Nov. 15, 1960 A. EVANS 2,960,622

TRAVELLING WAVE TUBES

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FIG.1.

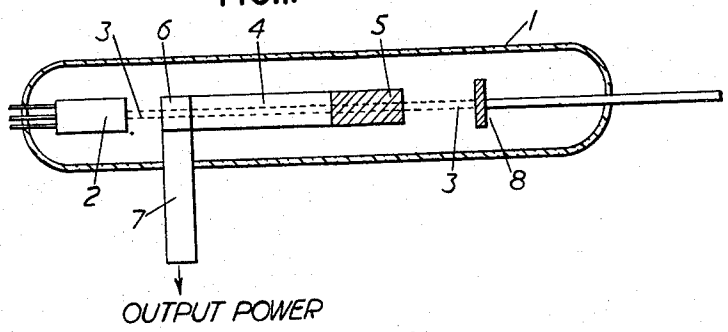


FIG.2.

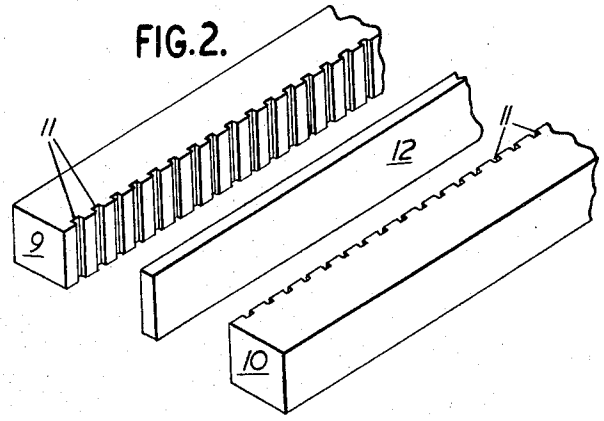


FIG.3.

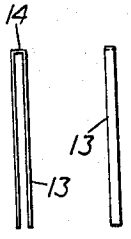
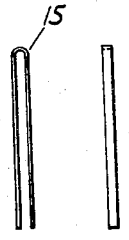


FIG.4.



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FIG. 5.

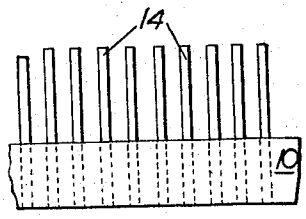


FIG. 6.

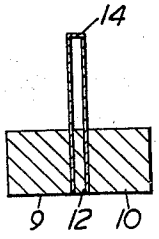


FIG. 7.

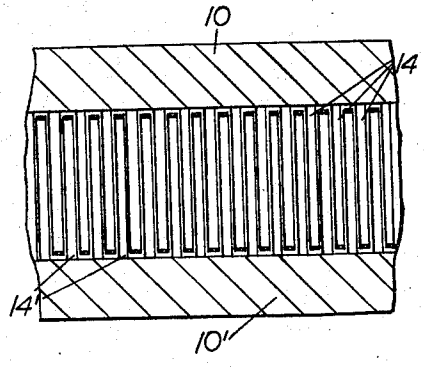
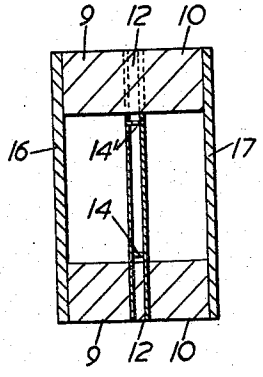


FIG. 8.



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2,960,622

TRAVELLING WAVE TUBES

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5 Claims. (Cl. 315—3.6)

The present invention relates to slow wave structures which are particularly useful in travelling wave tubes of the "backward" wave kind.

A "hairpin" type of interdigital line is described in the two papers "Backward Wave Oscillators," by R. Kompfner, and "A Hairpin Tube Backward Wave Oscillator," by G. E. Helmke, both published in Bell Laboratories Record, vol. XXXI, No. 8, August 1953. The slow wave structure described by Helmke was made by winding wire on a mandrel to form the "hairpins" and embedding the wire in a metal block so that only part of the turns project above the surface. The "hairpins" do not then lie perpendicular to the longitudinal axis of the slow wave structure but are inclined thereto at the pitch angle of the original winding. Difficulties of interleaving the two sets of "hairpins" are reduced if the hairpins are all perpendicular to the longitudinal axis and it is also advantageous if they can be formed of flat tape rather than round wire.

According to the present invention there is provided a slow wave structure for a travelling wave tube formed by two interleaved sets of parallel inverted U-shaped conductors projecting from the respective opposed surfaces of a pair of conductive bounding walls in which each of the said bounding walls comprises a pair of outer members separated by an inner member, each set of U-shaped conductors having its limbs held between the middle wall member and the adjacent outer wall members of one of said boundary walls.

