June 28, 1960 H. L. LEVIN 2,943,227

ELECTRON GUN SUPPORT

Filed July 6. 1956

Fig. 1

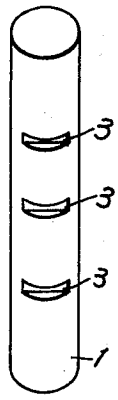


Fig. 2

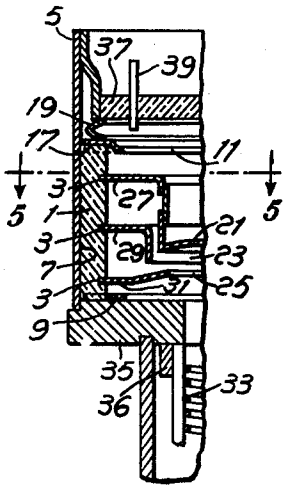


Fig. 3

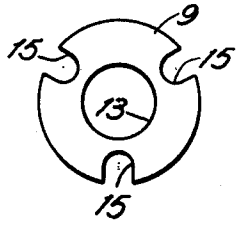


Fig. 4A

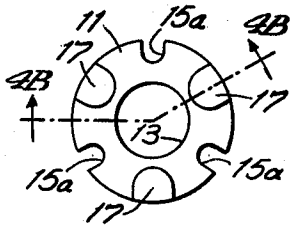


Fig. 4B

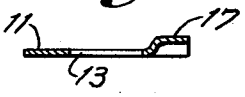


Fig. 6

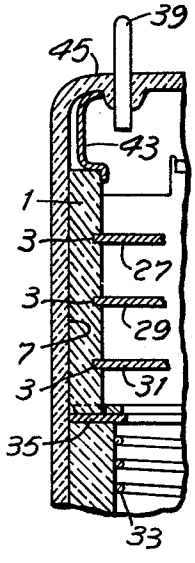


Fig. 7

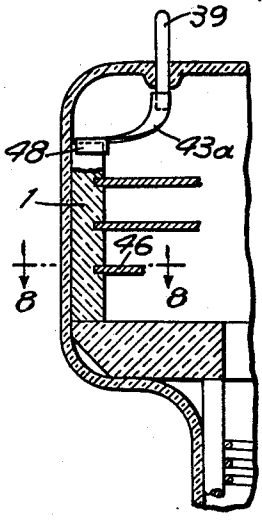


Fig. 5

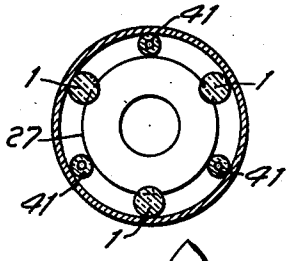
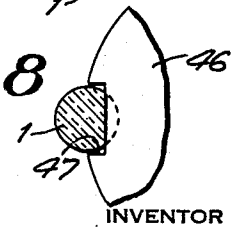


Fig. 8



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United States Patent Office 2,943,227 Patented June 28, 1960

2,943,227

ELECTRON GUN SUPPORT

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Filed July 6, 1956, Ser. No. 596,331

9 Claims. (Cl. 315—3.5)

This invention relates to an electron gun support and in more particular to means and methods for supporting electron gun elements.

Electron discharge devices in the nature of traveling-wave tubes and the like have electron gun structures which must be accurately positioned within the tube housing with respect to the centerline of the magnetic field. Further, the electron gun elements which go to make up the electron gun assembly must be accurately positioned with respect to each other, not only when assembled, but when the tube is in operation. Failure to maintain these accuracies produces faulty operation of the tubes with its inherent distortion and shortened life.

Traveling-wave tubes generally comprise two features, namely, a helix for producing a slow electromagnetic field along the helix with a corresponding longitudinal electric field, and an electron beam flow along the helix axis at the central portion thereof. Any circuit capable of propagating a slow electromagnetic wave can be used as a traveling-wave tube. The circuit most often associated with the traveling-wave tube is the helix, inasmuch as it is easy to construct and is a good circuit with high impedance and constant phase velocity over a wide frequency range. However, these advantages are seriously affected when the electron gun is not properly aligned with the helix, i.e., the centerline of the magnetic field.

