March 4, 1958 G. CONVERT 2,825,841

TRAVELLING WAVE TUBES

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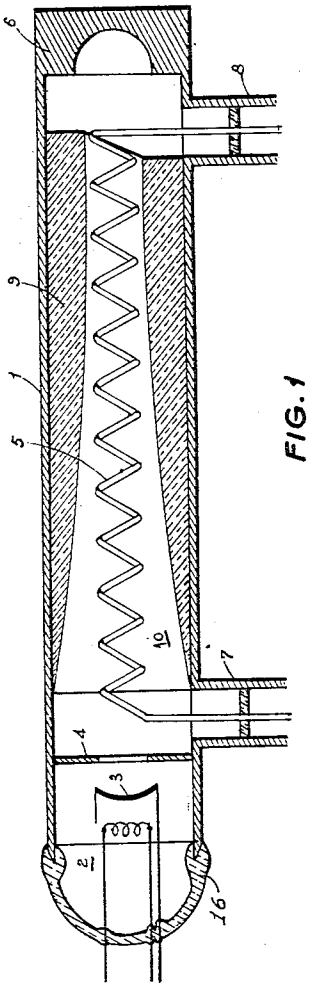

FIG. 1

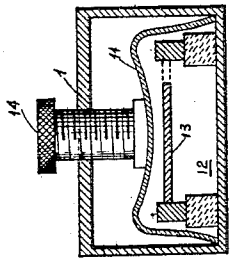

FIG. 3

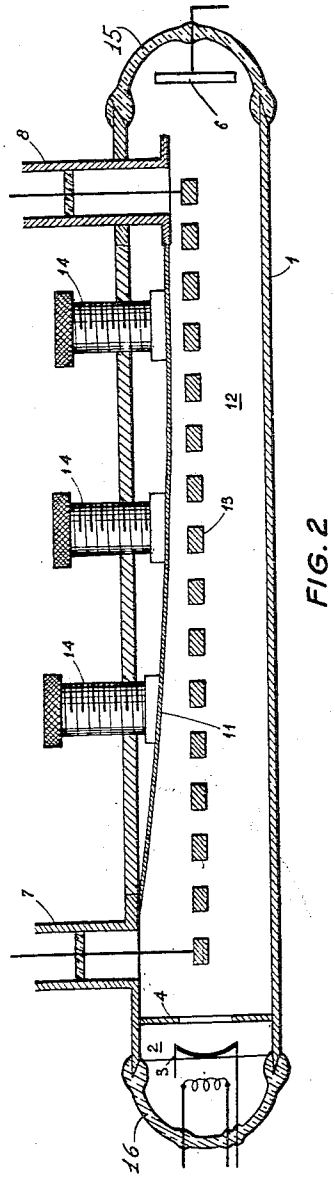

FIG. 2

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TRAVELLING WAVE TUBES

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8 Claims. (Cl. 315—3.5)

The present invention relates to travelling wave tubes. It is known that in such tubes the beam, which is emitted by the cathode and interacts with the ultra high-frequency wave propagated in the delay line, has a tendency to slow down as it moves away from the cathodes, i. e. as it gives up energy to the ultra high-frequency wave. Now, in order to ensure that the tube operates properly, it is necessary that the velocity of the electron beam and the phase velocity of the ultra high-frequency wave propagated along the delay line be substantially equal. If the velocity of the beam decreases too much the operation of the tube may be affected. This condition of equality between beam velocity and phase velocity is generally called synchronism.

To remedy this defect it has been proposed to provide delay lines whose delay ratio (i. e. the ratio of light velocity to phase velocity of the wave along the line) changes from one end to the other whereby the ultra high-frequency wave and the electron beam are maintained constantly in synchronism. But the construction of such delay lines gives rise to practical difficulties. For example, if the line is formed of a series of cavities having different dimensions, machining costs may be excessive, and if it consists of a variable pitch helix, it is difficult to ensure with precision and regularity the variation of the pitch according to a desired dimensional law.

