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TRAVELING WAVE ELECTRON DISCHARGE DEVICE

Filed Dec. 28, 1951

2 Sheets-Sheet 1

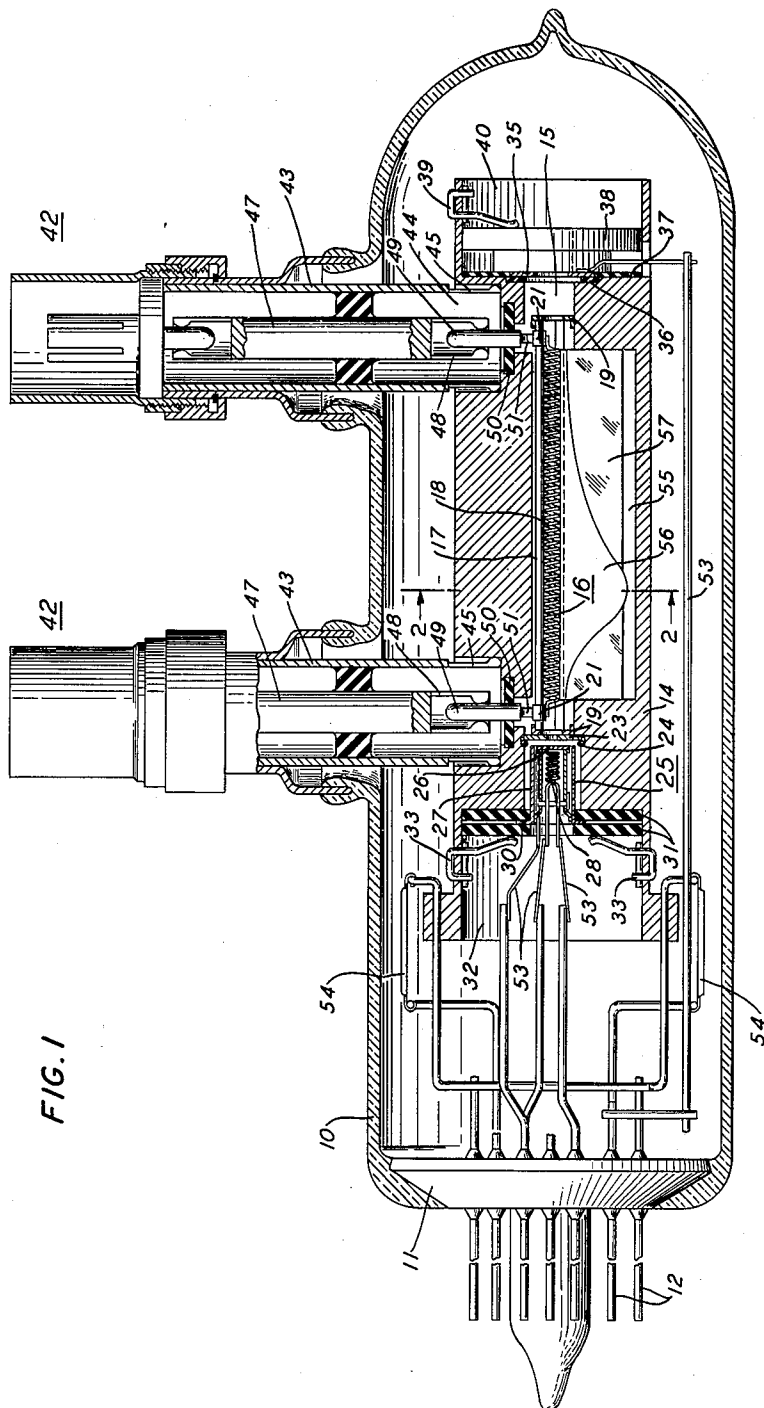


FIG. 1

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FIG. 2

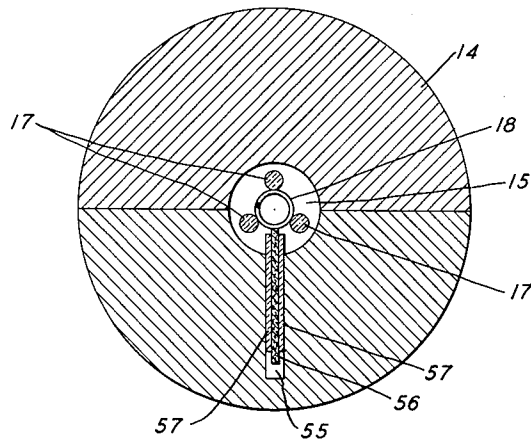
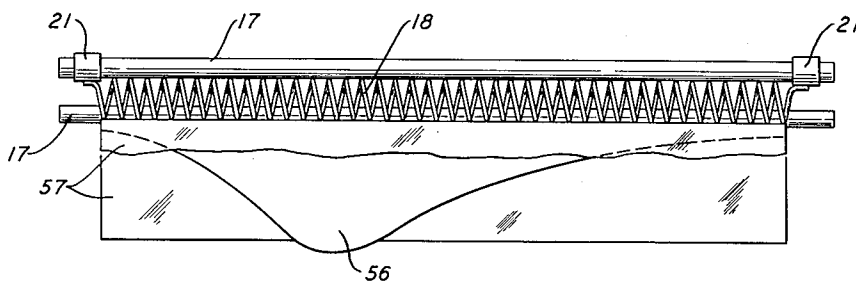