Therefore, it is one object of this invention to provide an improved electron gun structure for an electron discharge device.

Other objects of this invention are to provide an improved support for electron gun elements; to provide electron gun supports which are compact, easily fabricated, and rugged; to provide electron gun supports which maintain critical alignment and spacing of the gun elements relative to each other and a traveling-wave tube helix; to provide an electron gun support void of cements and brazing materials for supporting the gun elements; and to provide an electron gun support for reducing the electron gun size and allowing closer spacing of the gun elements.

Further objects, aspects and advantages of the invention together with the organization and method of operation of the invention may best be understood by reference to the following description taken in connection with the accompanying drawings, wherein:

Fig. 1 shows a ceramic rod, according to an embodiment of the invention with a plurality of slots cut transverse to the rod axis;

Fig. 2 shows a partial section of a metal type traveling-wave tube with the electron gun elements and supports therefor, according to the invention herein;

Fig. 3 shows a retainer washer, useful in Fig. 2, for positioning the ceramic rod members of Fig. 1;

Figs. 4A and 4B show a retainer washer, useful in Fig. 2 at the opposite extremity from the washer shown in Fig. 3, for positioning the ceramic rod members of Fig. 1, Fig. 4B being taken along line B—B of Fig. 4A;

Fig. 5 shows the section along the line 5—5 of Fig. 2;

Fig. 6 shows a partial section of a glass type traveling-wave tube with the electron gun elements and supports therefor, according to another embodiment of the invention;

Fig. 7 shows a partial section of a glass type traveling-wave tube with the electron gun elements and supports therefor, according to still another embodiment of the invention; and

Fig. 8 is a sectional view taken along line 8—8 of Fig. 7.

Throughout the specification and drawings, wherever it is possible to facilitate a better understanding of the invention, all like parts and/or members will be given like designation numbers or references.

Now referring in more detail to Figs. 1 and 2, there is shown an insulated rod-like member **1**, made preferably from ceramic material or other material having a very low coefficient of expansion, and which is rugged, durable and highly resistant to heat. The rod **1**, has a series of sequentially spaced slots or grooved portions **3**, cut transverse to the rod axis a predetermined depth, the said slots having a thickness in the axial direction to receive the edge portions of the electron gun elements. In Fig. 2, a partially sectioned metal envelope **5** is shown and the electron-gun elements mounted therein according to one embodiment of the invention.

The ceramic rods **1** are longitudinally positioned in the gun portion of the tube envelope **5** bearing against the inner cylindrical surface **7** thereof. The rods **1** are fixedly held in their spatial relation to each other, in their circuital orbit, by a pair of retainer washer members **9** and **11**, shown in Figs. 3, 4A and 4B. The retainer **9** is an annular disc member, preferably of metal, having an aperture **13** at its central portion, and three circularly notched portions **15** circumferentially spaced in equal degrees, the notched portions being adapted to fixedly engage the ceramic rod members **1**. The retainer washer **11** is an annular disc member, similar to retainer member **9** but with offset portions **17** which partially encompass the ceramic rods, when operatively mounted in the tube envelope, with spring loading by one or more compressive resilient members **19**. The retainer washer member **11** is mounted to the ceramic rods at their uppermost portions, whereas the retainer washer member **9** is fixedly positioned to partially encompass the lower extremity of the ceramic rod members.

The electron gun assembly of the traveling-wave tube, of Fig. 2 comprises a cylindrically apertured cathode electrode **21**, a cylindrically apertured control grid electrode **23** and an annular accelerating electrode **25**, all axially aligned with each of the corresponding electrodes having radially extending flanges **27**, **29** and **31**, respectively, which flanges slidably engage the slotted portions **3** of the ceramic rod members **1**. The depth of the slotted portions **3** determines and fixes the radial positioning of each of the electrodes whereas the longitudinal spacing of the slots governs the axial positioning of the electrodes in their vertical alignment array. For proper and efficient operation of the tube, the electron gun elements must be accurately positioned both axially and radially, a factor which makes the type of construction herein contemplated by this invention very useful and expedient. The slotted portions make possible the proper alignment of the respective electron gun elements with respect to each other but also make for the proper concentric alignment of the electron gun elements with respect to the traveling-wave tube helix **33** and the axis thereof. Further, the unique slotted features makes for fast and easy mounting of the gun electrodes, together with the retainer washer member, to form a compact and accurate assembly. There is no need here for great skill

