June 7, 1960 W. E. DANIELSON 2,939,995

TRAVELING WAVE TUBE

Filed May 19, 1958 2 Sheets-Sheet 1

FIG. 1

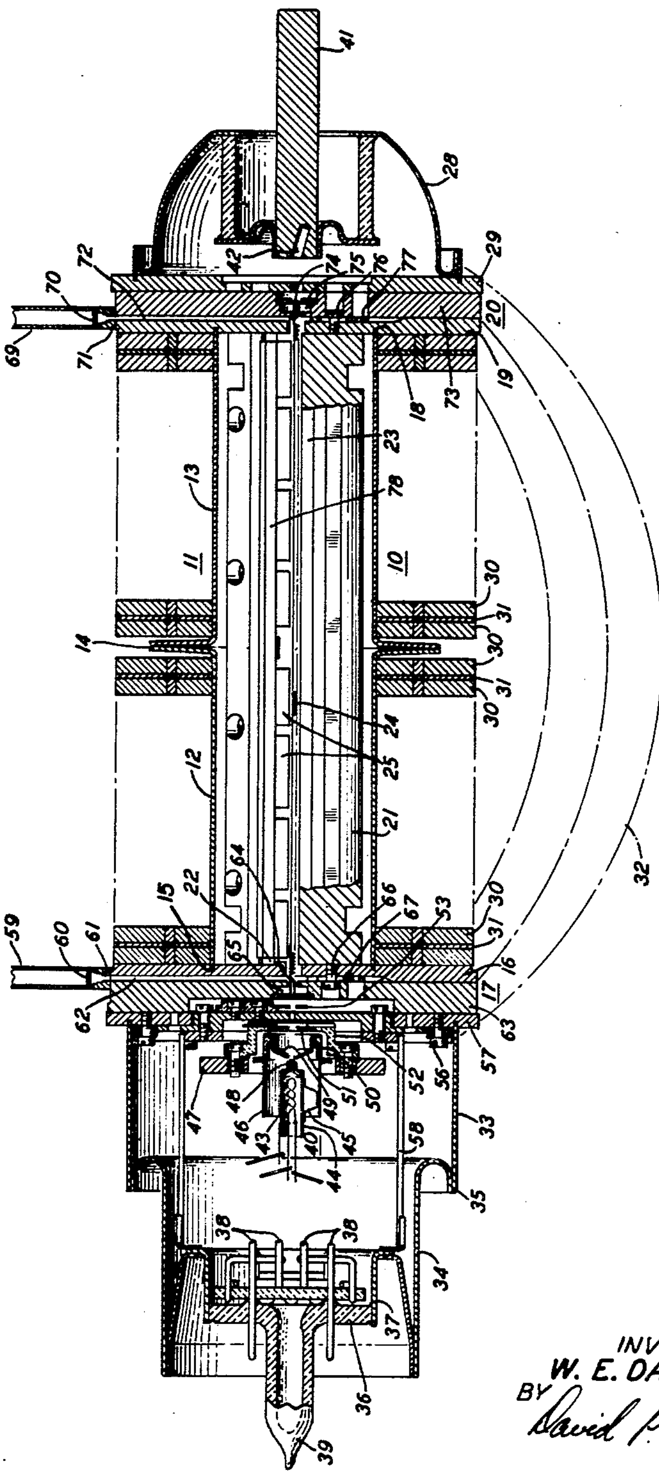

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FIG. 2

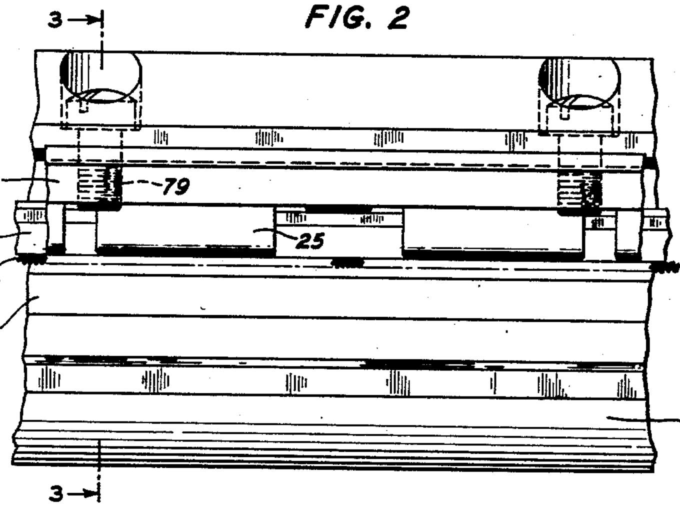
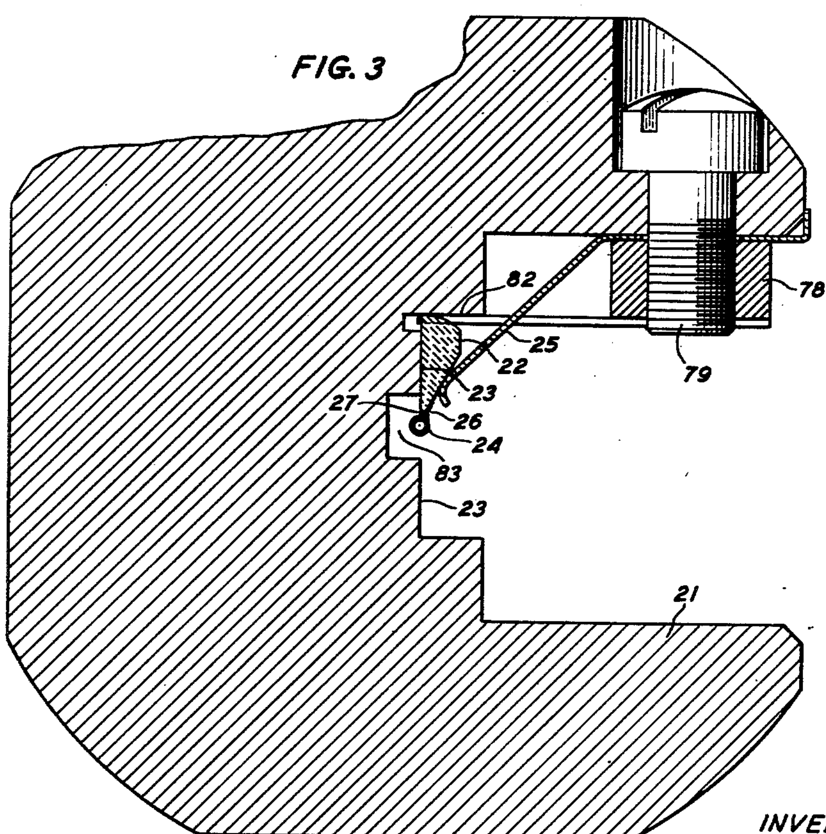


FIG. 3



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TRAVELING WAVE TUBE

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20 Claims. (Cl. 315—3.5)

This invention relates to traveling wave tubes, and more particularly, to a support structure for the wave propagation circuit or helix of such tubes.

In such devices, an electron beam is projected along a slow wave circuit a plurality of wavelengths long, and interaction takes place between the beam and an electromagnetic wave propagating on the circuit in synchronism with the beam over a substantial portion of the length of the circuit. The cumulative interaction between the beam and the wave on the slow wave circuit results in an interchange of energy and produces alternating-current components of electron velocity, known as velocity modulations. During this process, some of the electrons are slowed down while others are speeded up, which produces bunching of the electrons, or density modulations of the beam. These bunches, in turn, interact with another portion of the same circuit, generally to produce amplification of the wave energy.

One of the most commonly used slow wave circuits in traveling wave tubes is a conductive wire helix, the reason being that it lends itself readily to precision grid winding techniques, permits effective wave retardation characteristics to be attained, is compatible with various types of coupling arrangements, exhibits an extremely wide frequency bandwidth because of its nondispersive forward wave characteristics, and permits effective disposition of the beam current over the cross-section of the circuit.

At very high frequencies, effective operation dictates that the helix be of extremely fine dimensions. For example, at a midband operating frequency of 55,000 megacycles, a 2 mil by 4½ mil wire may advantageously be utilized to form a tape helix having a 15 mil inside diameter. These dimensions coupled with the fact that such helices often have a length ranging from 50 to 300 times their diameter makes them very fragile.

It thus becomes apparent that virtually all of the helices utilized in traveling wave tubes, and certainly those designed for high frequency operation, are, because of their small dimensions, very fragile and incapable of self-support. Accordingly, a more rigid support structure for the helix is required to provide suitable rigidity during fabrication and permanent placement of the helix thereafter. Moreover, since the helix diameter is very small, extremely accurate positioning of the helix is required in order to prevent excessive heat caused by impinging electrons from seriously impairing the operation of the device if not rendering the device inoperative. Similarly, even a tolerable amount of heat generated on the helix by either axial misalignment or distortion of the helix would result in a reduction from the maximum attainable efficiency of the device. Further, with the minutely dimensioned helices required at high frequencies, pitch uniformity becomes quite critical, and thus, fragile helices require a supporting structure which minimizes external forces or over-constraining of the helix during assembly as well as thereafter.

