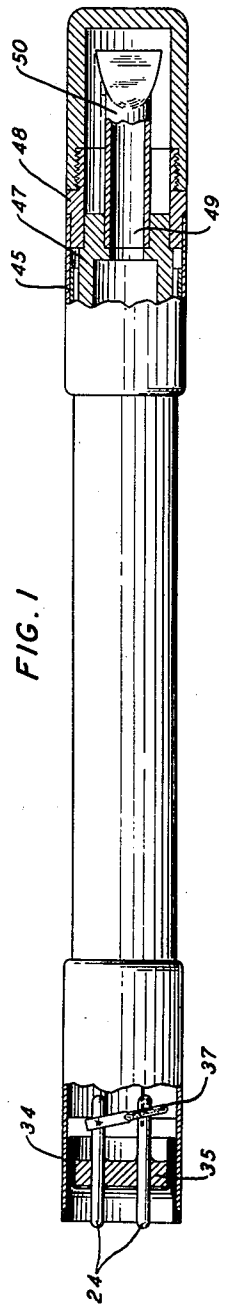

FIG. 1

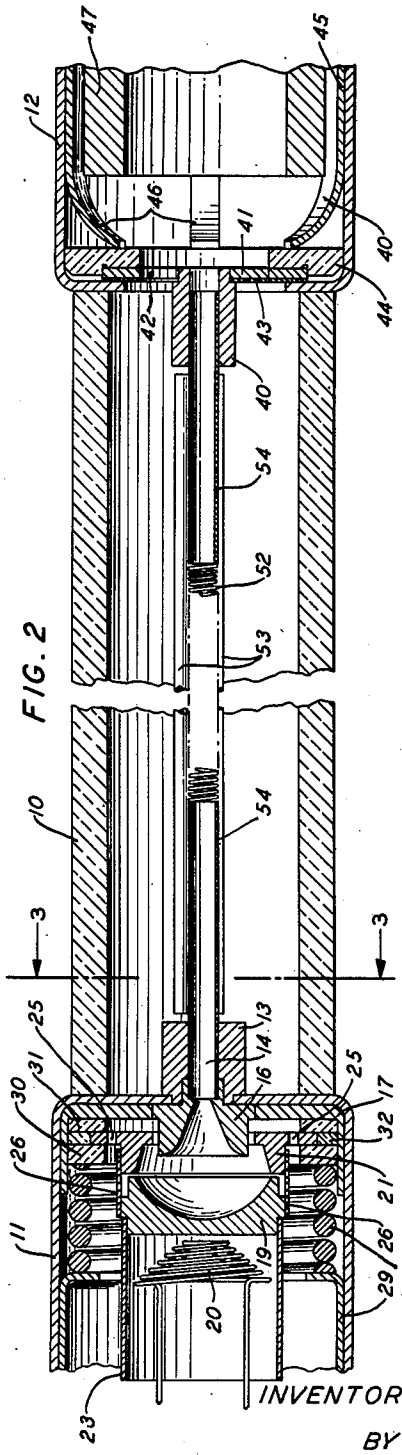

FIG. 2

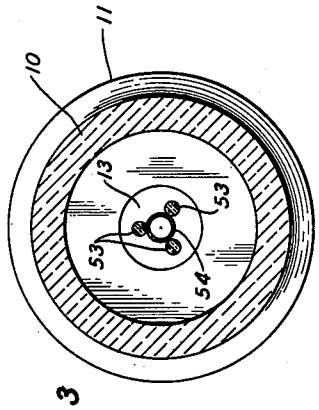

FIG. 3

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United States Patent Office 2,790,105 Patented Apr. 23, 1957

2,790,105

TRAVELING WAVE TUBES

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Application November 1, 1951, Serial No. 254,364

3 Claims. (Cl. 315—3.5)

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

Traveling wave tubes comprise, in general, an electron gun for projecting an electron stream through a helix of fine wire, along a magnetic field to a collector. Priorly the helix, which is advantageously supported by and within a plurality of support rods, has been positioned by having the glass envelope of the device fit closely around the rods, requiring accurate fabrication of the glass envelope with respect to the axis of the device in order to attain alignment of the electron gun and collector assemblies.

It is one object of this invention to accurately align the electron gun and collector assemblies with the helix of the device. Further, it is an object of this invention to obviate the employment of a glass envelope as the aligning means and thus to obviate the necessity of employing glass at all as a portion of the envelope of the device.

It is another object of this invention to prevent the appearance of secondary emisson electrons in the interaction space between the helix and the electron stream.

It is a further object of this invention to shield the electron gun and collector assemblies from the magnetic fields utilized with the device.

It is a still further object of this invention to provide an improved electron discharge device of the traveling wave type.

These and other objects of this invention are attained in accordance with one specific illustrative embodiment of this invention wherein the electron gun and collector assemblies are each positioned within magnetic cup members forming portions of the envelope of the device and a ceramic tube extends between these members and is sealed thereto. Each cup member has an aligning sleeve secured thereto extending towards the other cup member. A support tube is positioned in each aligning sleeve, the helix being positioned between the two support tubes and electrically attached thereto. Helix support rods extend along the outside of the support tubes and may advantageously be glazed to the support rods. The helix is thus accurately aligned between the gun and collector assemblies by the rods, support tubes, and aligning sleeves extending between the electron gun and collector cup members.

