Dec. 6, 1966 T. H. STAERCK 3,290,544

TRAVELLING WAVE TUBE

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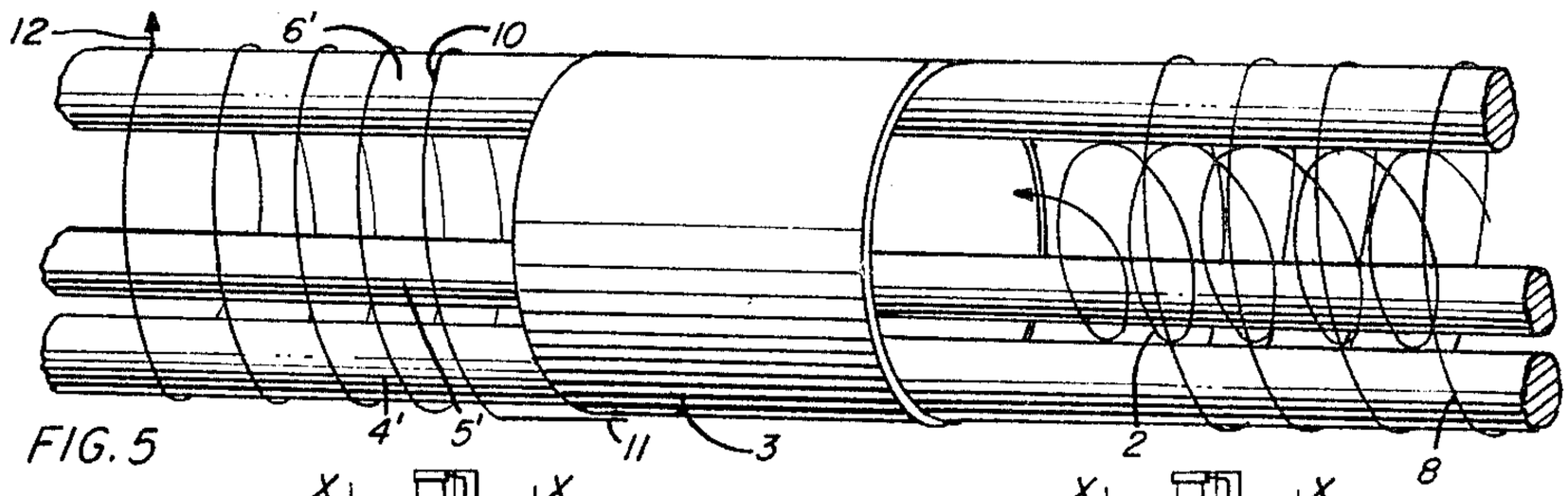


FIG. 5

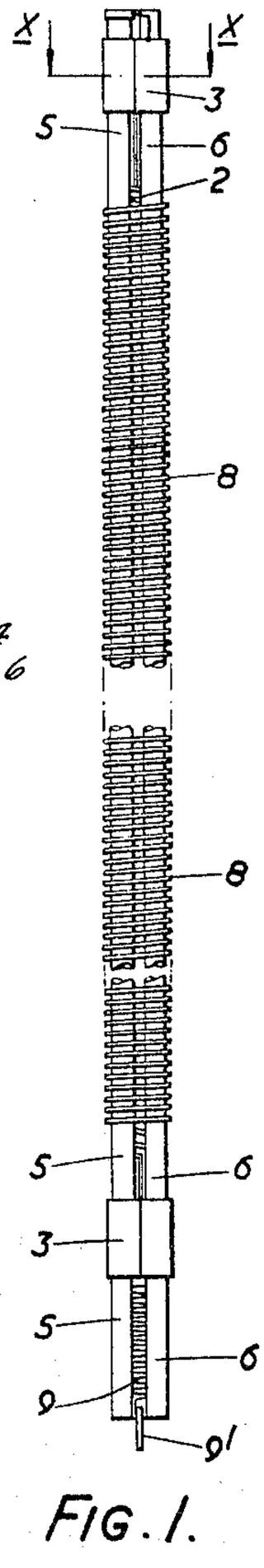


FIG. 1.

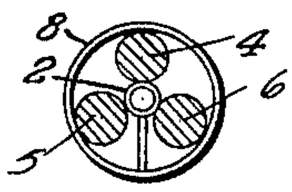


FIG. 2

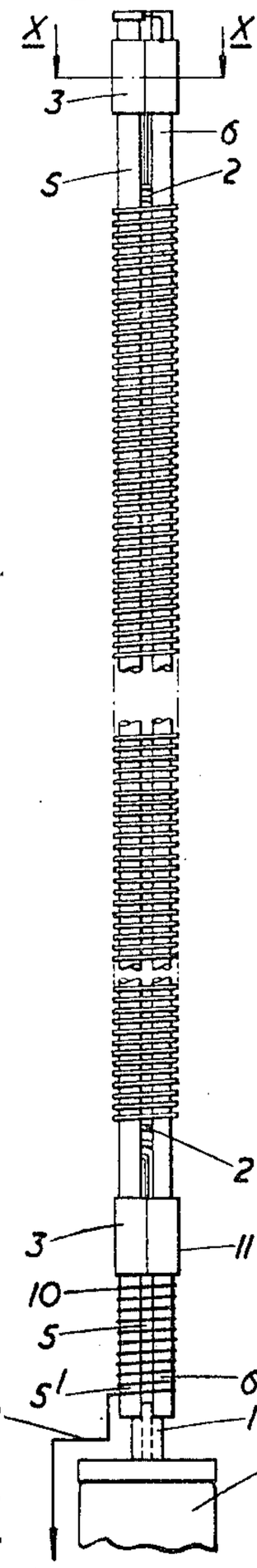


FIG. 3.