Such helix support structures, heretofore, have comprised two basic forms. One conventional form of helix support has been a hollow cylinder of insulative material surrounding the helix, which cylinder often comprises the envelope of the tube. A modification of this arrangement has comprised a long support member having a polygonally-shaped central aperture. In these structures, the helix is normally either bonded, as by glazing, to the centrally apertured member or frictional forces and mechanical clamping are relied upon to hold the helix in place. Examples of such structures are disclosed in F. H. Best Patent 2,706,366, issued April 19, 1955. Disadvantageously, in either of the above-mentioned arrangements, the helix straightness and alignment depend basically upon the uniformity in diameter and alignment of either the hollow tubing comprising the envelope or of the member with the polygonally-shaped central aperture. In addition, neither of the aforementioned types of helix support arrangements allows of the incorporation within the tube of various other elements, such as attenuation means, between the helix and the envelope that often may be desired, nor do such structures by encompassing the periphery of the helix allow for easy measurement of helix straightness. Similarly, and significantly, neither of these helix support arrangements permits the utilization of confined coaxial beam flow whereby one portion of the beam is within and another portion without the periphery of the helix which would result in a substantial increase in signal gain as well as a consequent improvement in the signal-to-noise ratio. This is especially true at very high frequencies where the necessity of an extremely small dimensioned helix drastically limits the value of beam current which may be transmitted axially through the helix in the normal case. Moreover, in multi-contact helix support arrangements a fragile helix is very susceptible to being over-constrained because of the transverse forces set up, particularly during the fabrication of the device.

The second basic type of helix support structure priorly utilized to avoid some of the aforementioned difficulties comprises two or more insulative support rods uniformly spaced in a symmetrical manner about the periphery of the helix and extending along the helix in a direction parallel to the axis thereof. As in the aforementioned structures, the helix is normally either bonded, as by glazing to the support members or frictional forces and/or mechanical clamping are relied upon to hold it in place. Such a structure is disclosed in J. A. Morton Patent 2,790,926, issued April 30, 1957. Disadvantageously, in this type of structural arrangement, as in the case with the first-mentioned helix support arrangements, helix straightness and alignment depend primarily upon accurate dimensioning of a number of interrelated elements, namely, the uniformity in diameter and straightness of the support rods. Since these support members have a longitudinal length considerably greater than their diameter, and because of the type of material utilized, they do not afford the degree of rigidity desired nor are such members of a type conducive to manufacturing techniques which will assure precise dimensioning as matched machined parts. Moreover, in the fabrication of such a helix support structure, over-constraining or transverse stress between the helix and the support rods often tends to distort or weaken the supporting bonds.

A helix support rod arrangement designed to bond more securely the supporting members to the helix as well as to reduce transverse stress during assembly is disclosed in G. H. Robertson Patent 2,812,499, issued November 5, 1957. In that patent, there are disclosed two pairs of ceramic rods, the two pairs being positioned adjacent to the helix at diametrically opposite regions and the rods of each pair being positioned contiguous to each other. The rods are then glazed to the helix in such a way that the glaze fills the volume defined by the arcuate sided triangle between the two contiguous rods and the helix, thereby providing a much stronger bond than is obtained with prior art plural support rod arrangements. However, in this helix support arrangement, as in the foregoing support structures, helix straightness and alignment is dependent basically upon the straightness and uniformity of diameter of a plurality of support rods. Similarly, the support structure does not readily lend itself to easy measurements of helix straightness because of the multi-rod arrangement on opposite sides thereof.

Another significant problem involved in traveling wave tubes, and particularly pertaining to the helix and support structure, is the manner in which thermal heat is transferred away from the helix. As is known, it is quite difficult to attain electron beam transmission efficiencies above 95 or 96 percent with extremely small helices. This means that there are a substantial number of stray electrons which impinge upon the helix generating heat. It is similarly known that interaction between the electron beam and electromagnetic waves results in the amplification of radio-frequency energy, which, in turn, results in heating of the helix. These two sources of heat would normally cause the helix temperature to rise to a point high enough to render the device inoperative if a thermal heat flow path of some sort away from the helix were not provided. The bonds between the helix and support rods in certain of the aforementioned structures are intended to transfer the thermal power from the helix to the rods. However, an effective thermal path from the rods to a suitable heat sink is still required.

One way of accomplishing this transfer of thermal heat from the support rods to a suitable heat sink is disclosed in J. P. Laico Patent 2,772,939, issued December 4, 1956. Therein is disclosed a technique of softening and shrinking a surrounding glass envelope until it makes intimate thermal contact with the support rods. However, the disadvantage with this arrangement is that, as pointed out above, the bonds connecting a number of support rods to the fragile helix set up transverse forces in the helix, which arise through normal handling during fabrication, as well as from the very nature of the multi-element helix support structure. These forces are very likely either to weaken the bonds or actually displace the multi-support rod arrangement and, thus, seriously distort the helix.

An associated problem encountered with minutely dimensioned helices, is the manner in which the direct-current voltage is applied thereto. Heretofore, metallic contact with the fragile helix has been utilized with considerable difficulty often being encountered in preventing a discontinuity in the helix wire at the point of contact.

Accordingly, it is an object of this invention to insure precise and rigid helix alignment in high frequency traveling wave tubes.

It is another object of this invention to minimize over-constraining of a helix during as well as after fabrication of the tube.