in positioning the elements nor is there any need for the application of cement or brazing to cause the said elements to adhere to the mounting ceramic rods **1**, a factor which makes for closer spacing of the elements and a resulting reduction in the size of the electron gun length. The complete electron gun assembly is then simply positioned within the tube envelope **5**, fixing the assembly so that the rods lie adjacent the cylindrical inner surface **7** of the tube along their respective tangential surfaces, and the rod surface extremities or bases engage the axial reference surface of tube member **35**. The tube member **35** is an annular member to which is attached a concentric helix holding device **36** for structurally holding and maintaining the helix **33** in axial alignment. In this embodiment the member **35** is preferably of magnetic material to function as a flux path. The electron gun assembly is fixedly held in its operative position by the resilient spring members **19** which repose between the retainer **17** and the tube stem **37**, and compressively causes the rod members of the assembly to fixedly maintain their position within the tube housing.

Fig. 5 shows a section through the line **5—5** of Fig. 2, illustrating the circumferential spacing of the rod members **1** and how the gun elements repose on the slotted portions **3** of the said rod members. The gun elements are externally connected by means of leads which connect to the stem pins **39** of stem **37** and are insulated by insulating tube members **41** which extend through cutouts **15A** in washer **11**.

Figs. 6 and 7 show other embodiments of the invention wherein glass envelopes are used instead of the metal type shown in Fig. 2. In Fig. 6, the compressive resilient member **43**, interposed between the tube stem **45** and rod member **1**, directly engages the upper end portion of the rod **1**, and causes the said rod and assembly of which it is a constituent part, to fixedly maintain its position relative to the tube envelope and the helix axis thereof. In both Figs. 6 and 7, the base members **35** may be different both in shape and material to accommodate different type helix members and envelopes, but the positioning of the electron gun assembly in each instance is the same, merely setting the assembly within the envelope so that it sets on the base and then applying the resilient members **43** and **43A** so that the assembly becomes rigidly fixed.

In Fig. 7 one or more of the gun elements such as **46** may be shaped to also serve as a positioning retainer for rods **1**. The element is provided with notched portions **47** to partially encompass the rod and also to be received in the groove **3**.

The resilient compressive elements **19**, **43** and **43A** may be formed in various shapes and arrangements. For example, the element **19** may be a U-shaped wire or ring and where a ring shape is used it may be corrugated to provide spring action. The element **43** may be cup-shaped and include longitudinal slots so that one segment would bear on the end of a rod **1** while adjacent segments engage the sides of the rod for positioning purposes. The element **43A** is made of sheet stock, one end of which is turned to clamp onto the stem lead **39** while the other end is kept flat for spring action and provided with flange-like tabs **48** to engage the sides of the rod.

Although only certain embodiments of the invention have been shown, the invention is not to be strictly limited thereto. That the electron gun element support members may take on various other type forms, sizes and shapes, e.g. square rods, etc., and that the slot portions may also have various and other type configurations than that illustrated in the drawings, is obvious. Although in the embodiments herein, a traveling-wave tube is illustrated, the invention is not limited thereto, but other types of electron discharge devices which embody the principle of electron gun structures as herein contemplated may make use of the invention as herein described.

I claim:

1. An electron discharge device comprising a vacuum envelope, the inner surface of said envelope providing a reference surface lengthwise of said envelope, a stem reference member disposed transversely of said envelope and bearing against said reference surface, a base reference member disposed transversely of said envelope spaced from said stem reference member and bearing against said reference surface, an electrode assembly including at least three insulating rods interposed between said stem reference member and said base reference member and sequentially spaced in a circular array, each of said rods bearing against said reference surface along the entire length of said rods, and a plurality of electron beam forming electrodes disposed in parallel relation to said reference members and mounted on said rods in a predetermined spaced relationship therealong for axial alignment, said rods and said reference surface providing radial alignment for said electrodes, and resilient compressive means interposed between one of said reference members and the adjacent end of each of said rods to fixedly position said assembly in said envelope by forcing the other end of each of said rods to bear against the other of said reference members.