FIG. 3



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## TRAVELING WAVE ELECTRON DISCHARGE DEVICE

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Application December 28, 1951, Serial No. 263,736

4 Claims. (Cl. 315—3.5)

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

In such devices, it has become usual to introduce additional attenuation or loss as disclosed in J. R. Pierce application Serial No. 640,597, filed January 11, 1946, now Patent 2,636,648 granted April 28, 1953. This may be done to maintain stability, prevent reflection of the signal, attain desirable impedance matches, prevent degradation of the amplified signal, and in general improve the performance of the device. In the past, this attenuation has been introduced in various ways, such as in the form of a glaze on the support rods for the helix of the device, by the deposition of a lossy substance onto the helix itself, or by the winding of a fine resistance wire around the helix. Difficulty is sometimes encountered, however, because it is not desired that the attenuation introduced be even or equal over the full length of the transmission line or interaction portion of the device.

Thus, as disclosed in C. C. Cutler application Serial No. 168,202, filed June 15, 1950, relatively short sections of low or substantially loss-less circuit may be left at each end of the device and the attenuation distributed between these sections so as to be greater near the input end of the device than at the output end. The attenuation may be greater near the input end and gradually decrease towards the output end to achieve maximum gain or maximum efficiency and stability.

Additionally, various other attenuation distributions may be desirable for coupling the input signal to the helix or for maximum power output. These desirable conditions sometimes are inconsistent in that the attenuation distribution for maximum efficiency or maximum power output of a device will not necessarily be the same for optimum gain. This in turn necessitates the provision of different distributions of attenuation in the same discharge device structure when these devices are to be employed for different purposes.

It is one object of the invention to provide attenuation or loss in transmission lines such as in traveling wave tubes. More specifically, it is an object of this invention to provide such attenuation in a facile manner that enables easy fabrication of such tubes.

It is another object of this invention to enable the accurate distribution of attenuation or loss in traveling wave tubes.

It is a further object of this invention to provide a discharge device in which may be facily incorporated various attenuation distributions depending on the desired optimum characteristic.

These and other objects of this invention are realized in one specific illustrative embodiment wherein the helix of the traveling wave tube is supported within a central aperture in a metal housing. A slit in the housing extends to the central aperture and a slip of lossy material, such as of carbonized paper, is positioned within the slit and rests on the helix. The amount of the attenuation at any

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point along the helix is facily and accurately determined by the height of the slip of lossy material at that point. Thus by precutting the slip of lossy material to a given shape any desired attenuation distribution may be facily attained.

It is therefore one feature of this invention that attenuation be introduced into a transmission circuit by a shaped slip of lossy material directly adjacent the helix of that circuit.

It is a further feature of this invention that the shaped slip of attenuating material be positioned in a slit in a metal housing surrounding and shielding the transmission circuit.

It is a still further feature of this invention that the slip of lossy material may be shaped to provide any desired attenuation distribution. More particularly, in accordance with this feature of the invention, different attenuation distributions may readily be incorporated in devices of the same general structure to attain any desired optimum characteristic by the utilization of differently shaped slips of lossy material.

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

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

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

Fig. 3 is an enlarged side view of the helix and attenuating member of the specific illustrative embodiment of Fig. 1.

Turning now to Fig. 1, the specific illustrative embodiment of the invention there depicted comprises a traveling wave tube having an envelope 10, a base 11, and a plurality of leads 12 extending through the base. Situated within the envelope 10 is a metallic housing 14 having a central bore 15 in which is positioned the helix assembly 16. The helix assembly 16 includes a plurality, such as three, support rods 17 which may advantageously be of a ceramic material and to which is secured, as by a glaze, the helix 18. The rods 17 advantageously are held in position by support rings 19 which are secured to the housing 14 in the center bore 15. Each end of the helix is secured to a ring member 21 attached to one of the support rods 17 for coupling of the signal to the helix as further described below.

A grid 23 is held in position against one of the support rings 19 by a snap ring 24 extending into a groove in the center bore 15. An electron gun assembly 25 extends into the center bore 15 adjacent the grid 23 and comprises a cathode 26 supported by a cathode cup member 27 and a heater 28. The cathode cup member 27 has a flanged base portion 30 which is held in position between two cathode support insulators 31 situated within a cup-shaped depression 32 at the end of the housing 14 by a plurality of spring members 33 extending through the wall of the housing 14 and into the depression 32.