In this specific illustrative embodiment of this invention, the magnetic cup members surrounding the gun and collector form portions of the envelope of the device and may advantageously have the input and output wave guide walls make direct contact thereto. Further, the cup members shield the electron gun and collector so that the magnetic field starts properly at the gun cup member and ends abruptly at the collector cup member. The gun cup member controls the penetration of the magnetic field into the electron gun region, the size and position of the central aperture in the gun cup member in relation to the position of the elements of the electron

gun insuring the correct starting conditions of the magnetic field for optimum focusing of the cylindrical electron beam within the helix. And the collector cup member assures that there is no magnetic field in the region of the collector so that the electron beam upon entering that region expands thereby facilitating the collecting of the electrons and insuring that secondary emission electrons will be confined within the collector.

It is therefore one feature of this invention that the helix be aligned with the electron gun and collector assemblies by elements secured to cup members associated with the assemblies and into which support members extend, the helix supports extending along the outer surface of the support members and being secured thereto.

It is a further feature of this invention that the electron gun and collector assemblies be positioned within magnetic cup members shielding the assemblies from the magnetic field employed with the device. Further in accordance with this feature of the invention, the electron collector is a hollow member so that the electron stream on entering the collector assembly where it is free of the constraining effects of the magnetic field can expand and the electrons impinge on the inner walls of the hollow collector.

It is a further feature of this invention that the envelope encompassing the aligning sleeves, support tubes, helix support rods, and helix be of ceramic and need not be accurately positioned with respect to the axis of the device, as it has no function in the aligning of the helix, electron gun assembly, and electron collector assembly.

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 of an electron discharge device in accordance with one illustrative embodiment of this invention, a portion of the base and collector assemblies having been broken away;

Fig. 2 is a sectional view of the device shown in Fig. 1; and

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

Referring now to the drawing, the specific illustrative embodiment there depicted comprises an outer tube **10** of insulating material, as of ceramic and more particularly of one of the ceramics known as steatites, an electron gun cup member **11** and a collector cup member **12**. The ceramic tube **10** may be sealed to the cup members **11** and **12** by the methods disclosed in A. J. Chick-L. J. Speck Patent 2,708,787, May 24, 1955. The cup members **11** and **12** are advantageously of magnetic materials to shield the electron gun and electron collector assemblies, as set forth further below, thereby defining magnetic housings. The magnetic field may advantageously be produced by a solenoid encompassing the ceramic tube **10** and having pole-pieces in which the cup members **11** and **12** are positioned, though permanent magnets may also be employed with the pole-pieces.

An aligning sleeve **13** is positioned in an aperture **14** in the base of the cup member **11**. The nose or positive electrode **16** of the electron gun has a portion extending into the aligning sleeve **13** and is itself secured in a shallow cup-shaped member **17** fitting in the base of the electron gun cup member **11**; the electrode **16** and member **17** may advantageously be integral. The rest of the electron gun in this illustrative embodiment comprises a cathode **19** which may advantageously be a hollowed out member with a substantially spherical or spheroidal surface facing the positive electrode **16**, a heater element **20**, and a beam forming electrode **21**. A heat shield **23** advantageously is secured to the base of the cathode and encompasses the heater element **20** which may be supported by its own leads from base terminals **24**. The

beam forming electrode 21 which may have apertures 25 therethrough to aid in evacuating the device is advantageously maintained at cathode potential and is secured to the cathode by a plurality of wires or struts 26, thereby supporting the cathode.

The cathode 19, beam forming electrode 21, and positive electrode 16 are maintained in position by a spring 28 supported by a spring support 29 which is secured, as by spot welding, to the cup member 11. The spring 28 bears against a first insulating ring 30 which in turn bears against the beam forming electrode 21. The beam forming electrode 21 is against a second insulating ring 31 which insulates it from the shallow cup-shaped member 17 and establishes the correct spacing between electrode 21 and member 17. A third insulating ring 32 is positioned in the plane of the beam forming electrode 21 insulating it from the side of the shallow cup-shaped member 17 and preventing any transverse motion.

The stem of the envelope, as best seen in Fig. 1, advantageously comprises an expansion shield 34 of a U-shaped section having its outer end secured, as by brazing, to the base of the cup member 11 and its inner end forming a cup in which is positioned an insulator disc 35 through which the leads 24 extend. The leads 24 and the expansion shield 34 may both be advantageously secured to the insulator disc 35 by means of a glaze which covers both surfaces of the disc and extends along the sides of the disc between it and the shield 34 and the leads 24, as more fully set forth in the above-mentioned Chick-Speck patent. A getter 37 may advantageously be attached to the leads 24.