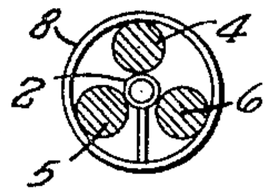


FIG. 4

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TRAVELLING WAVE TUBE

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4 Claims. (Cl. 315—3.5)

This invention, which is for improvements in or modifications of the invention contained in the parent British Patent No. 844,332, relates to travelling wave electron discharge tubes and more specifically to such tubes of the kind in which an electron beam is projected axially down a delay winding which is coupled thereto. Such travelling wave tubes are now well known and in fairly common use for microwave amplification and other purposes.

According to the parent invention a travelling wave electron discharge tube of the kind having a delay winding which is co-axial with the electron beam part of the tube, is provided with a plurality of rods supporting said winding and in contact with the outside thereof along a plurality of lines distributed around the periphery thereof, and coiled strained elastic metal spring means encircling said plurality of rods over at least a substantial proportion of the lengths thereof, said coiled spring means having, in the unstrained condition, a diameter less than that of an imaginary cylinder on which said rods lie, whereby spring force exerted by said coiled spring means presses said rods against said winding.

According to a feature of the parent invention a travelling wave electron discharge tube of the kind having a delay helix which is co-axial with the electron beam path of the tube is provided with a plurality of rods supporting said helix and in contact with the outside thereof along a plurality of lines distributed around the periphery thereof, and at least one helically coiled strained elastic metal spring in a radially strained condition encircling said plurality of rods over at least a substantial part of the lengths thereof, whereby said spring, due to its strain, presses said rods against said helix. There may be a single coiled spring extending over the required portion of the helix length or there may be a number of such springs, end to end or spaced apart a little, over said length.

The invention is illustrated in and further explained in connection with the accompanying drawings in which FIGURES 1 and 2 are two views showing the delay line structure and arrangement of a typical tube in accordance with the parent patent, FIGURE 2 being a section on the line X—X of FIGURE 1. FIGURES 3 and 4 are two views showing the delay line structure and arrangement of an improved tube in accordance with the present invention, FIGURE 4 being a section on the line X—X of FIGURE 3. FIGURE 5 is a perspective view of the lower portion of the structure shown in FIGURE 3. Like references denote like parts in the different figures.

Referring to FIGURES 1 and 2 the tube therein partly shown has, within its evacuated envelope (not shown), a helical delay winding **2** between end members or so-called "chokes" **3**. The term "choke" is really a misnomer, since the end members **3** act as coupling devices rather than as isolating devices, but they are none the less, called "chokes" by those skilled in the art, and they will be called "chokes" in this patent application. In practice, the "chokes" may take any number of forms, but in the particular example illustrated in the drawings, "chokes" **3** each comprise open ended hollow cylinders, one end of which is coupled to a helical delay winding **2**, and the other end of which is coupled to the input

lead for the R.F. signal to be applied to the helical delay winding. Helical delay winding **2** co-axially surrounds the electron discharge path (not represented) which extends axially along inside the said winding in the customary manner. The winding **2** is supported by three insulating rods **4**, **5** and **6** spaced at 120° round the winding periphery and contacting it along three lines which are parallel to the axis. The said rods are coated with graphite or other suitable resistance material over desired portions of their lengths to provide attentuation in accordance with well known travelling wave tube practice. Such graphite coating is not represented for reasons of simplifying the drawing.

The rods **4**, **5** and **6** are pressed inwardly on to the helix **2** by means of a coiled helical metal spring **8** long enough to extend at least over the greater part of the length of the helical winding **2** and having in its unstrained condition an internal diameter a little less than the diameter of the imaginary circle circumscribing the rods **4**, **5** and **6** and to which these rods are internally tangential. It is in general preferred to have the helix **2** and the spring **8** wound in the same direction. To fit the coil spring **8**, the rods **4**, **5** and **6** are placed in position and the spring **8** is unwound a little so as to increase its internal diameter sufficiently to allow it to be slipped over the said rods **4**, **5** and **6**. It is then released when in the required position. It will be appreciated that, when released, the spring will provide radially inward forces which press the rods **4**, **5** and **6** inwardly against the helix **2** and position the latter with precision and in a stable manner.

At the end towards the electron gun assembly (not shown in FIGURE 1) i.e. at the end which is lowermost in FIGURE 1, the rods, **4**, **5** and **6** project well beyond the "choke" **3** and between them is disposed what is termed a choke helix **9** which acts as an impedance to radio frequency. This choke helix is connected in circuit between the adjacent end of the delay winding **2** and the appropriate connection **9'** to the base of the tube.

