May 24, 1960 H. L. LEVIN 2,938,134

ELECTRON GUN

Filed Jan. 13, 1958

Fig. 1

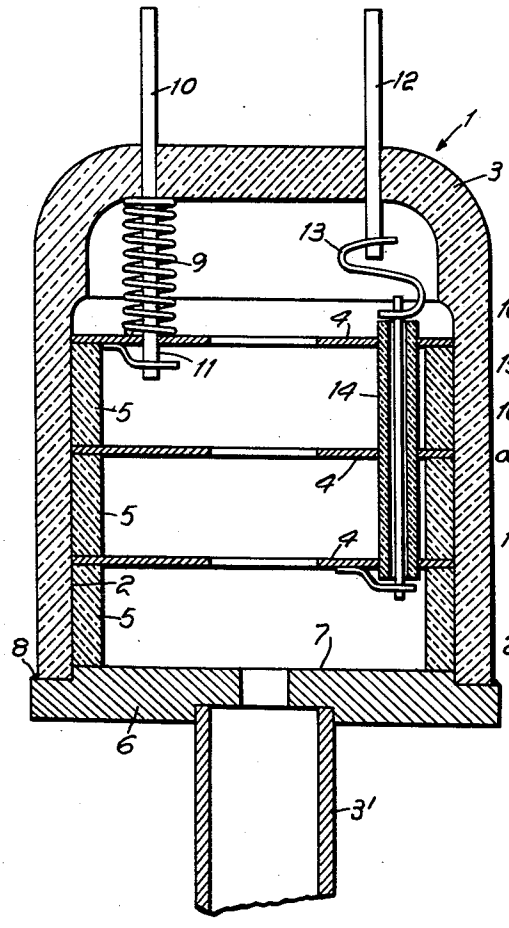
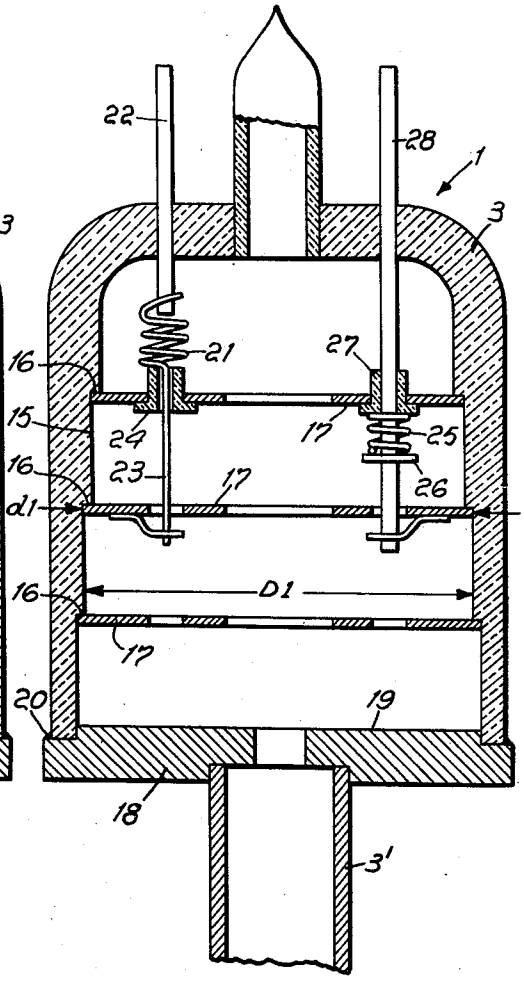


Fig. 2



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ELECTRON GUN

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10 Claims. (Cl. 313—82)

This invention relates to electron gun structures and more particularly to improvements in electrode mounting in electron gun structures.

In the design of electron discharge devices, many parameters must be taken into account to insure a finalized structure which is operative. One of the most important parameters is the accuracy with which the electron gun must be constructed. This is particularly true with respect to traveling wave tubes wherein an electron beam must be transmitted over a relatively long distance without interference with the many elements which lie in its path. Because the beam transmission must be carried out in this manner, the various elements require very critical alignment.

Displacement or movement of any of the electrode elements can make the tube inoperative. It is axiomatic, therefore, that extreme care in manufacture and assembly must be used. Present techniques have produced traveling wave tubes which fulfill the criterion for accuracy in manufacture and assembly, but most of them require the use of relatively skilled labor and are generally very expensive. Prior art schemes generally require highly accurate machining and assembly steps because the electrode support elements are separate from the vacuum envelope. In one prior art device the ceramic electrode supporting means requires extremely accurate internal and external machining. Even though this machining may be accomplished properly, a further machining step is required to provide for accurate radial positioning of the electrode supporting elements within the vacuum envelope. Further, extensive fastening by means of soldering, brazing, or welding must be done to properly assemble the various parts of this device. Here again, extremely careful assembly is in order so that the various parts may be properly aligned.