An aligning sleeve 40 is supported from the collector cup member 12 as by a support disc 41 which advantageously has a plurality of apertures 42 therethrough to aid in evacuating the device. An insulating glaze 43, shown greatly exaggerated in Fig. 2, is positioned on the support disc 41 and between it and the collector cup member 12. In the specific illustrative embodiment of this invention shown in the drawing, the insulating glaze 43 provides direct-current isolation between the collector assembly and the helix so that direct-current measurements of electron current can be made of the collector and helix independently, thereby facilitating focussing determination. However, it is to be understood that as the collector, helix, and positive electrode 16 may be at the same potential, the aligning sleeve 40 may advantageously be directly mounted by the collector cup member 12 similarly to the direct mounting of the aligning sleeve 13 by the electron gun cup member 11.

An insulating ring 44 bears against the support disc 41 and is in turn biased by spring fingers 46 extending from a cylindrical member 45 secured, as by spot welding, to the cup member 12. The collector 47 is itself in turn supported from the cup member 12 by a cylindrical member 48 forming a portion of the envelope of the device. The collector is advantageously hollow to facilitate the collection of electrons, as set forth further below, and has an aperture 49 in its base in which is positioned an evacuating tubulation 50 sealed to the collector at its base and sealed off at its other end.

The helix 52 is supported within the ceramic tube 10 by support rods 53. These rods 53 extend at each end along metallic tubes 54 to which they are secured as by a glaze. The tubes 54 in turn extend into the aligning sleeves 13 and 40 supported by the cup members 11 and 12, respectively. The tubes or hollow tubular members 54, the support rods 53, and the aligning sleeves 13 and 40 accurately determine the alignment of the helix 52 between the electron gun and collector assemblies which may have been previously advantageously aligned on a common axis. The ceramic tube 10 serves no function in the aligning of the helix and gun and collector assemblies and therefore need not be positioned accurately with respect to the tube axis. Thus all the advantages of employing a ceramic, rather than a glass envelope may be readily attained.

In one specific illustrative embodiment of this invention for operation as an amplifier at 4000 megacycles, the helix 52 was wound from .002 inch tungsten wire at 250 turns per inch with a .040 inch inside diameter. The support rods 53 were of .027 inch ceramic rods and the helix was glazed to the rods, loss being applied to the rods 53 as is known in the art. The helix 52 was advantageously formed by winding a .002 inch tungsten and molybdenum wires side by side on a molybdenum mandrel and securing the ends of the wires to the tubes 54, which may also advantageously be of tungsten. The assembly is then placed in an alumina jig and the three rods glazed in place, after which the molybdenum parts are etched away, leaving a self-supporting structure.

The cup members 11 and 12 in accordance with this invention are advantageously of a magnetic and electrically conducting material, such as "Kovar" alloy to which copper may readily be brazed. As these magnetic members enclose the electron gun and collector assemblies the magnetic field is caused to start properly in relation to the elements of the gun and to end abruptly. The control thus obtained of the penetration of the field in the region of the gun is advantageous in attaining the best focussing condition for minimum magnetic field. And the abrupt removal of the magnetic field at the collector end of the device after the electron beam has passed through the helix causes the electron beam to expand and strike the collector 47, which may advantageously be of copper. The electrons thus strike the inner sides of the hollow collector 47 and not along the axis so that any secondary electron emission caused by the impingement of the electron beam is confined within the collector and the secondary electrons are not present in the region of the helix.

Further, in accordance with this invention, the cup members 11 and 12 also serve in coupling the helix 52 to the input and output wave guides in which the device is situated. The hollow tubular members 54 are electrically connected to the cup members 11 and 12 by the aligning sleeves 13 and 40, respectively. The insulating glaze 43 between the support disc 41 and the cup member 40 while providing for direct-current isolation allows the output end of the helix 32 to be capacitatively coupled to the collector cup member 12. The wave-guide walls would, during the operation of the device, be in contact with the cup members so that a radio frequency contact is made between each end of the helix and the wave-guide walls.

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 first cup-shaped member of a magnetic material, electron gun means positioned within said first cup-shaped member, a second cup-shaped member of magnetic material, electron collector means positioned within said second cup-shaped member, said electron collector means comprising a hollow electron collector member positioned within said second cup-shaped member and magnetically shielded by said second cup-shaped member so that electrons entering said second cup-shaped member deviate from the axis of the tube and impinge on the inner side walls of said hollow electron collector member, an aligning sleeve axially supported in the base of each of said cup-shaped members and extending toward the other of said cup-shaped members, a hollow tubular member positioned in each of said aligning sleeves, a plurality of rods extending axially of said tubular members and secured to the outer surfaces thereof, and a helix supported by said rods extending between said tubular members.

2. A traveling wave tube in accordance with claim 1 wherein said cup-shaped members form portions of the

envelope of the traveling wave tube and comprising a ceramic tube extending between said cup-shaped members and secured thereto forming a further portion of the envelope of said traveling wave tube.

3. A traveling wave tube in accordance with claim 2 comprising a support disc attached to the aligning sleeve supported by said second cup-shaped member, an insulating glaze on one side of said support disc, and spring means within said second cup-shaped member biasing said support disc against said second cup-shaped member, whereby said helix is capacitatively coupled to said second cup-shaped member but isolated therefrom for direct current.

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