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2,806,170

TRAVELING WAVE TUBE

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Fig-1

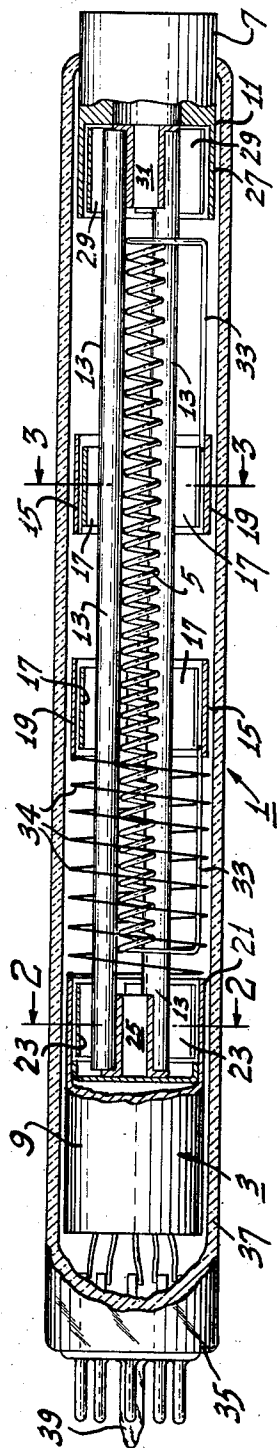
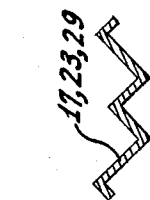


Fig-4

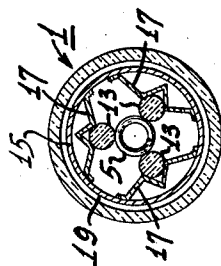


Fig-5

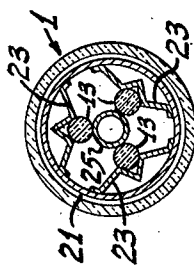


Fig-2

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TRAVELING WAVE TUBE

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18 Claims. (Cl. 315-3.5)

The present invention relates to electron discharge tubes, and particularly to improved electrode mounting structures for the electrodes of electron beam tubes of the traveling wave type.

In a conventional traveling wave tube an electron beam is projected along the longitudinal axis of a relatively-long slender helical conductor at an appropriate velocity for interaction with high frequency signal waves traveling along the helix in the same direction, for the purpose of amplifying the signal. The essential elements of such a tube are an electron gun, a relatively-long slender helical conductor of small diameter, a collector, an envelope enclosing these elements, and means for coupling the input and output ends of the helical conductor to input and output transmission lines. The tube is normally mounted in a suitable magnetic field coil, or a permanent magnet, to provide a focusing magnetic field axial to the electron beam.

The helix in a traveling wave tube is sometimes mounted within a precision tubular glass or quartz envelope by means of three or more ceramic or other low-loss rods extending longitudinally between the helix and the envelope, with the ends of the rods abutting a pair of annular members which also serve as high frequency coupling sleeves, as shown in Pierce Patent No. 2,602,148, dated July 1, 1952. In another method, the helix is inserted into a length of precision, internally-fluted, glass tubing which is held coaxially within two or more short metal cylinders by means of mica supports. Sauereisen cement is used to hold the parts together. The helix assembly, electron gun assembly and collector assembly are held in alignment as separate units by a precision tubular glass envelope snugly fitting the exterior surfaces of the various assemblies. The disadvantages of these methods of mounting the parts are:

1. The helix is usually relatively loose within the rods or fluted tubing, and hence, sensitive to vibration;
2. The close fit required between the parts and the glass envelope occasions fabricating difficulties and high glass breakage;
3. Sauereisen cement has a tendency to chip and crack and is suspected as a source of gas; and
4. The helix assembly has a tendency to slide inside the envelope and get out of position if it is not fixed relative to the electron gun and collector assemblies.

Therefore, the object of the present invention is to devise an improved method or means for mounting the helix and other elements of a traveling wave tube which will not be subject to the above disadvantages.

In accordance with the invention, the helix of a traveling wave tube is mounted coaxially within a tubular dielectric envelope of circular cross-section by means of a plurality of straight longitudinal ceramic rods spaced from the envelope wall and resiliently held coaxially within a plurality of axially spaced support rings which may fit relatively loosely within the envelope. Preferably, the rods are extended beyond the ends of the helix into annular extensions of the electron gun and collector and are

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resiliently held in said extensions, so that the electron gun, the helix and mounting rods and rings, and the collector constitute a unitary assembly.

In the accompanying drawing:

Fig. 1 is a longitudinal sectional view of a traveling wave tube embodying the present invention;

Figs. 2 and 3 are transverse sectional views taken on lines 2-2 and 3-3, respectively, of Fig. 1; and

Fig. 4 is a cross sectional view of a resilient clip used in Figs. 1-3.

