

June 12, 1956

G. H. ROBERTSON ET AL
ELECTRON DISCHARGE DEVICE

2,750,529

Filed March 12, 1952

2 Sheets-Sheet 1

FIG. 1

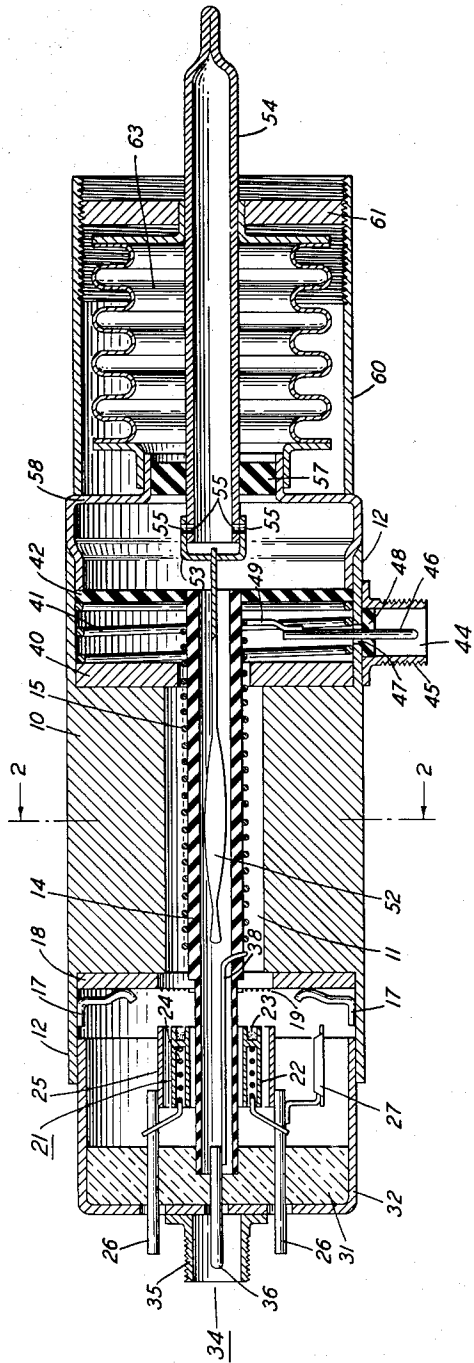
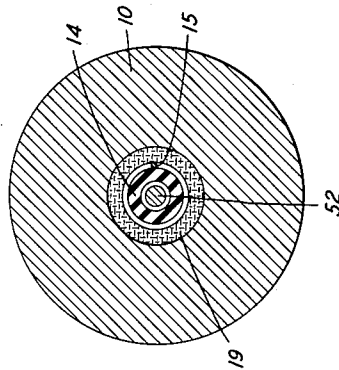


FIG. 2



INVENTORS: G. H. ROBERTSON
E. J. WALSH

BY

[Signature]

ATTORNEY

1

2,750,529

ELECTRON DISCHARGE DEVICE

George H. Robertson, Summit, and Edward J. Walsh, Morristown, N. J., assignors to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application March 12, 1952, Serial No. 276,174

3 Claims. (Cl. 315—3.5)

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

In one known form of traveling wave tube, a high frequency signal is coupled to a helix along which an electron stream is projected, amplification of the signal occurring due to the interaction of the electromagnetic wave associated with the signal with that associated with the electron beam. In order to improve the characteristics of the traveling wave tube, it is usual to position attenuation or loss along the interaction path, the attenuation being introduced in such ways as by a deposition of lossy material onto the helix itself or the placing of a lossy glaze on the support rods. In application Serial No. 263,736, filed December 28, 1951, to which reference is made for a further discussion of the employment of attenuation in these devices, a shaped slip of lossy material is positioned directly adjacent the helix, as by resting thereon, to provide the attenuation. Reference may also be made to application Serial No. 168,202, filed June 15, 1950, of C. C. Cutler and the corresponding British patent 697,550 for a disclosure and discussion of specific attenuation distributions along the helix.

An object of this invention is to provide an improved manner of introducing loss or attenuation into traveling wave tubes. More specifically it is an object of this invention to provide an improved traveling wave tube in which the attenuating means may be facily incorporated.

It is a further object of this invention to enable the variation of the attenuation applied to a traveling wave tube after fabrication of the device, in accordance with the optimum operating condition desired.

These and other objects of this invention are realized in specific embodiments wherein the helix support structure includes at least one hollow rod and an attenuation defining member is insertable into that hollow rod. This attenuation defining member may be an unevenly shaped rod or may be a smooth rod on which is deposited distributed lossy material. Further in accordance with this invention, the inserted attenuating member may be affixed permanently to the hollow rod or may be supported for axial motion within the hollow rod so that its position relative to the helix may be varied after fabrication of the device.