2. An electron discharge device comprising a vacuum envelope, the inner surface of said envelope providing a reference surface lengthwise of said envelope, a stem reference member disposed transversely of said envelope and bearing against said reference surface, a base reference member disposed transversely of said envelope spaced from said stem reference member and bearing against said reference surface, an electrode assembly including at least three insulating rods interposed between said stem reference member and said base reference member and sequentially spaced in a circular array, each of said rods bearing against said reference surface along the entire length of said rods, and a plurality of electron beam forming electrodes disposed in parallel relation to said reference members and mounted on said rods in a predetermined spaced relationship therealong for axial alignment, said rods and said reference surface providing radial alignment for said electrodes, and resilient compressive means interposed between said stem reference member and the adjacent end of each of said rods to fixedly position said assembly in said envelope by forcing the other end of each of said rods to bear against said base reference member.

3. An electron discharge device comprising a vacuum envelope, the inner surface of said envelope providing a reference surface lengthwise of said envelope, a stem reference member disposed transversely of said envelope and bearing against said reference surface, a base reference member disposed transversely of said envelope spaced from said stem reference member and bearing against said reference surface, an electrode assembly including at least three insulating rods interposed between said base reference member and sequentially spaced in a circular array, each of said rods bearing against said reference surface along the entire length of said rods, each of said rods having a plurality of partially grooved portions disposed transversely of the longitudinal axis of said rods, and a plurality of electron beam forming electrodes disposed in parallel relation to said reference members and mounted on said rods in a predetermined spaced relation therealong for axial alignment, said rods and said reference surface providing radial alignment for said electrodes, said electrodes including annular portions, the circumference of said annular portions being received in the grooved portions of said rods, and resilient compressive means interposed between one of said reference members and the adjacent end of each of said rods to fixedly position said assembly in said envelope by forcing the other end of each of said rods to bear against the other of said reference members.

4. An electron discharge device according to claim 3,

wherein at least one of said electrodes includes notched portions adapted to partially encompass each of said rods to position each of said rods in said circular array.

5. An electron discharge device comprising a vacuum envelope, the inner surface of said envelope providing a reference surface lengthwise of said envelope, a stem reference member disposed transversely of said envelope and bearing against said reference surface, a base reference member disposed transversely of said envelope spaced from said stem reference member and bearing against said reference surface, an electrode assembly including at least three insulating rods interposed between said stem reference member and said base reference member and equally spaced in a circular array, each of said rods bearing against said reference surface along the entire length of said rods, each of said rods having a plurality of partially grooved portions disposed transversely of the longitudinal axis of said rods, and a plurality of cylindrically apertured electron beam forming electrodes having radially extending flanges thereon, the flange portions slidably engaging the grooved portions of said rods to position said electrodes in parallel relation to said reference members and in a predetermined spaced relationship along said rods for axial alignment, said rods and said reference surface providing radial alignment for said electrodes, means for fixedly retaining said rods in their equally spaced circular array, and resilient compressive means interposed between said stem reference member and the adjacent end of each of said rods including said fixedly retaining means to fixedly position said assembly in said envelope by forcing the other end of each of said rods to bear against said base reference member.

6. A traveling wave tube having a helix comprising a vacuum envelope, the inner surface of said envelope providing a reference surface lengthwise of a portion of said envelope, a stem reference member disposed transversely of said envelope and bearing against said reference surface, a base reference member disposed transversely of said envelope spaced from said stem reference member and bearing against said reference surface, an electrode assembly including at least three insulating rods interposed between said stem reference member and said base reference member and circumferentially spaced equally in a circular array, each of said rods bearing against said reference surface along the entire length of said rods, each of said rods having a plurality of slotted portions in transverse relation to the longitudinal axis of said rods, and a plurality of cylindrical, apertured, electron beam forming electrodes having radially extending flanges thereon, a circumferential portion of said flanges slidably engaging said slotted portions of said rods to mount said electrodes in parallel relation to said reference members and in a predetermined spaced relationship along said rods for axial alignment, said rods and said reference surface providing radial alignment of said electrodes with respect to said helix and each other, means for fixedly retaining said rods in their equally spaced circular array, and resilient compressive means interposed between said stem reference member and the adjacent end of each of said rods including said fixedly retaining means to fixedly position said assembly in said envelope by forcing the other end of each of said rods to bear against said base reference member.