The present invention avoids these difficulties. The travelling wave tubes according to this invention are provided with a uniform delay ratio delay line, for example a line having a constant pitch helix, and in the vicinity of this line there is disposed, substantially along its entire length or at least along a major part thereof, a metallic or dielectric body which is capable of deflecting the lines of force of the electric field of the wave propagated along the delay line. Theory and practice show that the phase velocity of the wave along the delay line varies in direct proportion with the distance between this body and the delay line and therefore slows down as said distance decreases. It will be understood that, by modifying this distance lengthwise of the delay line, it is possible to obtain that the ultra high-frequency wave propagated along the delay line and the electron beam always remain in synchronism.

According to one mode of carrying out the invention, means are provided for adjusting the distance between the delay line and the body mentioned above so as to modify the phase velocity of the wave.

Other features and advantages of the invention will appear from the ensuing description with reference to the accompanying diagrammatic drawing, wherein:

Fig. 1 shows a travelling wave tube which is provided with a delay line according to the invention;

Fig. 2 shows a modification of the travelling wave tube according to the invention;

Fig. 3 shows a fragmentary transverse sectional view of the tube shown in Fig. 2.

Fig. 1 shows an amplifier travelling wave tube. This

tube is well known per se and it is therefore not necessary to describe it in detail. In the illustrated example, this tube comprises an evacuated envelope 1 which is for example of metal. Disposed in this envelope is an electron gun 2, comprising a cathode 3, an accelerating anode 4; a delay line 5, for example of helical form; a collector electrode 6, an input 7, and an output 8. At the cathode end, the envelope 1 is ended by a glass-foot 16. As is known, the electron beam, which in the illustrated example is propagated inside the delay line 5, interacts with the wave which is fed at the input 7, is propagated along the delay line 5 and is collected at the output 8.

The pitch of the helix 5 forming the delay line is constant, but the line is encompassed by a body 9 of a dielectric or conductive material extending substantially along the entire length of the line. This body forms a sleeve provided with an axial hole 10, in which is housed the line 5. The diameter of this hole decreases from the end of the body 9 adjacent the input 7 to the end adjacent the output 8. The distance between the periphery of the delay line 5 and the body 9 therefore decreases from the input of the line to the output thereof, whereas the delay ratio of the line 5 accordingly increases, so that the phase velocity decreases. This variation in the delay ratio may be so selected that the propagation of the wave along the line be always in synchronism with the propagation of the electron beam, which as has been already explained slows down whilst propagating parallel to the line.

Figs. 2 and 3, where like reference numerals designate like elements as in Fig. 1, show another embodiment of the tube according to the invention.

According to this modification, the tube comprises inside the envelope 1 a thin and flexible wall 11 extending substantially along the entire length of the line; this wall defines an evacuated chamber 12 in which are disposed all the active elements of the tube, that is the electron gun 2, the collector 6 and the delay line 13, which in this example is of the interdigital type. The collector end 15 and the cathode end 16 of the tube 1 are made, for instance, of glass.

It can be seen from Fig. 2 that the distance between the wall 1 and the delay line 13 decreases from the input 7 to the output 8 of the tube.

Three screws 14 are screwed into the envelope 1 and their respective ends are made integral with the wall 11. As the latter is deformable it may be moved toward, or away from, the delay line 13 by screwing, or unscrewing, the screws 14, as can be seen in Fig. 3. The wall 11 has the same effect as that of the body 9 shown in Fig. 1.

In order to shorten the description, travelling wave tubes of the simplest type have been shown. But it is obvious that the invention is applicable to all amplifying or oscillating travelling wave tubes, which are with or without magnetic fields and are rectilinear or circular in shape.