In one specific illustrative embodiment of this invention, the helix is wound around a hollow tube of insulating material and a shaped rod of lossy material is insertable along the axis of the helix, means being provided for varying the position of the attenuating rod within the hollow tube.

In another specific illustrative embodiment of this invention, the helix is mounted by three support rods, as by being glazed thereto. Each of the support rods is hollow and has inserted therein a smooth rod of an insulating material on the surface of which has been deposited a lossy material. The three smooth attenuating rods are supported from a nest which is movable to vary the posi-

2

tion of the attenuating rods within the hollow helix support rods.

It is therefore one feature of this invention that the helix of a traveling wave tube be supported by a hollow rod into which is inserted an attenuating member.

It is a further feature of this invention that the attenuation defined by the attenuating member vary over the length of the helix and that the position of the attenuating member be adjustable within the hollow helix support rod to alter the attenuation distribution along the helix.

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

Fig. 1 is a sectional view of a traveling wave tube illustrative of one embodiment of this invention;

Fig. 2 is a sectional view along the line 2—2 of Fig. 1; and

Fig. 3 is a sectional view of a traveling wave tube illustrative of another embodiment of this invention.

Referring now to the drawing, the specific illustrative embodiment of this invention depicted in Fig. 1 comprises a metallic housing 10 having an axial center bore 11 and thin end portions 12 at each end thereof. A hollow insulating tubing 14 which may advantageously be of ceramic, extends axially within the bore 11 and supports a helix 15 which is wound thereon and advantageously secured thereto, as by glazing. The hollow insulating tubing 14 is distinct from the metallic housing or envelope 10 over substantially its entire length between its end supports which are suitably secured to the housing, as is apparent in Fig. 1. A plurality of springs 17 secured, as by welding, to the end portions 12 of the housing 10 position a grid frame 18 against one end of the central portion of the housing 10. A mesh grid 19 is supported by the frame 18, the grid 19 having a central aperture therein for passage of the hollow tubing 14 therethrough.

A cathode assembly 21 is positioned within the end portion 12 for projecting a hollow electron beam along the helix 15, the cathode assembly comprising a cylindrical double grooved cathode member 22 having cathodic material 23 positioned in the shallow groove facing the grid 19 and a heater element 24 positioned in the deep groove and a heat shield 25. The cathode assembly 21 is supported by a plurality of terminal pins 26 to which electrical connection is made to the heater 24 and the cathode member 22. Two of the terminal pins 26 also advantageously supports a getter member 27.

The terminal pins 26 extend through a block of vitreous material 31 sealed in an end cap 32 which is in turn sealed to the thin end portion 12 of the housing 10, thereby forming a vacuum tight enclosure. A coaxial terminal 34 is positioned in the center of the end cap 32, the terminal 34 comprising an outer threaded cylinder 35 and an inner pin 36, the pin extending through the vitreous block 31 and axially into the tubing 14. The end of the tubing 14 is advantageously inserted into the block 31 and sealed thereto. A lead 38 extends from the center pin 36 of the coaxial input terminal 34 through an aperture in the wall of the tubing 14 and is secured to one end of the helix 15.

A disc-shaped collector element 40 is held against the central portion of housing 10 within the other end portion 12 by a spring member 41, the collector 40 having a central aperture therein through which the helix support tubing 14 extends. The spring member 41 also bears against a support member 42, advantageously of ceramic, in which the helix support tubing 14 rests. A coaxial output terminal 44 comprises an outer threaded cylinder 45 attached to the housing 10 and an inner pin 46 extending through an aperture 47 in the end portion 12 adjacent the spring member 41, the pin 46 being sealed to and sup-

3

ported by an insulating ring 48. A lead 49 extends from the terminal pin 46 to the other end of the helix 15.

A rod 52 of non-uniform diameter is positioned within the hollow tubing 14 and provides the attenuation for the helix 15, the shape of the rod being chosen to attain the desired optimum operating characteristic, as is known in the art. As can readily be seen in Fig. 1, the attenuating rod 52 is coupled only electromagnetically to the helix 15, there being no physical contacts between these two elements. The rod 52 is of a lossy material, which may be a non-magnetic metal or alloy, such as stainless steel or lanthanum boride, or a lossy non-metallic material, such as silicon carbide in porcelain, as described by G. K. Teal, M. D. Rigterink, and C. J. Frosch in an article entitled "Attenuator Materials, Attenuators and Terminations for Microwaves," published in the A. I. E. E. Transactions, vol. 67, pt. 1, pages 419-428. The rod 52 is supported by a yoke member 53 from the exhaust tubing 54, mating apertures 55 being provided in the yoke member 53 and the exhaust tubing 54 to allow evacuation of the device thereby. The exhaust tubing is slidably supported by a guide member 57 positioned by an end cap 58 which is sealed to the end portion 12 of the housing 10.

