Sept. 9, 1969 W. EICHIN ETAL 3,466,494

TRAVELING WAVE TUBE WITH DELAY LINE SUPPORTS HAVING A LOSSY LAYER AND AN INSULATION LAYER

Filed May 1, 1968 2 Sheets-Sheet 1

Fig.1

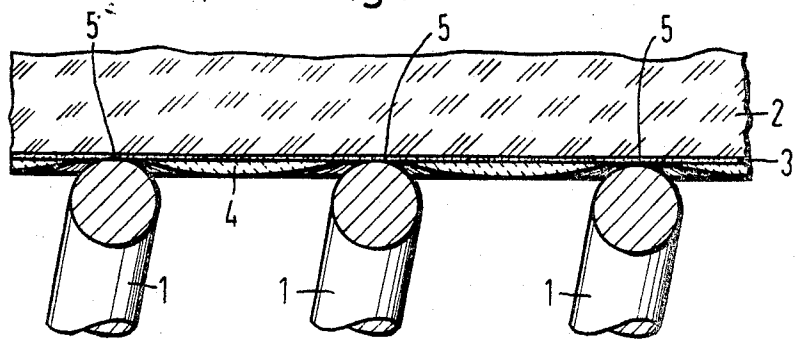


Fig.2

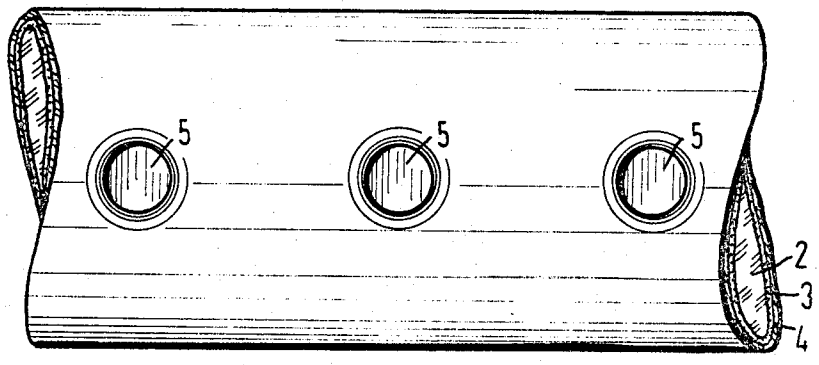
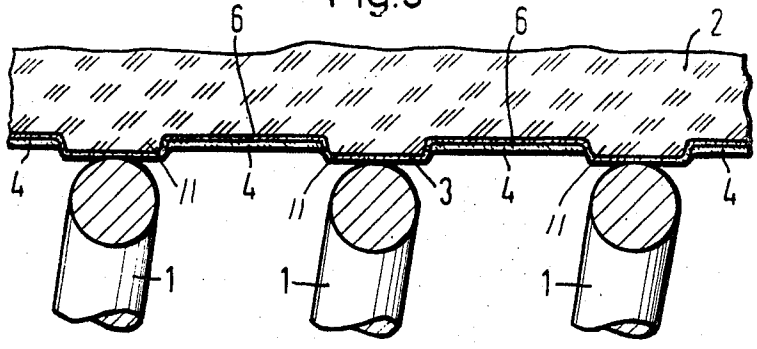


