May 12, 1964 A. COHEN ETAL 3,132,410

METHODS OF CONSTRUCTING A TRAVELING WAVE TUBE

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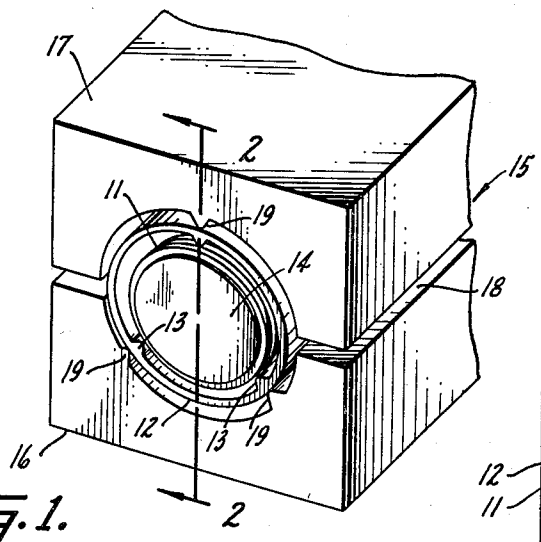


fig. 1.

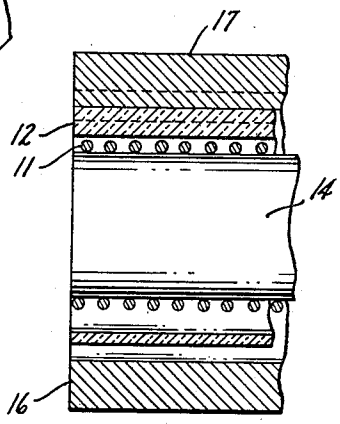


fig. 2.

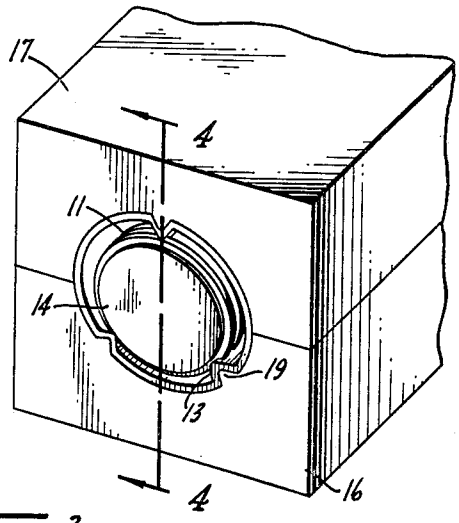


fig. 3.

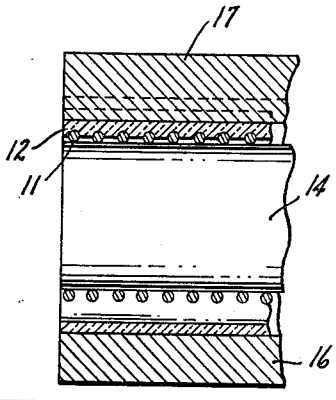


fig. 4.

INVENTORS
AARON COHEN
MAURICE F. LISCIO
PAUL OKSTEIN
BY W. W. Tasche
Paul S. Collignon
ATTORNEYS.

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METHODS OF CONSTRUCTING A TRAVELING WAVE TUBE

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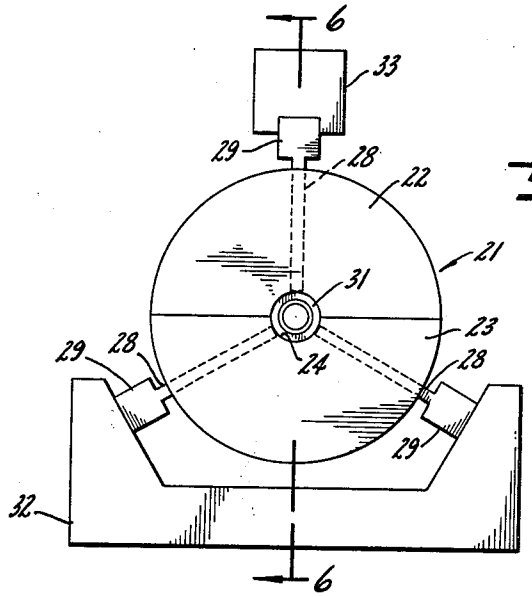


Fig. 5.