It is still another object of this invention to support a helix in a manner which is conducive to known techniques for measuring helix straightness, allows of the incorporation of circuit elements between the helix and the surrounding envelope, and permits the utilization of confined coaxial electron beam flow therealong.

An additional object of this invention is to insure precise and rigid helix alignment after fabrication while simultaneously affording an effective thermal conductance path through which thermal power is transferred away from the helix to a suitable heat sink.

It is still another object of this invention to apply direct-current voltage to a fragile helix without the necessity of metal-to-metal contact therewith.

It is still a further object of this invention to support a fragile helix accurately and rigidly with a structural arrangement of simple and unique design and which may be manufactured with accurate dimensions by conventional machining operations.

In a specific illustrative embodiment of my invention, an electron discharge device of the traveling wave type comprises an evacuated envelope with removable end portions, an elongated slow wave helical conductor disposed longitudinally within the envelope and supported by a single insulative support member extending along a line parallel to the axes of the helix, an electron gun and target positioned beyond opposite ends of the helical conductor for forming and projecting an electron beam along an extended path in close proximity to the helical conductor, signal input and output circuits at opposite ends of the helical conductor and a magnetic focusing system for establishing and shaping a uniform longitudinal magnetic field along the path of electron flow.

In accordance with one aspect of my invention, the helix is rigidly held in precise axial alignment and with pitch uniformity, by a single substantially wedge-shaped insulative helix support rod. Successive turns of the helix are glazed to a narrow edge of the support rod along a line parallel to the axis of the helix. This type of single support rod arrangement minimizes the tendency of the helix to be over-constrained. Moreover, such an open helix support assembly allows for easier measurement of helix straightness as well as permits the utilization of confined coaxial beam flow whereby an annular portion of the beam may be projected on either side of the helix periphery for increased gain. Similarly, with such a helix support arrangement, the helix is held in substantially free-space relationship with respect to its surroundings which makes possible incorporation of circuit elements between the helix and the envelope wall, such as attenuation elements.

In accordance with another aspect of this invention, the single substantially wedge-shaped support rod is seated in an accurately machined step of a rigid metal block, which may form a portion of the envelope. Such a rigid metal block provides a very effective heat sink to which the thermal heat generated on the helix is transferred. Moreover, a helix straightness depends primarily upon the single machined step in the rigid metal block and the straightness and parallelism of the surfaces of the single wedge-shaped support rod member which are in contact with either the metal block or the helix. Advantageously, these surfaces may easily be machined with extreme accuracy by conventional grinding or milling operations.

Conductive spring contacts, in accordance with my invention, produce a pressure contact between flat surfaces of the metal block and the wedge-shaped insulative support rod, which assures adequate thermal conductance away from the helix through the support rod to the metal block while simultaneously providing an effective way to ensure precise and rigid helix alignment during as well as after assembly of the helix.

Further, in accordance with my invention, an applied loss coating on the support rod between the helix and one or more of the conductive spring contacts provides an effective and advantageous way to apply direct-current voltage to the fragile helix. This applied loss coating, which can be of aquadag, for example, may also be utilized to prevent wave reflections and enhance overall stability of the device.

It is a feature of my invention that a fragile traveling wave tube helix be supported by a single support rod, spring mounted on an accurately machined flat surface of a support member.

It is another feature of my invention that the support rod be of substantially wedge shape, the helix being mounted, as by glazing, to the thin edge of the support rod.

It is another feature of my invention that the spring members be mounted on the support member and define, together with a conductive coating on the sloping surface of the support rod, a conductive path for the application of direct-current potentials to the helix. Further in accordance with this feature of the invention, the conductive coating may be of a lossy material.

It is a further feature of this invention that the mounting member be substantially massive relative to the minute fragile helix and comprise a heat sink for the removal of heat from the helix through the large area contiguous surfaces of the support rod and the mounting member, the spring bias of the support rod against the flat surface of the mounting member serving to assure good thermal conductance between these two members.

It is still a further feature of my invention that the mounting member supporting the helix extend continuously between two endplates to which endplates the electron gun and collector assemblies are secured. Further in accordance with this feature of my invention accurate axial alignment of the helix can be attained by radial adjustment of the mounting member between the endplates.

A complete understanding of this invention and of these and other features thereof may be gained from consideration of the following detailed description taken in conjunction with the accompanying drawing, in which:

Fig. 1 is a sectional view of a traveling wave tube amplifier illustrative of one specific embodiment of this invention;

Fig. 2 is a partial sectional view in detail of the helix support structure depicted in Fig. 1; and

Fig. 3 is a cross-sectional view of the helix support structure depicted in Figs. 1 and 2.