The present invention seeks to simplify the construction of a known tube in accordance with the parent patent and as illustrated by FIGURES 1 and 2 and to provide a strong and rigid structure.

According to this invention the delay winding support rods of a tube as claimed in the parent invention are extended well beyond the "choke" near the end of the delay winding nearer the gun and the extensions of said rods are encircled by a helically coiled strained elastic metal spring which exerts inward force and which is so connected in circuit with said delay winding and is so dimensioned as to act also as a choke helix.

Preferably said helically coiled strained elastic spring surrounding the rod extensions is connected at one end, e.g. by welding, to the normally provided "choke" which is between the delay winding and said spring, the adjacent end of said delay winding being also connected to said "choke."

Preferably also the end of the electron gun structure nearer the ends of the rod extensions is provided with an upstanding peg adapted to fit axially into the space between the rod extensions and thus maintain those extensions correctly parallel despite the radial inward force of the strained spring encircling said extensions. This results in a structure which is very strong and rigid.

When manufacturing a tube in accordance with this invention it may be found that, when the spring encircling the rod extensions is placed in position, and before the peg is put in place in the space between those extensions, the spring force may bend the rod extensions—the rods will usually be of quartz—inwards. To prevent this it is preferred to insert between the rod extensions and be-

fore the encircling spring is fitted, a temporary coiled wire helix of appropriate strength, length and diameter to support said extensions against such inward bending when the encircling spring is fitted. The delay line and rod structure is then fitted over the peg. The inserted temporary helix may then be withdrawn by pulling it out, turn by turn, through the space between two of the rod extensions.

FIGURES 3 and 4 illustrate a preferred embodiment. In view of the description already given with reference to FIGURES 1 and 2, FIGURES 3 and 4 are almost self explanatory. The rod extensions which appear in FIGURE 3 are marked **5'** and **6'** and the strained coil spring encircling all three extensions—which are, of course, of the same length—is referenced **10**. One end of this spring is connected, as by welding at **11**, to the "choke" **3** and the other end is connected by lead **12** to the appropriate base connection (not shown). The adjacent end of the electron gun structure—the anode end—is shown broken away at **13** and the anode is provided with an upstanding stepped hollow peg **14** the reduced diameter stepped end of which fits axially as shown into the space between the three rod extensions. In order to prevent inward bending of the rod extensions by the spring **10** before the peg **14** is in position it is preferred to insert between the rod extensions and before the encircling spring is fitted, a temporary coiled wire helix of appropriate strength, length and diameter to support said extensions against such inward bending when the encircling spring is fitted. The temporary helix is not shown in FIGURE 3. It would be inserted in the space S. After inserting the temporary helix the spring **10** is put in place, the structure is fitted correctly in position over the reduced diameter stepped end of the peg **14** and the necessary electrode connections are made preparatory to enveloping in glass. The end of the temporary helix is then seized by a suitable tool and the said helix is pulled out, turn by turn through the space between two of the rod extensions. In practice, in a typical case, a temporary helix of 0.005" tungsten wire, wound with 120 turns per inch on an accurately ground mandrel, has been found satisfactory for the purpose specified.

I claim:

1. A travelling wave tube having an electron gun for generating an electron beam, a helical delay winding coaxially surrounding the path of the electron beam, a plurality of rods supporting said winding and in contact with the outside thereof along a plurality of lines distributed around the periphery thereof, a choke near the end of the delay winding nearer the gun, said rods extending beyond the gun end of said choke, and a helically coiled strained elastic metal spring encircling the extension of said rods beyond the choke so as to exert an inward force on the rods, said spring being so connected in circuit with said delay winding and being so dimensioned as to act as a choke helix.

2. A tube as claimed in claim **1** wherein the helically coiled strained elastic spring surrounding the rod extensions is connected at one end to the normally provided choke which is between the delay winding and said spring, the adjacent end of said delay winding being also connected to said choke.

3. A tube as claimed in claim **1** wherein the end of the electron gun structure nearer the ends of the rod extensions is provided with an upstanding peg adapted to fit axially into the space between the rod extensions and thus maintain those extensions correctly parallel despite the radial inward force of the strained spring encircling said extensions.

4. A method of assembling a travelling wave tube comprising the steps of taking a plurality of rods for supporting a helical delay winding having a "choke" situated near one end thereof, arranging the rods to contact the outside of the delay winding along a plurality of lines distributed around the periphery thereof so that they extend beyond the "choke," inserting between the extensions of the rod beyond the "choke" a temporary wire helix, fitting over the outside of the said extensions of the rods a helically coiled elastic metal spring so dimensioned as to exert an inward force on the rods, the temporary wire helix being so dimensioned as to make contact with the rods and prevent their inward bending by the spring, fitting the ends of the rod extensions over an upstanding peg provided on an electron gun structure for the tube, the peg being adapted to fit axially between the rod extensions to prevent their inward bending, and withdrawing the temporary helix.

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