7. A support for electron beam forming electron gun electrodes in an electron discharge device comprising a vacuum envelope, the inner surface of said envelope providing a reference surface lengthwise of said envelope, a stem reference member disposed transversely of said envelope and bearing against said reference surface, a base reference member disposed transversely of said envelope spaced from said stem reference member and bearing against said reference surface, at least three insulating rods interposed between said stem reference member and said base reference member, each of said rods bearing against said reference surface along the entire length of said rods, each of said rods having a plurality of partially grooved portions in transverse relation to the longitudinal axis of said rods, means including said partially grooved portions for supporting said gun electrodes in parallel relation to said reference members and in a predetermined spaced relationship along said rods for axial alignment, said rods and said reference surface providing radial alignment for said electrodes, means having spaced recesses therein to engage one end of each of said rods contiguous with said stem reference member and means having spaced recesses therein to engage the other end of said rods in contiguous relation with said base reference member, both of said last-mentioned means fixedly positioning said rods and said gun electrodes in said envelope.

8. A support for electron beam forming electron gun electrodes in an electron discharge device comprising a vacuum envelope, the inner surface of said envelope providing a reference surface lengthwise of said envelope, a stem reference member disposed transversely of said envelope and bearing against said reference surface, a base reference member disposed transversely of said envelope spaced from said stem reference member and bearing against said reference surface, at least three circularly spaced insulating rods interposed between said stem reference member and said base reference member, each of said rods bearing against said reference surface along the entire length of said rods, each of said rods having a plurality of slotted portions in transverse relation to the longitudinal axis of said rods, means including said slotted portions for mounting said electron gun electrodes in parallel relation to said reference members and in a predetermined spaced relationship along said rods for axial alignment, said rods and said reference surface providing radial alignment for said electrodes, said gun electrodes including flanged portions having circumferentially spaced recesses therein to encompass a portion of said rods and engage said slotted portions to fixedly retain the circularly spaced position of said rods, and resilient compressive means interposed between one of said reference members and the adjacent end of each of said rods cooperating with said recessed flanges for fixedly positioning said rods and said electrodes in said envelope by forcing the other end of each of said rods to bear against the other of said reference members.

9. A traveling wave electron discharge device comprising an electron gun for projecting a beam of electrons along the longitudinal axis of said device and a helical slow wave structure disposed in interacting relation with said beam, said electron gun including a portion of the vacuum envelope of said device disposed coaxially of said axis, the inner surface of said envelope providing a reference surface lengthwise of said portion of said vacuum envelope, a stem reference member disposed transversely of said portion of said envelope and bearing against said reference surface, a base reference member having an axially disposed aperture for passage of said electron beam disposed transversely of said portion of said envelope spaced from said stem reference member and bearing against said reference surface, at least three insulating rods interposed between said stem reference member and one surface of said base reference member, each of said rods bearing against said reference surface along the entire length of said rods, a plurality of electron beam forming electrodes disposed in parallel relation to said reference members and mounted on said rods in a predetermined spaced relationship therealong for axial alignment, said rods and said reference surface providing radial alignment for said electrodes, resilient compressive means interposed between one of said reference members and the adjacent end of each of said rods to fixedly position said electrodes in said envelope by forcing the other end of each of said rods to bear against the other of said reference members, and said slow wave structure including a helical conductor and a plurality of rods

disposed lengthwise of said helical conductor in supporting relation thereto and means mounted on the other surface of said base reference member to support the ends of said last-mentioned rods to position said rods and said helical conductor in a coaxial relation to said beam.

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