At the other end of the housing 14 a suppressor grid 35 is positioned across the end of the center bore 15 and is biased in position against a suppressor grid insulator 36. The suppressor grid 35 in turn fits within an annular grid spacer insulator 37 against which the collector electrode 38 is biased by spring members 39 similar to spring members 33, the collector electrode 38 and spring members 39 being positioned within a cup-shaped depression 40 in the housing 14.

The signal advantageously is coupled to the helix by two coaxial terminals 42 each of which comprises an outer cylinder 43 fitting in mating apertures 44 in one outer side of the housing 14 and having spring fingers 45 bearing against the housing 14; the cylinders 43 and

apertures 44 may alternatively be advantageously threaded. The center conductor of the coaxial terminal 42 comprises a center rod 47 having spring fingers 48 fitting over a pin 49 which is supported by an insulating disc 50 in the base of the aperture 44 in the housing 14. A strip of metal 51 is connected, as by welding, to the ring 21 on the helix support rod 17 and to the pin 49. Appropriate connections are made to the suppressor grid, cathode and heater by lead means 53 connected to terminal leads 12 in the base 11. Also a plurality of getters 54 may advantageously be supported between pairs of the leads 12.

As best seen in Fig. 2, the housing 14 may advantageously be formed of two semicircular portions, one of which has a slit 55 therein communicating with the center bore 15 and extending almost to the periphery of the semicircular portion. A slip 56 of lossy material is positioned within the slit 55 and has its base extending along and contiguous to the helix 18. The slip 56 may advantageously be of carbonized ceramic, of paper or ceramic having a colloidal graphite commercially known as "Aquadag" sprayed thereon, or of other lossy material. The loss may advantageously be applied to the slip of insulating material, whether of paper, ceramic, or other material, by completely carbonizing the entire surface of the slip, which may then be cut to the desired shape. Or the loss may be applied only to certain portions of the surface of the slip, the remainder of the surface of the slip having been masked while the loss was applied. Thus the mask may be so shaped as to provide the desired shaped slip of attenuating or lossy material. Or lines or rows of lossy material, such as lines of carbonized strips, may extend along the surface of the slip of insulating material parallel to the axis of the helix, the lines advantageously being of various lengths as desired. An insulating member 57, as of mica or ceramic is positioned to either side of slip 56 and insulates the lossy material from the housing 14. The slip 56 of attenuating material and the insulating members 57 advantageously tightly fit within the slit 55 so that once they are placed therein they will maintain their position. However, if desired a positioning spring could be employed.

As best seen in Fig. 3 the slip 56 is shaped to provide desired attenuation distribution, the amount of attenuation at any point along the transmission circuit defined by the helix 18 being determined by the height of the slip 56. As the outline or shape of the slip 56 can readily be controlled, the amount of attenuation at any point can accurately be controlled. Further it is to be understood that, while the base of the slip is shown in this specific embodiment as contiguous to the helix along the entire length of the helix, such need not be the case. The slip of attenuation material may be adjacent the helix without resting thereon and it need not extend the whole length of the helix, if regions of no attenuation along the transmission line are desired. Two advantageous shapes for the slip 56 are such as to provide the attenuation distributions disclosed in the above-mentioned Cutler application.

If it is desired that a number of traveling wave tubes be of the same structure to operate in the same frequency

range but with different optimum characteristics, it is apparent that, in accordance with this invention, the same structural elements may be employed for each tube but with attenuation slips of different shapes positioned within the slits in the housings.

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. An electron discharge device comprising a wire helix, a cylindrical metal housing member encompassing said helix having a central aperture therethrough and a radially-disposed slit communicating with said aperture, means supporting said helix in said aperture, means at one end of said helix for projecting a stream of electrons through said aperture, means at the other end of said helix for collecting said electrons and a shaped sheet of attenuating material positioned in said slit and insulated from said housing member, said shaped sheet resting on said helix, providing a distributed attenuation along said helix, and being shaped in accordance with the desired distributed attenuation along said helix.

2. An electron discharge device in accordance with claim 1 wherein said shaped sheet of attenuating material comprises a sheet of shaped carbonized paper.

3. An electron discharge device comprising a metal shielding member having a central aperture extending therethrough and a longitudinal slit extending radially from said aperture, a metallic wire helix defining an electromagnetic wave transmission circuit, means supporting said helix in said aperture, means for coupling a signal to said helix at each end thereof, means at one end of said helix for projecting a stream of electrons through said aperture, means at the other end of said helix for collecting said electrons, a shaped thin elongated member of attenuating material positioned in said slit and contiguous to said helix providing distributed attenuation along said transmission circuit and insulator members to each side of said shaped thin elongated member and insulating said shaped member from said shielding member, said insulator members and said shaped elongated member tightly fitting in said slit and said thin elongated member being shaped in accordance with the desired distribution of attenuation along said helix.

4. An electron discharge device in accordance with claim 3 wherein said shaped thin elongated member is of carbonized paper.

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