The traveling wave tube shown in Fig. 1 comprises a tubular glass envelope 1 of circular cross-section containing an electron gun 3, an elongated helix 5, and a collector 7, in that order. The details of the electron gun 3 and collector 7 are not pertinent to the present invention except that they should have similar cylindrical exterior surfaces 9 and 11 loosely fitting within the envelope 1 and should be designed to project and collect an electron beam coaxial with said surfaces, and hence, coaxial with the envelope 1.

The helix 5, which has an outer diameter much smaller than the inner diameter of the envelope 1, is resiliently mounted coaxially in the envelope 1 between three ceramic rods 13 extending parallel to the axis of the helix by means of two or more axially spaced metal support rings 15 and a plurality of spring clips 17. The clips 17 preferably resemble the letter W in cross section, so that the rods 13 will be positively held thereby in the desired positions around the helix 5, as shown in Figs. 2 and 3.

In assembly, the three rods 13 are located at equal intervals around the helix 5, within one of the support rings 15, and a spring clip 17 is depressed and inserted between each rod and the inside of the support ring. The end tabs of the spring clips 17 may then be welded to the support ring 15. Sufficient pressure is developed between the ceramic rods and the encircling support ring to hold the helix firmly in position. The rods 13 and helix 5 are similarly assembled within the other support ring or rings 15. The exterior surfaces 19 of the support rings 15 should be similar to the surfaces 9 and 11, to fit within the envelope 1.

With the helix 5 and rods 13 mounted within a sufficient number of support rings in the manner described, a self-contained unit or sub-assembly is formed which, when inserted within the envelope 1 between the electron gun 3 and the collector 7, will maintain the helix 5 in satisfactory alignment with the electron gun and collector, if the looseness between the surfaces 9, 11 and 19 and the envelope 1 is not too great. It is preferred, however, to integrate the electron gun, helix unit and collector into a single assembly in the following manner. The exterior shell of the electron gun 3 is provided with an annular extension 21 toward the helix 5, having a length approximately equal to the width of each of the support rings 15 and clips 17. The rods 13 extend beyond the end of the helix 5 into said extension and are resiliently clamped therein by spring clips 23, identical with the clips 17, in the same manner as described above in connection with the support rings 15. To prevent the developed pressure, which holds the assembly together, from breaking off the ends of the rods 13, a close-fitting metal ring 25 is inserted within the rods. The ring 25 may also serve as an accelerating electrode of the electron gun 3.

The collector 7 is also provided with an annular extension 27, similar to the gun extension 21, into which the ends of the rods 13 extend and are clamped by spring clips 29 in the manner described above. A metal ring 31, similar to the ring 25, is provided to support the ends of the rods 13.

It will be understood that in a tube having a short helix the end supports for the rods 13, at the electron

gun 3 and collector 7, may be sufficient, in which case the intermediate support rings 15 may be omitted.

In the particular embodiment illustrated in Fig. 1, the two support rings 15 and the extensions 21 and 27 also serve as high frequency coupling sleeves for coupling the tube to input and output transmission lines. The input and output ends of the helix 5 are connected to the rings 15 by means of antenna conductors 33 extending back over the helix parallel to the axis of the tube, as set forth in the copending application of W. J. Dodds, Serial No. 291,189, filed June 2, 1952, now U. S. Patent No. 2,758,244, issued August 7, 1956. With this type of coupling the tube can be coupled to external waveguides or coaxial resonators. An electrical connection is made between the helix 5 and the electron gun extension 21, which is connected to the accelerating electrode 25, by means of a coil 34 connected to one of the rings 15.

In the final assembly of the tube, the electron gun leads are connected to the terminals of a glass button stem 35, and the assembly of the electron gun 3, helix 5, collector 7 and associated mounting structure is inserted within a section of glass tubing 37. The envelope 1 is completed by sealing the button stem 35 and the collector 7 to the ends of the glass tubing 37. A conventional exhaust tubulation 39 may be carried by the button stem 35.

In a traveling wave tube constructed as described in accordance with the invention, the helix is positively but resiliently held between the ceramic rods, by the spring clips and the support rings and the annular extensions of the electron gun and collector. Moreover, the construction automatically aligns the helix with the electron gun and collector, thus eliminating the necessity of special alignment procedure. The necessity for a closely-fitting precision glass envelope to hold the parts together and in alignment is eliminated, because the parts are aligned independently of the envelope. The fit between the envelope and the cylindrical exterior surfaces of the rings, etc., can be relatively loose to allow greater tolerance in the dimensions and straightness of the glass tubing used for the envelope. Translation of the parts within the envelope is positively prevented. The use of cement, with its attendant disadvantages, is completely eliminated. The time required for assembly of the tube and breakage during assembly and afterward are reduced to a minimum.

What is claimed is:

1. A traveling wave tube including a tubular envelope of circular cross-section, means for projecting an electron beam axially within said envelope, a helical conductor, and means for mounting said conductor coaxial with the path of said beam; said mounting means comprising a plurality of insulating members engaging and extending along the outside of said conductor, a plurality of axially spaced support rings surrounding said insulating members and fitting relatively loosely within said envelope, and spring means interposed between said insulating members and each of said support rings.