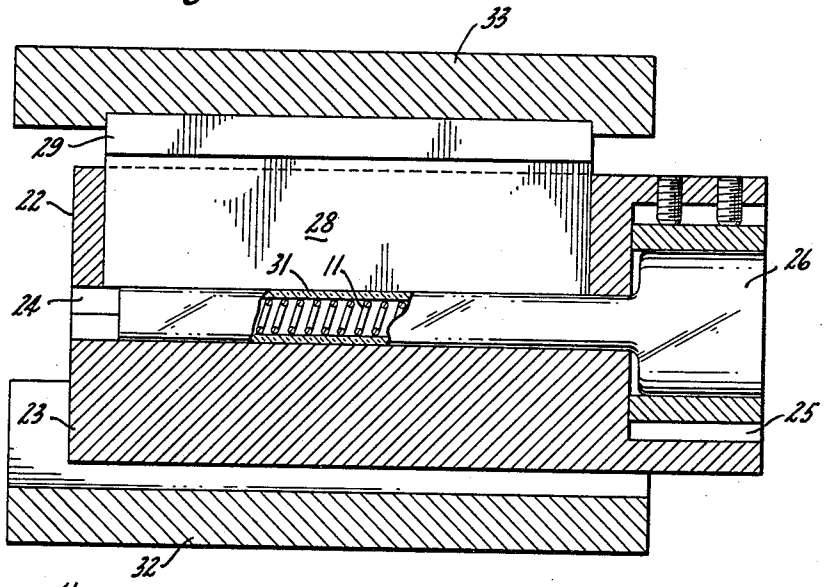


Fig. 6.

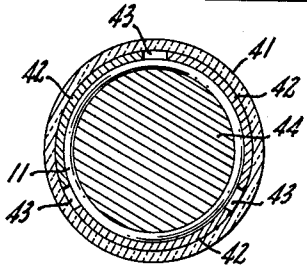


Fig. 7.

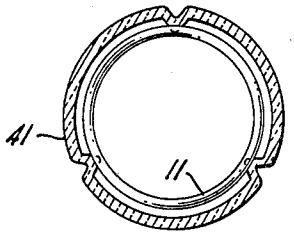


Fig. 8.

INVENTORS
AARON COHEN
MAURICE F. LISCIO
PAUL OKSTEIN
BY W. W. Leech
Paul S. Collignon
ATTORNEYS.

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3,132,410
METHODS OF CONSTRUCTING A TRAVELING WAVE TUBE

Aaron Cohen, San Diego, Calif., Maurice F. Liscio, West Orange, N.J., and Paul Okstein, Brooklyn, N.Y., assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Navy

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3 Claims. (Cl. 29—25.14)

The present invention relates to traveling wave tubes and more particularly to methods of constructing a helix assembly in traveling wave tubes.

A traveling wave tube is a device which provides for the continuous interaction between an electron beam and an electromagnetic wave so that the wave is amplified. In order that such interaction be obtained, the electromagnetic wave must be retarded or slowed so that its phase velocity will be approximately the same as the speed of the electrons in the beam. The most common type of retarding structure used in traveling wave tubes is a metal helix whose diameter and pitch are set to produce the desired axial phase velocity of an electromagnetic wave propagated therealong. Since the structure of the helix is an elongated one, care must be observed in the fabrication thereof to assure that the desired pitch and diameter will be maintained throughout its entire length so as to accordingly provide the proper phase relationship between the electromagnetic wave and the electron beam.

One heretofore known method of supporting a helix assembly consists in using three of four ceramic rods which are attached externally to the helix turns. The rods are rigidly attached lengthwise of the helix to produce a support which is actually integrated with the slow-wave structure. These rods are attached to the helix with a thin glass coating. However, this method of assembly requires that both the rods and the helix be precision ground so as to avoid breakage due to misalignment. Another disadvantage of using rods is that their relative low strength limits the type of application to which a traveling wave tube may be put. A further disadvantage of using ceramic support rods is that the diameter of the tube is materially increased.

In the present invention, the wire helix is supported by a vitreous tube having a plurality of longitudinal convex ribs which engage with the wire helix. In one embodiment, a plurality of longitudinal ribs are provided in the vitreous tube prior to assembly with the wire helix, and after assembly pressure is applied during heating, and the ribs are embedded around the wire helix. In another embodiment, the plurality of ribs are formed during the heating and pressing operation. In the preferred embodiment of using a vitreous tube that has preformed longitudinal ribs, the wire helix is inserted into the vitreous tube which is of sufficient size so that the longitudinal ribs slightly clear the outside diameter of the wire helix. The tube assembly is then placed in an embedding fixture that has a top and bottom block. Each block is provided with a trough that is slightly smaller in diameter than the outside diameter of the vitreous tube and the troughs are provided with a number of longitudinal ribs equal in number to the number of ribs in the vitreous tube. With the tube assembly in place, the longitudinal ribs in the troughs contact the outer surface of the vitreous tube and the top and bottom blocks are separated by a predetermined amount. Upon heating, the vitreous tube softens and the top block moves down under its own weight until it rests on the bottom block. The longitudinal ribs in the vitreous tube are pressed into the coils of the wire helix and the outside diameter of the vitreous tube is nested into the troughs of the top and bottom blocks. The depth to

which the longitudinal ribs penetrate between the turns of the wire helix is determined by the original gap between the top and bottom blocks and the size of the longitudinal ribs in the troughs.

It is therefore a general object of the present invention to provide an improved method of assembling a wire helix in a traveling wave tube.

Another object of the present invention is to provide an improved method of embedding a wire helix in a vitreous tube.