Referring now to Fig. 1, there is depicted a traveling wave tube **10**, comprising an elongated evacuated central envelope portion **11**, comprised of two sections **12** and **13**, preferably of non-magnetic material, such as copper, brazed together at a flange **14** as a step in the fabrication of the tube described in greater detail hereinafter. The end of envelope section **12** opposite the flange **14** is positioned within a circular groove **15** in a conductive member **16** of an input endplate assembly **17**, and similarly the corresponding end of envelope section **13** is positioned within a circular groove **18** in a conductive member **19** of an output endplate assembly **20**.

In accordance with an aspect of this invention, there is positioned axially within the envelope portion **11** a metallic block **21** abutting conductive endplate members **16** and **19** of endplate assemblies **17** and **20**, respectively. The conductive block **21** may be of any suitable conductive material, such as molybdenum, as long as it is rigid, has good thermal characteristics, and is machinable. A single substantially wedge-shaped insulative support rod **22**, best seen in Figs. 2 and 3, is seated into an accurately machined step **23** of block **21**, and supports an elongated conductive helix **24**. The single insulative support rod **22** is advantageously of ceramic or other suitable material of low radio-frequency loss and having approximately the same coefficient of thermal expansion as the material comprising the helix **24** so as to minimize pitch distortion during a subsequent heat treating process of the helix before assembly. By way of example, a ceramic known as F–66 Steatite or a material such as synthetic sapphire has been found quite adequate for the purpose intended with a helix made of molybdenum. It is to be understood that while the support rod is shown as being substantially wedge-shaped, other geometric configurations may be utilized with equal effectiveness.

In accordance with another aspect of this invention, one or more conductive spring contacts **25**, brazed to an indented flat surface of the conductive block **21**, best seen in Fig. 3, extend toward and are in contacting relationship with the sloping flat surface of the wedge-shaped insulative support rod **22** ensuring precise and rigid helix alignment after the support rod **22** is positioned within a machined step of the conductive block **21**. Such spring contacts correspondingly afford an effective pressure contact between flat surfaces of the conductive block **21** and support rod **22** which provides an adequate thermal conductance path for transferring heat from the helix **24** through the support rod **22** to the metal block **21**. Any suitable non-magnetic conductive material with a certain amount of spring resiliency and good thermal characteristics may be utilized for the spring contacts **25**, such as a material known as Inconel–X.

Surrounding and extending along the central envelope portion **11** is a succession of apertured magnetic discs **30** of high permeability material separated from each other by aluminum spacers **31** as seen in Fig. 1. The significance of and the patentable features of such an arrangement of magnetic discs are disclosed in a copending application of C. C. Cutler, Serial No. 664,015, filed June 6, 1957. Briefly, these discs constitute a field straightener assembly for straight field permanent magnet structures and effectively remove the stray magnetic fields encountered in the focusing structure so that a strong, straight magnetic field is assured along the path of electron flow. The straight magnetic field is established by a permanent magnet structure **32**, shown in partial section in Fig. 1 as being semicircular, however, it is to be understood that other shapes and types of magnetic focusing systems may be utilized with equal effectiveness.

On the side of input endplate assembly **17** opposite the helix **24** is another evacuated envelope portion comprised of two sections **33** and **34** brazed together at an overlapping region **35**. These envelope sections may be of the same non-magnetic material as central envelope portion **11**. Enclosing the extreme end of this evacuated portion is a suitable insulative base **36**, such as glass or ceramic, or a combination thereof, brazed along the outer periphery to one end of a support member **37**. Insulative base **36** supports a plurality of lead stem connections **38**. For convenience and simplicity, the connections from a suitable voltage source through the lead connections **38** to to the various tube elements are not shown. An exhaust tubulation **39** extends from the insulative base **36** allowing for the evacuation of the envelope after assembly of the tube elements, described in more detail hereinafter.

Attached to the input endplate assembly **17** opposite the helix **24** is an electron gun assembly **40** for forming and projecting an electron beam along an extended path past the helix **24** to a target **41** which has an inclined cavity **42** therein for minimizing secondary emission effects. An evacuated envelope portion **28** encloses the collecting portion of target **41** and is brazed to a conductive member **29** forming a part of output endplate assembly **20**. The electron gun **40** comprises a heater element **43** enclosed by a conductive cathode sleeve **44**. The heater element **43** and cathode sleeve **44** are positioned axially with respect to the helix **24** by a number of wire-like members **45** in contact with an outer cylindrical member **46** which is brazed to a ceramic support member **50**. At the end of cathode sleeve **44** is the emitting surface **48** of the cathode and positioned in axial alignment therewith is a beam forming electrode **49** also held in spaced relationship by the ceramic member **50**. A beam accelerating electrode **51** is held in spaced axial relationship with respect to the electron beam by an insulative member **52**. A beam shaping electrode **53** is positioned between the accelerating electrode **51** and the input end of helix **24** so as to remove any stray electrons from the path of flow before the beam enters the magnetic focusing region along the helix. Excessive heating of the fragile helix normally caused by impinging electrons is thereby minimized.