Fig.3



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Fig. 4

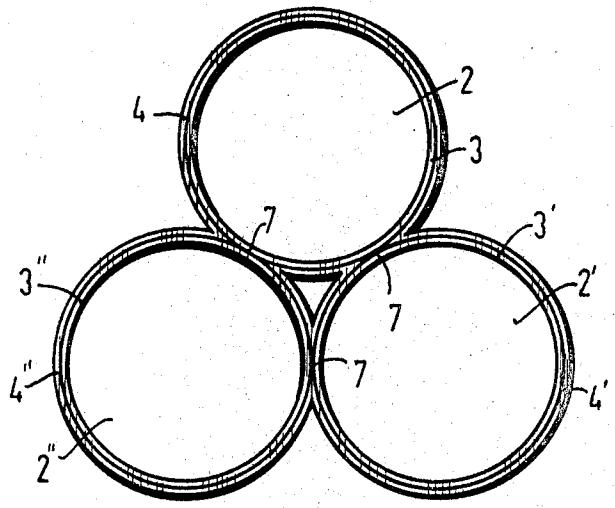
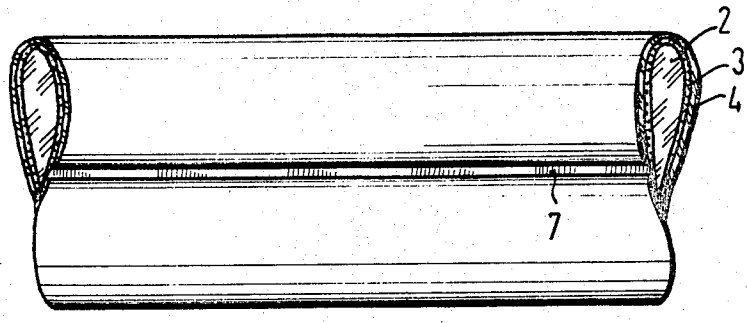


Fig. 5



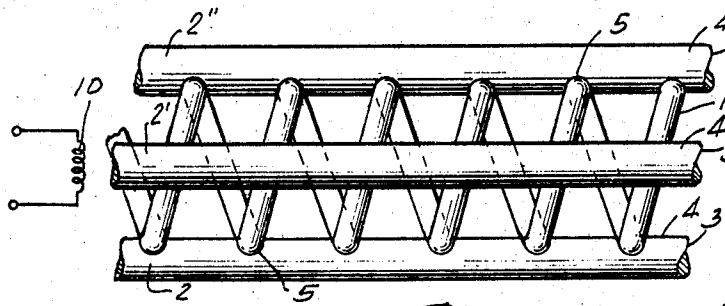


Fig. 6

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TRAVELING WAVE TUBE WITH DELAY LINE SUPPORTS HAVING A LOSSY LAYER AND AN INSULATION LAYER

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U.S. Cl. 315—3.5 15 Claims

ABSTRACT OF THE DISCLOSURE

A traveling wave tube comprising a spiral delay line supported by longitudinal supporting rods which are coated with an attenuation layer. An insulation layer is formed over the attenuation layer at least except at the points of contact between the spiral delay line and the supporting rods so as to prevent the dropping of the operating attenuation due to erosion during use.

BACKGROUND OF THE INVENTION

Field of the invention

The invention relates in general to traveling wave tubes and particularly to support means for a delay line of the spiral type.

Description of the prior art

In prior traveling wave tubes with spiral delay lines supported by rods along the periphery it has been known to cover the rods with an attenuation layer with an insulation layer.

However, in such structures due to the presence of the insulating interlayer between the spiral delay line and the damping layer, the conductance of the high frequency transition is not sufficient to provide attenuation (damping) of feedback or self-excitation of 75 db. or more, which is necessary for the operation of high efficiency traveling wave tubes using a spiral or helical delay line.

Recent traveling wave tubes with a helical line supported between insulating bars have had only a damping layer with no insulating layer, and the helix (spiral) is normally allowed to lie directly against the damping (attenuation) layer. Such damping layers are usually composed of a material containing mostly carbon or graphite and the use of such layers allows high values of operating attenuating (more than 75 db.) to be obtained. With such structures well defined high-frequency transitions between the helical line and the damping layer can be obtained. However, the operating attenuation must not drop below a certain value during the life of the tube. The tube life is normally determined by the cathode of the tube. It has been shown that attenuation layers with a protective coating give more constant operating characteristics than those without, so for that reason the protective layer should not be dispensed with.

SUMMARY OF THE INVENTION

The present invention overcomes the shortcomings of the prior art by providing a traveling wave tube with a helical delay line which is supported between dielectric holding or support bars which are coated with a damping layer, in such a way that the electrical properties of the damping (attenuation) layer remain largely preserved in the operation of the tube and which are coated by an insulation layer at points excepts where the support bars engage the helical delay line.