What I claim is:

1. A travelling wave tube of the type comprising, in a vacuum tight envelope having at least a metallic portion, an electron gun having an emissive cathode and an accelerating anode electrically connected to said metallic portion of said envelope, a collector for electrons emitted by said gun, a delay line between said anode and said collector extending parallel to the path of electrons emitted by said cathode, said line having a constant delay characteristic along its length, and means for propagating an ultra high frequency wave along said line; an elongated member supported by said envelope inwardly thereof, extending along a substantial portion of said delay line and having a surface facing said delay line at least along a major part of its length, said surface being

curved; said member bounding inwardly thereof a passage through which said delay line extends, the distance between the conductive surface of said line and said surface of said member varying progressively along said line and means for displacing at least a portion of said elongated member towards and away from said line.

2. A tube according to claim 1 wherein said means are controllable from outside the tube.

3. A travelling wave tube of the type comprising, in a vacuum tight envelope having at least a metallic portion, an electron gun having an emissive cathode and an accelerating anode electrically connected to said metallic portion of said envelope, a collector for electrons emitted by said gun, a delay line between said anode and said collector extending parallel to the path of electrons emitted by said cathode, said line having a constant delay characteristic along its length, and means for propagating an ultra high frequency wave along said line; an elongated member supported by said envelope inwardly thereof, extending along a substantial portion of said delay line and having a surface facing said delay line at least along a major part of its length, said surface being curved; said member bounding inwardly thereof a passage through which said delay line extends, the distance between the conductive surface of said line and said surface of said member varying progressively along said line, said elongated member having deformable walls surrounding said delay line and mechanical means extending through said vacuum tight envelope and controllable from outside for displacing said walls towards and away from said delay line.

4. A travelling wave tube of the type comprising, in a vacuum tight envelope having at least a metallic portion, an electron gun having an emissive cathode and an accelerating anode electrically connected to said metallic portion of said envelope, a collector for electrons emitted by said gun, a delay line between said anode and said collector, extending parallel to the path of electrons emitted by said cathode, said line having a constant delay characteristic along its length, and means for propagating an ultra high frequency wave along said line; an elongated member supported by said envelope inwardly thereof, extending along a substantial portion of said delay line and having a surface facing said delay line at least along a major part of its length, said surface being curved; said member bounding inwardly thereof a passage through which said delay line extends, said elongated member having deformable walls surrounding said delay line, the distance between said delay line and said walls changing progressively along at least a major portion of said line, and mechanical means extending through said vacuum tight envelope and controllable from outside for deforming said walls, whereby said progressively changing distance may be varied.

5. A travelling wave tube of the type comprising, in a vacuum tight envelope having at least a metallic portion, an electron gun having an emissive cathode and an accelerating anode electrically connected to said metallic portion of said envelope, a collector for electrons emitted by said gun, a delay line between said anode and said collector extending parallel to the path of electrons emitted by said cathode, said line having a constant delay characteristic along its length and means for propagating an ultra high frequency wave along said line; an elongated member supported by said envelope inwardly thereof, extending along a substantial portion of said delay line and having a surface facing said delay line at least along a major part of its length, said surface being curved; said member bounding inwardly thereof a passage through which said delay line extends, the distance between the conductive surface of said line and said surface of said member varying progressively along said line.

6. A tube as claimed in claim 5 wherein said member is of a dielectric material.

7. A tube as claimed in claim 5 wherein said member is a sleeve provided with an axial hole of progressively varying transversal dimension.

8. A travelling wave tube of the type comprising, in a vacuum tight envelope having at least a metallic portion, an electron gun having an emissive cathode and an accelerating anode electrically connected to said metallic portion of said envelope, a collector for electrons emitted by said gun, a delay line between said anode and said collector extending parallel to the path of electrons emitted by said cathode and having an input and an output, said line having a constant delay characteristic along its length, and means for propagating an ultra high frequency wave along said line from said input to said output; an elongated member supported by said envelope inwardly thereof, extending along a substantial portion of said delay line and having a surface facing said delay line at least along a major part of its length, said surface being curved; said member bounding inwardly thereof a passage through which said delay line extends, the distance between the conductive surface of said line and said surface of said member decreasing progressively from the input to the output of said line.

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