Preferably each U-shaped conductor is formed of metal ribbon, while the wall members and the conductors, where these last are required to be low-loss are gold-plated and bonded together by one of the known gold-diffusion processes or brazed with suitable solder. On the other hand the U-shaped conductors at one end of the structure can be made of resistive material, or can be coated with such material, to provide a wave absorbing termination for use in a backward wave oscillator tube.

The invention will be further described with reference to the accompanying drawings in which:

Fig. 1 shows, schematically, the arrangement of a backward wave oscillator tube;

Fig. 2 shows an exploded view of part of one of the bounding walls of a slow wave structure according to the present invention;

Figs. 3 and 4 show front and side views of the U-shaped conductors having, respectively, flat and curved bases to the U;

Figs. 5 and 6 show, respectively, a fragmentary side view and a cross section of the assembly of the members of Figs. 2 and 3; and

Figs. 7 and 8 show, respectively, corresponding views of the completed slow wave structure.

In the drawing of Fig. 1, an evacuated envelope **1** encloses an electron gun **2** which projects a beam of electrons, represented by the dotted lines **3**, along a slow wave structure **4**. At one end the slow wave structure

comprises a wave absorbing termination **5** and at the other it is coupled by way of an impedance transforming section **6** to an output transmission line **7**. The electron path is terminated by an electron collector electrode **8**.

The slow wave structure according to the present invention is formed by an interdigital "hairpin" arrangement of inverted U-shaped conductors projecting from the opposed surface of a pair of longitudinally extending metal walls bounding two sides of the slow wave structure. Each of these walls is formed of three members as shown in Fig. 2, namely a pair of outer members **9** and **10**, each, in the embodiment shown, having slots **11**, and a central insert **12** separating the two outer members **9** and **10** and the limbs of the U's. Suitable U-shaped conductors formed from metal ribbon are shown in Figs. 3 and 4, the conductor **13** having the base **14** of the U flattened, while in Fig. 4 the base **15** is rounded.

The U-shaped conductors may be brazed into the slots **11** and may be of resistive material, or may be coated with resistive material, to provide the wave absorbing termination **5** of Fig. 1. Over most of the length of the slow wave structure, however, the component members should be as loss-free as possible and it is preferred that the U-shaped conductors and the abutting surfaces of the wall members **9**, **10** and **12** should be gold-plated and then subjected to one of the known gold-diffusion bonding processes or soldered while being maintained under lateral pressure. The resultant assembly is shown in Figs. 5 and 6, U-shaped conductors of the Fig. 3 type being used. For a backward wave oscillator tube operating over the range of wave lengths from 4 cms. to 7 cms. with a beam voltage varying from 1,200 v. to 300 v., in a typical embodiment of the invention, the U-shaped conductors **13** were made from molybdenum ribbon 0.020" wide and 0.006" thick. The length of the U-shaped conductor protruding from the base plate was 0.170" and adjacent U-conductors were spaced by 0.066". The central base member **12** was 0.040" thick. Two such assemblies are made and joined together, as shown in Figs. 7 and 8, with the aid of side plates **16** and **17**. In Figs. 7 and 8 the members of the second bounding wall are identified as **9'**, **10'**, and **12'**, while the corresponding U-shaped conductors are given the reference numeral **14'**.

The slow wave structure of the invention has the advantages that the U-shaped members are flat and can be interleaved without difficulty, while they need not all be made of the same material so that, if desired, a gradual transition can be made from a low loss structure, in the working region, to one having high absorption in the termination region **5** of Fig. 1. Assuming that an electron beam is arranged to "flood" the structure, that is that electrons pass on both sides of each of the limbs of the U's, employing metal ribbon for their construction reduces beam interception to a minimum.

While the principles on the invention have been described above in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation on the scope of the invention.

What is claimed is:

1. A slow wave structure for a travelling wave tube comprising a pair of boundary walls having conductive surfaces facing each other, two interleaved sets of aligned parallel opposed U-shaped conductors projecting from the respective opposed surfaces of said pair of conductive surfaces and positioned longitudinally along said surfaces with the U-shaped ends of the conductors on each surface positioned between adjacent ends of the conductors projecting from the opposite surface, in which each of the said bounding walls comprises a pair of outer members separated from each other and fastened to an inner member, said U-shaped conductors having

their limbs fastened between the inner member and the adjacent outer members of one of said boundary walls whereby an electron beam passes between the limbs of said U-shaped conductor.

2. A slow wave structure according to claim 1 in which the U-shaped conductors at one end of the structure are provided with a surface of resistive material to provide a wave absorbing termination for the structure.

3. A slow wave structure according to claim 1 in which each U-shaped conductor is formed of a separate metal ribbon, the width of said ribbon being perpendicular to the plane of the U-shaped conductor.

4. A slow wave structure according to claim 3 in which the base of the U-shaped conductor is flat.

5. A slow wave structure according to claim 3 in which said outer members of the bounding walls are slotted to receive the limbs of the U-shaped conductor.

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