We have discovered that the undesired dropping of the operating attenuation in prior traveling wave tubes has been caused by erosion of the attenuation layer, which is caused by the impact of ions which come from the residual gas content of the tube. We have verified this phenomenon with experiments using an electron-microscope. The insulation layer of the present invention protects the attenuation layer from ion impact and because of the conductive contact between the delay line and attenuation layer an operating attenuation of over 75 db. is obtained.

Many other advantages, features and additional objects of the present invention will become manifest to those versed in the art upon making reference to the detailed description and the accompanying sheets of drawings in which preferred structural embodiments incorporating the principles of the present invention are shown by way of illustrative example.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partial cross-sectional view of a supporting rod and helix.

FIG. 2 is a side view of a supporting rod showing the points of a contact of the helix.

FIG. 3 is a partial cross-sectional view of a modification of a support rod and helix.

FIG. 4 is an end view of three supporting rods and illustrates a manner of applying the protective insulation layers according to this invention.

FIG. 5 is a side view of a support bar of FIG. 4; and

FIG. 6 is a schematic view of a traveling wave tube.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 6 illustrates schematically a traveling wave tube having an electron source **10** which passes electron beam through the helix **1**. The helix **1** is supported between parallel spaced supporting rods **2**, **2'** and **2''**. The vacuum envelope and the catcher of the tube as well as the input and output couplings are not illustrated since such structures are well known to those skilled in the art. For a detail description of a traveling wave tube reference may be made to Patent No. 2,626,371.

The supporting rods **2**, **2'** and **2''** may be made of quartz for example and are formed by grinding quartz to a tolerance of 2 microns for example. Each of the rods **2**, **2'** and **2''** are coated with an attenuation layer, **3**, **3'** and **3''**. A single bar is shown in FIGS. 1 and 2, for example, and the attenuation layer **3** is formed by a suitable carburization process or by painting or spraying on a graphite solution in which graphite is in suspension.

After the attenuation layer **3** has been formed on the rods insulating layers **4**, **4'** and **4''** are formed on the rods **2**, **2'** and **2''**. The insulating layer **4** may comprise for example silicon dioxide and may be attached by a vaporizing-on process, for example.

At points **5** on the rods **2**, **2'** and **2''** at which the helix **1** engages the rods **2**, **2'** and **2''** the insulating layers **4**, **4'** and **4''** is left off. In other words at the points **5** illustrated in FIG. 2 for example the attenuation layer **3** is formed on the rods **2**, **2'** and **2''** but the insulation layer **4** is not formed at those points. This may be accomplished for example by masking the points **5** as the insulation layer is applied by vaporizing-on or other suitable process.

FIG. 1 for example is a partial view of a rod **2** illustrating the attenuation layer **3** which covers the entire surface of the rod **2** and shows the insulating layer **4** overlaying the attenuation layer **3** at all points except where the helix **1** engages the rod. These points are indicated by the numeral 5 in FIG. 1, for example.

FIG. 2 is a side view of a rod **2** illustrating the points **5**.

FIG. 3 illustrates a modification of the invention wherein a rod **2** is formed with depressions **6** between adjacent

coils of the helix **1** and the coils of the helix **1** engage the rod **2** at extensions **11** formed in the rods **2**. The depression **6** may be milled for example into the rods **2** and the attenuation layer **3** is applied over the entire surface of the rods. An insulating layer **4** may then be formed over the entire surface of the rod including the attenuation layer and then the projections **11** may be ground or otherwise milled down so as to remove the insulation layer on the projections **11**. However, the attenuation layer is left on the projections **11** so that the turns of the helix **1** engage the attenuation layer.