In accordance with one feature of this invention, the shaped attenuating rod 52 is movable within the hollow helix support tubing 14 to vary the optimum characteristics of the device after fabrication. In the specific embodiment of Fig. 1, motion of the attenuating rod 52 is attained by rotation of a rotatable adjusting nut 60 which is threadedly engaged by a support member 61 secured to the exhaust tubing 54. A bellows 63 is positioned between the end cap 58 and the exhaust tubulation 54, as is known in the art.

Turning now to Fig. 3, in the specific embodiment of this invention illustrated there, the helix 70 is positioned within the central bore 71 of the housing 72 by a plurality, such as three, hollow support rods 73 to which the helix is secured, as by a glaze. An attenuating rod 75 extends into each of these hollow support rods 73. In the specific embodiment depicted, the rods 75 are advantageously of an insulating material, such as ceramic, and have sprayed thereon a lossy material, such as a colloidal graphite commercially known as "Aquadag." In accordance with this invention, the lossy material may be unevenly distributed over the surface of the rods 75 to attain various attenuation distributions along the helix 70.

The rods 75 are supported by disc 76 secured to the inner end of the exhaust tubulation 77, the axial position of the rods 75 being varied by rotation of the threaded adjusting nut 80 in cooperation with the bellows 81, as in the embodiment of Fig. 1. A collector 83 is supported by a plurality of legs 84 from a support member 85, advantageously of metal, to which the hollow helix support rods 73 are secured. The support member 85 is advantageously held in position between an end shoulder portion of the housing 72 and the end cap 82 in which is sealed the guide member 79.

Opposite the collector 83 is positioned a cathode assembly 86 comprising an elongated cathode tube 87 having a heater element 88 therein and a heat shield 89. The cathode assembly 86 is advantageously supported by an insulator ring member 94 and held in position by spring

4

leads 90 connecting the heat shield 89 to terminal pins 91 extending through a vitreous base 92, the spring leads 90 biasing the heat shield 89 against a shoulder portion of the insulator ring member 94 and thus, through a grid ring 95, against an end shoulder portion of the housing 72. A plurality of wires 96 defining a grid are supported by the grid ring 95. A ring shaped member 97 is positioned against the grid ring 95 and supports the other end of the helix support rods 73. Leads 98, which unlike leads 90 do not act as springs, connect the heater element 88 to terminal pins 91.

Coaxial input and output terminals 100 at opposite ends of the housing 72 each comprise a threaded outer conductor 101 and an inner pin 102 extending through an insulating member 103 to which they are sealed, leads 104 connecting the inner pins 102 to the ends of the helix 70.

It is to be understood that the above-described arrangements are illustrative of the application of the principles of this 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 an envelope, a helix positioned within said envelope, means at one end of said envelope for projecting a stream of electrons along said helix, means at the other end of said envelope for collecting said electrons, means for supporting said helix, said supporting means being distinct from said envelope over substantially its entire length between its end portions and including the external surface of at least one hollow tubular member, said member being supported at each end from said envelope, means for introducing a signal to said helix and means for defining an attenuation distribution along said helix, said last-mentioned means comprising a rod having a shaped lossy characteristic positioned within said hollow tubular member and coupled only electromagnetically to said helix.

2. A traveling wave tube in accordance with claim 1 wherein said supporting means comprises a single hollow tubular member having an external surface, said helix being wound around said external surface.

3. A traveling wave tube in accordance with claim 1 wherein said supporting means comprises a plurality of hollow support rods, said helix being positioned within the region bounded by said rods and being secured to the external surface of said rods.

References Cited in the file of this patent

UNITED STATES PATENTS

2,167,519	Manthorne	July 25, 1939
2,197,123	King	Apr. 16, 1940
2,443,917	Lafferty	June 22, 1948
2,541,843	Tiley	Feb. 13, 1951
2,575,383	Field	Nov. 20, 1951
2,602,148	Pierce	July 1, 1952
2,654,047	Clavier	Sept. 29, 1953
2,669,674	Diemer	Feb. 16, 1954

FOREIGN PATENTS

934,220	France	Jan. 7, 1948
---------	--------	--------------