Other objects and advantages of the present invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawing wherein:

FIGURE 1 is a partial perspective view showing a tube assembly before heating;

FIGURE 2 is a sectional view of FIGURE 1;

FIGURE 3 is a partial perspective view showing a tube assembly after heating;

FIGURE 4 is a sectional view of FIGURE 3;

FIGURE 5 is an end view showing another embodiment of the present invention;

FIGURE 6 is a sectional view taken on line 6—6 of FIGURE 5;

FIGURE 7 is an end view of another embodiment showing an assembly prior to heating; and

FIGURE 8 is an end view of the embodiment of FIGURE 7 after heating.

Referring now to FIGURES 1 through 4 of the drawing that show a preferred embodiment of the present invention, a wire helix **11** is inserted in the bore of a vitreous tube **12**, such as tubular glass, that is provided with three longitudinal convex ribs **13**. A mandrel **14** may be provided to preserve the as-wound accuracy of the wire helix **11** in the tube **12**. The assembled unit of the mandrel **14**, wire helix **11**, and tube **12** are placed in a fixture **15** comprised of a bottom portion **16** and a top portion **17**, and as shown in FIGURE 1 of the drawing, a small predetermined gap **18** exists between the top and bottom portions of the fixture **15**. Three convex ribs **19** are provided longitudinally in fixture **15** and are spaced so that one each will be opposite each convex rib **13**. Fixture **15** is placed in a heat environment, such as a furnace, and as the vitreous tube **12** softens, the top portion **17** moves down under its own weight until it rests on the bottom portion **16**. As the vitreous tube **12** softens, the convex ribs **19** in fixture **15** presses the longitudinal convex ribs **13** into engagement with the wire helix **11** and the wire helix **11** becomes embedded in the ribs **13**, as shown in FIGURE 4 of the drawing.

Referring now to FIGURES 5 and 6 of the drawing, another embodiment is shown for assembling a wire helix in a vitreous tube. Fixture **21**, which is comprised of an upper half **22** and a lower half **23**, can be separated to allow the placement of a wave tube assembly in a cylindrical opening **24**. An oversized recess **25** is provided on one end to permit the gun bulb **26** to clear the fixture. A plurality of slots **27** are provided in fixture **21** and extend from the outer periphery to the cylindrical opening **24**. An embedding blade **28** is provided in each slot, and each blade is provided with a head portion **29** that cannot enter the slot **27**. Thus it can be seen that the embedding blades can travel only a limited distance.

In operation, a wire helix **11** is slip-fitted inside a vitreous tube **31** and placed in the cylindrical opening **24**. The embedding blades **28** are then inserted in slots **27** with the ends thereof being in contact with the vitreous tube **31**. The fixture is then placed in a base **32** that engages with the head portions **29** of two of the embedding blades **28**. A weight **33** is placed on top of the third embedding blade **28**. The fixture is then placed in a heat

environment, such as an oven, and as the vitreous tube **31** softens, the embedding blades **28** force the softened vitreous tube against the wire helix and upon cooling the wire helix is embedded in the vitreous tube **31**.

Another embodiment of the present invention is shown in FIGURES 7 and 8 of the drawing. A wire helix **11** is supported inside a precision glass tube **41** by a plurality of longitudinal metal strips **42**. The strips are spaced so as to provide gaps **43** through which the glass can move to embed the wire helix **11**. A mandrel **44** may be provided to preserve the as-wound accuracy of the helix. The processing can be accomplished in either the fixture shown in FIGURE 1 of the drawing or the fixture shown in FIGURES 5 and 6 of the drawing. FIGURE 8 of the drawing shows the complete tube assembly after the heating and cooling steps and after the mandrel **44** and strips **42** have been removed by selective etching. By way of example, the wire helix **11** might be made of tungsten and the strips **42** and mandrel **44** might be made of molybdenum.

It can thus be seen that the present invention provides an improved method of embedding a wire helix in a vitreous tube and that the assembled unit is small and compact. Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood, that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A method of constructing a helix assembly comprising:

(*a*) placing a wire helix in a vitreous tube having a plurality of longitudinal convex ribs integral with the inner periphery thereof whereby said wire helix is supported by said convex ribs,

(*b*) heating said vitreous tube to a viscid condition, and

(*c*) then applying pressure to the outer periphery of said vitreous tube at a line where each convex rib is positioned while said tube is in a viscid condition whereby said longitudinal convex ribs are embedded with said wire helix.

2. A method of constructing a helix assembly as set forth in claim 1 wherein said helix is supported by a mandrel during the heating of said vitreous tube.

3. A method of constructing a helix assembly comprising:

(*a*) placing a wire helix in a vitreous tube having a plurality of longitudinal convex ribs integral with the inner periphery thereof whereby said wire helix is supported by said convex ribs,

(*b*) then positioning said vitreous tube in a cylindrical fixture having a plurality of embedding blades the ends of which contact the outer periphery of said vitreous tube at lines where said convex ribs are positioned, and

(*c*) then heating said vitreous tube while in said fixture whereby said embedding blades move a predetermined distance thereby embedding said convex ribs into said wire helix.

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