FIGS. 4 and 5 illustrate a particular manner in which rods **2**, **2'** and **2''** may be formed. The rods **2**, **2'** and **2''** are coated with a suitable attenuation layer **3** over their entire surfaces. Then the rods are spaced together as shown in FIG. 4 and the three rods are coated with a suitable insulating layer **4** as for example SiO_2. For example, the three rods may be placed into a chamber in which a silicon compound is decomposed into a gaseous form by thermal chemical action in the presence of oxygen so that SiO_2 will be formed. The rods act as masks to cover the areas **7** at which they engage each other and the surfaces of the rods **2**, **2'** and **2''** will be coated with an insulation layer except at lines along their longitudinal lengths as shown in FIGS. 4 and 5. As shown in FIG. 5 a narrow strip **7** will be formed on the rods **2** which does not have a coating of insulation layer **4**. Because of the close galvanic contact between the helical delay line **1** and the attenuation layer **3** in the assembled traveling wave tube even the complete erosion of the small area **7** between the turns of the helix **1** will not appreciably reduce the operating attenuation of the traveling wave tube. The places of contact, themselves, are protected from impact by the helix **1** which at those places engages the bar directly. The current, then, which at first tends to run preferentially along these exposed zones in the attenuation layer **3**, is thus deflected by the erosion of the attenuation layer **3**, into the adjacent zones of the attenuation layer which are protected by the insulation.

The insulating layer may be formed of various materials as, for example, aluminum dioxide, magnesium oxide and particularly SiO_2. All of these substances are capable of being installed in a vacuum and particularly resistant to ion bombardment. The structure according to the invention to avoid undesirable reflections requires that the attenuation layer should provide a smooth transition from the damped to the undamped part of the delay line since reflections occur at discontinuities and the smooth transition will therefore, substantially eliminate reflections. To improve the impedance matching characteristics of the helical line **1** the thickness and length of the damping or attenuation layer **3** may be gradually decreased towards both ends of the helix as shown in FIG. 6 so as to suitably match the impedance. Thus in the end areas it is very important that the insulation layer covers the attenuation layer to protect it from ion bombardment which would remove the impedance layer and result in a discontinuity.

It will be understood that variations and modifications may be effected without departing from the spirit and scope of the novel concepts of this invention.

What we claim is:

1. A traveling wave tube with an electron beam comprising:

a delay line through which the electron beam passes,
support means in engagement with the delay line,
the support means covered with a first layer of attenuation material, and
the support means covered with a second layer of insulation material which overlaps the first layer of attenuation material at least except at the points of contact between the delay line and the support means.

2. Apparatus according to claim **1** wherein the delay line comprises a helix formed from electrical conducting material.

3. Apparatus according to claim **2** wherein the support means comprises at least one longitudinal member which engages the helix at a number of points.

4. Apparatus according to claim **3** wherein the support means comprises a plurality of rods of quartz.

5. Apparatus according to claim **4** wherein the rods are formed with projections at the points at which they engage the helix.

6. Apparatus according to claim **4** wherein the first layer of attenuation material has relatively low electrical impedance.

7. Apparatus according to claim **6** wherein the first layer is formed of carbon.

8. Apparatus according to claim **6** wherein the first layer is in the form of a graphite suspension.

9. Apparatus according to claim **6** wherein the thickness of the first layer of attenuation material is thicker at the mid portion of the helix than it is at either end of the helix.

10. Apparatus according to claim **6** wherein the second layer of insulation material comprises a refractory oxide.

11. Apparatus according to claim **9** wherein the second layer comprises silicon oxide.

12. Apparatus according to claim **9** wherein the helix makes good electrical contact with the first attenuation layer on the rods.

13. The method of forming longitudinal members for supporting a helix of a traveling wave tube comprising:
spraying a layer of attenuation material on the longitudinal members and forming an insulation layer on the longitudinal members except at the points where they engage the helix.

14. The method of claim **13** wherein the longitudinal members are covered completely with the layer of attenuation material and are then stacked so that they engage at lines along their longitudinal lengths and are then covered with the insulation layer except at the lines where they engage.

15. The method of claim **13** wherein the insulation layer is formed on the longitudinal members with a mask formed to cover the longitudinal members except where they engage the helix.

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F. PRINCE BUTLER, Assistant Examiner

U.S. Cl. X.R.

315—39.3; 333—31, 81C