2. A traveling wave tube including a tubular envelope containing an electron gun adapted to project an electron beam along a path within said envelope and comprising an annular part coaxially surrounding said path, a helical conductor extending along said path, and means for mechanically connecting said conductor and said electron gun in fixed coaxial relation independently of said envelope comprising at least one support ring surrounding said conductor, a plurality of insulating members engaging and extending along the outside of said conductor and extending into said annular part, and spring means interposed between said insulating members and each of said support ring and said annular part.

3. A traveling wave tube according to claim 2, wherein each of said spring means comprises a separate spring clip interposed between each of said insulating members and each of said support ring and said annular part.

4. A traveling wave tube including a tubular envelope containing an electron gun adapted to project an electron beam along a path within said envelope, a collector in the path of said beam, a helical conductor coaxially surrounding said path between said electron gun and said collector, and means for mounting said electron gun, conductor and collector in fixed coaxial relation independently of said envelope comprising an annular part of each of said electron gun and said collector extending toward said conductor, a plurality of insulating members engaging and extending along the outside of said conductor and extending into said annular parts, and spring means interposed between said insulating members and each of said annular parts.

5. A traveling wave tube according to claim 4, wherein said mounting means further comprises at least one support ring surrounding said insulating members within said envelope intermediate the ends of said conductor, and spring means interposed between said insulating members and said support ring.

6. A traveling wave tube according to claim 5, wherein said annular parts and said support ring fit relatively loosely within said tubular envelope.

7. A traveling wave tube including a tubular dielectric envelope of circular cross-section, means for projecting an electron beam axially within said envelope, a helical conductor, and means for mounting said conductor coaxial with the path of said beam; said mounting means comprising a plurality of insulating members engaging and extending along the outside of said conductor, a pair of support rings surrounding said insulating members and said conductor and fitting within said envelope, and spring means interposed between said insulating members and each of said support rings; each of said support rings being adjacent to said envelope and electrically connected to the adjacent end of said conductor, whereby said rings also serve as coupling elements for coupling said helix to external input and output transmission lines.

8. An electrode sub-assembly, for use in a traveling wave tube, comprising an elongated helical conductor, a plurality of insulating members engaging and extending along the outside of said conductor, a plurality of axially spaced support rings surrounding said insulating members, and a separate spring clip interposed between each of said insulating members and each of said support rings for maintaining said conductor in fixed coaxial relation with said support rings.

9. An electrode sub-assembly according to claim 8, wherein each of said spring clips has a cross-section resembling the letter W.

10. An electrode sub-assembly according to claim 9, comprising three equally-spaced insulating members, whereby said conductor is automatically centered thereby.

11. An electrode sub-assembly according to claim 8, wherein said insulating members are similar cylindrical ceramic rods.

12. An electrode assembly, for use in a traveling wave tube, comprising an electron gun, a helical conductor and means for mechanically mounting said elements together as a single coaxial unit comprising at least one support ring surrounding said helical conductor, an annular part of said electron gun extending toward said conductor, a plurality of insulating members engaging and extending along the outside of said conductor within said support ring and extending into said annular part, and spring means interposed between said insulating members and each of said support ring and said annular part.

13. An electrode assembly according to claim 6, wherein said securing means comprises a separate spring clip interposed between each of said insulating members and each of said support ring and said annular part.

14. An electrode assembly according to claim 12, wherein said helical conductor terminates short of said annular part, and the ends of said insulating members

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are supported by an inner support ring positioned within said annular part.

15. An electrode assembly, for use in a traveling wave tube, comprising an electron gun, a helical conductor and a collector, arranged in that order, and means for mechanically connecting said elements together as a single coaxial unit comprising an annular part of each of said electron gun and said collector extending toward said helical conductor, a plurality of insulating members engaging and extending along the outside of said conductor and extending into said annular parts, and spring means interposed between said insulating members and each of said annular parts.

16. An electrode assembly according to claim 15, wherein said spring means comprise a separate spring clip interposed between each of said insulating members and each of said annular parts.

17. An electrode assembly according to claim 15, wherein said helical conductor terminates short of said annular parts, and the ends of said insulating members are supported by an inner support ring positioned within each of said annular parts.

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18. An electrode assembly, for use in a traveling wave tube comprising an electron gun, a helical conductor and a collector, arranged in that order, and means for mechanically mounting said elements together as a single coaxial unit comprising at least one support ring surrounding said helical conductor, an annular part of each of said electron gun and said collector extending toward said conductor, a plurality of insulating members engaging and extending along the outside of said conductor within said support ring and extending into said annular parts, and spring means interposed between said insulating members and each of said support ring and said annular parts.

References Cited in the file of this patent

UNITED STATES PATENTS

2,602,148	Pierce	July 1, 1952
2,611,102	Bohlke	Sept. 16, 1952

FOREIGN PATENTS

993,491	France	July 25, 1951
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