Advantageously, the electron gun assembly **40** is arranged so that the entire unit is held in proper position on the side of endplate assembly **17** opposite the helix **24** by a plurality of fastening screws **56** arranged in a symmetrical circular manner near the outer edge of pole piece member **57** which is a part of endplate assembly **17**. Two or more conductive spacer rods **58** together with the support member 57 to which they are attached securely hold the insulative base member 36 in spaced axial relationship with respect to the electron gun assembly 40 before assembly of or during removal thereafter of envelope sections 33 and 34. With this arrangement, it becomes apparent that one can replace a defective electron gun assembly 40 with a completely new gun assembly, for example, by the simple expedient of reducing the vacuum, then removing the envelope sections 33 and 34 by known techniques and then removing the fastening screws 56 which attach the electron gun assembly 40 to the input endplate assembly 17.

An external input waveguide section 59 is connected through a suitable mica window 60 to a tapered waveguide section 61 for establishing the proper impedance transformation to a reduced size internal input waveguide passage 62 formed between the conductive member 16 and a conductive member 63, both being integral parts of input endplate assembly 17. A quarter wave conductive sleeve 64 extends across a mid-band resonant cavity 65 for effecting an efficient input coupling impedance match. Similarly, an adjustable member 66 varies the position of a metal block 67 within the extended portion of the internal waveguide passage 62 so as to obtain a suitable impedance match between the guide and the helix. A similar configuration is utilized at the output end of helix 24. An output section 69 is coupled through a mica window 70 to a tapered waveguide section 71 for establishing the proper impedance transformation to a reduced size internal output waveguide passage 72 formed between the conductive member 19 and member 73 of output endplate assembly 20. A quarter wave conductive sleeve 74 extends across a mid-band resonant cavity 75 for effecting an efficient output coupling impedance match. An adjustable member 76 varies the position of a metal block 77 within the extended portion of the internal waveguide passage 72 so as to obtain a suitable impedance match between the helix and the output guide.

As seen in Fig. 2, the spring contacts 25 may be of considerable longitudinal length; and as shown in Fig. 3, they are in contact with the wedge-shaped support rod 22 along the flat tapering side thereof. The spring contacts 25 are securely positioned between a flat surface of the rigid metal block 21 and a longitudinally extending conductive member 78 abutting thereagainst under compression of fastening elements 79. As also seen in Fig. 3, the substantially wedge-shaped support rod 22 is seated along an accurately machined step 23 of the conductive block 21 which assures precise axial alignment of the narrow edge of support rod 22 in contact with the helix 24; support rod 22 also bears against side wall 82 of the block 21. The support rod 22 is attached to the helix 24 by a thin glaze 27, seen in Fig. 3, which may comprise any of the known glazing materials utilized for such purposes; as can be seen the helix is thus situated in a groove 83 in the block 21. The helix 24 is thus glazed to a narrow edge of the support rod 22 defined between the surface of the rod 22 abutting step 23 and the sloping surface of the rod 22 against which the springs 25 bear. This edge at the intersection of the two surfaces will have a finite width but may advantageously be quite small.

Similarly, in accordance with another aspect of this invention, a thin coating of lossy material 26, such as aquadag, as applied to certain portions of the single support rod 22 where one or more of the spring contacts 25 are in contacting relationship therewith. Preferably, as seen in Fig. 3, this coating 26 is applied to the support rod 22 over a short longitudinal region near the center thereof between the helix 24 and the one or more spring contacts 25. In this manner, the applied loss coating will not only afford an effective and advantageous way to apply direct-current voltage to the fragile helix 24, but will minimize the tendency of self-oscillation and thereby increase the operating stability of the tube in general.

In fabricating the helix support assembly, the helix is wound upon a mandrel by any known method, with the mandrel being of a material such as copper, if the helix is of a material such as molybdenum which would permit the mandrel to be dissolved chemically before heat treatment. Alternatively, the mandrel might be of the same or similar material as the helix 24 having approximately the same coefficient of thermal expansion if the mandrel is to support the helix during a subsequent normalizing heat-treating process so as to minimize distortion of the helix pitch. Similarly, the single insulative support rod 22 should have a coefficient of thermal expansion approximately equal to that of the helix material as should be glaze 27 utilized to bond the helix 24 to the support rod 22.

The glaze 27 is then applied to the support rod 22 along a line coinciding with the area to be in contact with the periphery of the helix by spraying or any of the other known methods. Similarly, the applied loss coating 26, such as aquadag, is applied to the surface of the insulative support rod 22 between the helix 24 and one or more of the spring contacts 25, preferably along a short intermediate length of the helix in accordance with principles of this invention. The helix assembly is then positioned in a suitable jig, not shown, and the helix heat treated to normalize the stress set up in the winding process as well as to bond the helix to the support rod by melting the glaze material 27. The mandrel is then removed, if not previously removed, and the single insulative support rod 22 and the helix 24, as an integral unit, is placed in the accurately machined step 23 of the conductive block 21, firmly held in place by the spring contacts 25.

The complete helix support assembly, including the metal block 21, is then attached to the input endplate assembly 17 by a plurality of suitable fastening screws, not shown. The two intermediate envelope sections 12 and 13, to be subsequently brazed at the flange 14, together with the permeable magnetic discs 30 and aluminum spacers 31 coaxially therewith, are positioned to surround the metal block 21. One end of envelope section 12 is positioned within the circular groove 15 of the conductive member 16 which comprises an integral part of input endplate assembly 17. The output endplate assembly 20 is then attached to the other end of the conductive block 21 by means of a plurality of suitable fastening screws, not shown. The envelope section 13 is then fitted within the circular groove 18 of conductive member 19 which is an integral part of the output endplate assembly 20.

Advantageously, pole piece member 57 of input endplate assembly 17 and pole piece member 29 of output endplate assembly 20 may, before being permanently secured, be adjusted axially until, as determined by known optical techniques, they are suitably aligned with respect to the helix. Similarly, the gun assembly 40 may be adjusted axially by means of the fastening elements 56 to insure precise alignment with respect to the helix before final assembly of the device.

Fabrication of the helix assembly in this manner advantageously results in a minimum of stress being placed upon the input and output endplate assemblies as the flange 14 of envelope portion 11 is capable of being compressed slightly so as to adjust readily to the exact longitudinal length between the two endplate assemblies 17 and 20 defined by the longitudinal length of the conductive block 21. The gun assembly 40 may then be attached to the input endplate assembly 17, if not previously attached thereto by the fastening screws 56. The insulative base 36 is then attached to the input endplate assembly 17 by means of the support member 37 and the spacer rods 58. Envelope sections 33 and 34 are then positioned to enclose the gun assembly 40 and envelope portion 28 is positioned to enclose the output target end portion of the tube 10. The various flanges, regions of overlap between the various envelope portions and points at which the envelope sections are abutting the input and output endplate assemblies are brazed, such as by the heliarc process.

It is to be understood that the specific embodiment disclosed and the method of fabrication described herein are merely illustrative of the principles of the instant invention. Numerous other arrangements and variations in fabrication could be devised by those skilled in the art without departing from the spirit or scope of the invention.

What is claimed is:

1. A traveling wave tube comprising an evacuated envelope, an electron gun and collector spaced apart within said envelope, a slow wave propagation circuit positioned axially therebetween, and means for accurately aligning and supporting said wave propagation circuit in substantially free space relationship with respect to said envelope, said means including a wedge-shaped insulative support member, one edge of which is glazed to said wave propagation circuit along the length thereof, a rigid conductive member extending longitudinally along said support member and having means for aligning said support member, means for retaining the alignment of said support member with respect to said longitudinally extending conductive member and simultaneously providing a portion of a conductive direct-current voltage path between said conductive member and said wave propagation circuit, and low resistance means for completing the conductive direct-current voltage path between said conductive member and said wave propagation circuit.

2. A traveling wave tube in accordance with claim 1 wherein said wave propagation circuit comprises a helix and said conductive member comprises a metal block having a flat surface extending longitudinally of and in contiguous relationship with one surface of said substantially wedge-shaped support member.

3. A traveling wave tube in accordance with claim 2 wherein said means for retaining the alignment of said support member with respect to said metal block and for simultaneously providing a portion of a conductive direct-current voltage path comprises at least one metal spring contact between said metal block and said support member, respectively, and said low resistance means for completing the direct-current voltage path comprises an applied loss coating on said support member.

4. A traveling wave tube comprising an evacuated envelope, an electron gun and collector spaced apart within said envelope with a slow wave propagating helix positioned in axial alignment therebetween, and means for accurately aligning and supporting said helix, said means including an elongated wedge-shaped insulative support rod, one edge of which is glazed to successive turns of said helix along the length thereof, a conductive block extending longitudinally of said support rod and having means for aligning said support rod, and means for retaining the alignment of said support rod with respect to said conductive block and simultaneously providing a portion of a conductive path through which direct-current voltage is applied to said helix.

5. A traveling wave tube in accordance with claim 4 wherein said last-mentioned means comprises at least one metal spring contact extending between said conductive block and said support rod and further including a short longitudinal region of applied loss coating along the intermediate portion of said insulative support rod between the helix and at least said one metal spring contact for completing the conductive path through which direct-current voltage is applied to said helix.

6. A traveling wave tube comprising an evacuated envelope, an electron source and collector spaced apart within said envelope with a slow wave propagating helix positioned in axial alignment therebetween, means for accurately aligning and supporting said helix, said means including an elongated wedge-shaped insulative support rod, one edge of which is glazed to successive turns of said helix along the length thereof, a conductive block having means for aligning said support rod, said means comprising an accurately machined step extending longitudinally of said conductive block, and means for securely holding said support rod in said step and simultaneously providing a portion of a conductive path for applying voltage to said helix, said last-mentioned means including at least one metal spring contact between said conductive block and said support rod, respectively, and resistance means for completing said conductive path for applying voltage to said helix.

7. A traveling wave tube in accordance with claim 6 wherein said resistance means for completing said conductive path for applying voltage to said helix comprises a short longitudinal region of applied loss coating along the intermediate portion of said insulative support rod between the helix and at least said one metal spring contact.

8. A traveling wave tube comprising a helix and means for supporting said helix, said means comprising a support member having a flat surface, a substantially wedge-shaped insulating support rod having a first surface abutting said flat surface and a second surface at an angle to said first surface, said helix being secured to said support rod along the edge intersection of said first and second surfaces, and spring means mounted on said support member and bearing against said second surface to position said support rod against said flat surface.

9. A traveling wave tube in accordance with claim 8 wherein said support member is of a conducting material, and conducting means on said second surface and contiguous to said helix, said spring means and said conducting means defining an electrical connection between said support member and said helix for applying a direct-current potential to said helix.

10. A traveling wave tube in accordance with claim 9 wherein said conducting means comprises a coating of a lossy material.

11. A traveling wave tube comprising a conductive helix and means for supporting said helix, said means comprising a conductive support member having a flat surface and a side surface at an angle to said flat surface, an insulating support rod having a first surface abutting said flat surface and a sloping surface at an angle to said first surface, said conductive helix being secured to said support rod along the edge intersection of said first and sloping surfaces, and spring means mounted on said support member and bearing against said sloping surface and biasing said support rod against said flat and side surfaces.

12. A traveling wave tube comprising a helix and means for supporting said helix, said means comprising a conductive support member having a flat surface, a side surface to one side of said flat surface, and a groove to the other side of said flat surface, an insulating support rod having a first surface abutting said flat surface and a sloping surface at an angle to said first surface, said helix being secured to said support rod along the edge intersection of said first and sloping surfaces and positioned in said groove, and spring means mounted on said support member and bearing against said sloping surface and biasing said support rod against said first and side surfaces.

13. A traveling wave tube in accordance with claim 12 wherein said spring means comprises a plurality of wide flat spring members.

14. A traveling wave tube in accordance with claim 13 further comprising lossy conductive means positioned on said sloping surface and electrically connecting said spring means to said helix whereby direct-current potentials can be applied to said helix from said support member.

15. A traveling wave tube comprising a helix and means for supporting said helix along its entire length,

said means comprising a support member at least coextensive with said helix and extending adjacent thereto, said support member having a flat surface, an insulative support rod having a flat portion positioned on said flat surface, said helix being attached to said support rod, and spring means mounted on said support member and biasing said support rod against said flat surface.

16. A traveling wave tube comprising a slow wave propagation circuit and means for supporting said circuit along its entire length, said means comprising a conductive support member at least coextensive with said slow wave circuit and extending adjacent thereto, said support member having a plane surface, an insulative support member having a surface extending along and in contiguous relationship with said plane surface, said slow wave propagation circuit being secured to said insulative support member, and means mounted on said support member and biasing said insulative support member against said conductive support member.

17. A traveling wave tube comprising a first endplate member, a second endplate member, a conductive support member extending between said endplate members and contiguous thereto, said conductive support member having a flat surface, an insulative support member positioned on said flat surface, a slow wave propagating circuit secured to said insulative support member, spring means biasing said insulative support member against said conductive support member, electron gun means to the opposite side of said first endplate member than said wave propagating circuit, electron collector means to the opposite side of said second endplate member than said wave propagating circuit, and means for securing said conductive support member to said endplate members after radial adjustment of the position of said conductive support member.

18. A traveling wave tube in accordance with claim 17 further comprising a first metallic envelope portion around said conductive support member and secured to said first endplate member and a second metallic envelope portion around said conductive support member and secured to said second endplate member, said metallic envelope portions having abutting deformable flanges.

19. A traveling wave tube comprising a first and second endplate, a substantially massive conductive support member extending between said endplates and adjustably secured thereto, said conductive member having a longitudinal groove therein and a flat surface longitudinally extending adjacent said groove, a substantially wedge-shaped insulating support member having a first surface on said flat surface and a sloping surface at an angle to said first surface, a small conductive wire helix mounted by said insulating support member at the edge intersection of said first and sloping surfaces and positioned in said groove, spring means bearing against said sloping surface and biasing said first surface against said flat surface, electron gun means mounted by said first endplate to the other side thereof than said conductive support member, and electron collector means mounted by said second endplate to the other side thereof than said conductive means.

20. A traveling wave tube in accordance with claim 19 further comprising a conductive lossy coating on said sloping surface continuous to said helix and said spring means for applying a direct-current potential to said helix from said conductive support member.

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