The above technique leaves much to be desired as far as mass-production techniques are concerned. Since traveling wave tubes are finding broader application, a simplified technique for the manufacture and assembly of electron guns is needed which overcomes the complicated steps now required.

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

Another object of this invention is to provide an improved electron gun structure for an electron discharge device which is amenable to mass-production techniques.

Still another object of this invention is to provide an improved electron gun structure which requires a minimum of precision machining and assembly steps.

A further object of this invention is to provide an improved electron gun structure which can be fabricated from commercially available items.

Other objects of this invention are to provide an improved electron gun support for electron gun electrodes, to provide electron gun supports which are compact and rugged, to provide electron gun supports which maintain critical alignment and spacing of the gun electrodes relative to each other, and to provide an electron gun support for reducing the electron gun size.

A feature of this invention is the provision of means for supporting an electron gun structure in fixed axial and radial alignment which comprises at least a portion of the dielectric vacuum envelope of an electron discharge device whose inner surface has at least one given diameter and a number of electrode elements circumferentially contacting the inner surface of the dielectric envelope to radially position these electrodes coaxial of the longitudinal axis of the dielectric envelope. Also included are spacing means to axially position the electrodes along the longitudinal axis of the envelope and retaining means which in cooperation with the dielectric vacuum envelope retain the electrode elements in their established radial and axial alignment.

Another feature of this invention is the utilization of a dielectric envelope which simultaneously acts as at least a portion of a vacuum envelope and as an electron gun support.

Still another feature of this invention is the utilization of the precision machined inner surface of at least a portion of a dielectric vacuum envelope to provide axial and radial alignment of electrode elements.

A further feature of this invention is the utilization of resilient retaining members to fixedly maintain the established axial and radial alignment of the electrode elements.

Still a further feature of this invention is the utilization of resilient retaining members which in cooperation with a transverse reference surface maintains the established axial and radial alignment of the electrode elements.

The above-mentioned and other features and objects of this invention will become more apparent by reference to the following description taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a longitudinal cross-sectional view of an electron gun following the principles of this invention; and

Fig. 2 is a longitudinal cross-sectional view of another embodiment following the principles of this invention.

Referring to Fig. 1, there is disclosed therein an electron gun 1 composed of a plurality of elements in which the inner surface 2 of a dielectric vacuum envelope 3 acts as a reference surface to radially align the electrode elements coaxially of the longitudinal axis of the inner surface 2 in accordance with the principles of this invention. Included are dielectric spacing means to axially space the electrode elements along the longitudinal axis of envelope 3 and resilient retaining means which in cooperation with a reference member, which may be an electrode element, maintain the electrodes in their established radial and axial position.

In accordance with the principles of this invention, the electrodes of electron gun 1 are positioned radially and axially by the following support arrangement. Dielectric envelope 3 which may be of ceramic, sapphire, or glass has an accurately machined or formed inner surface 2 having a given diameter. Electrode elements 4 are thin annular apertured discs of stainless steel or other suitable conductive material located transverse of the longitudinal axis of inner surface of envelope 3 and of such outer diameter that they circumferentially contact inner surface 2 of dielectric envelope 3. Electrode elements 4 may take other forms than annular discs as described herein above. The electrode elements 4 may have portions removed from their periphery such that contact with inner surface 2 is discontinuous. This arrangement has the advantages that room for lead passage without drilling is obtainable, less metal is present making outgassing easier and the danger of trapped gases during outgassing is minimized. In this manner, electrodes

4 which may be formed by stamping or the like are radially aligned, that is, coaxial with respect to the longitudinal axis of the electron gun 1. Dielectric spacer elements 5 having a given height which may be of ceramic, sapphire, or glass are cylindrical in shape and are located between adjacent electrode elements 4 to axially space the electrode elements 4. The dielectric spacing elements 5 are in substantially loose-fitting contact with inner surface 2 of dielectric envelope 3 and are apertured to permit transmission of an electron beam. Gun barrier element 6, which in certain instances may be an electrode element of gun 1, is an apertured disc of stainless steel or some other suitable conductive material located transverse of the longitudinal axis of the inner surface 2 of envelope 3 and contains a reference surface 7 which is in contacting relationship with the surface of an adjacent dielectric spacing element 5. Gun barrier element 6 contains a circumferentially disposed annular groove 8 adapted to accept and have secured thereto the annular open end of dielectric envelope 3. Gun barrier element 6 in cooperation with retaining spring 9 maintains electrode elements 4 and dielectric spacing elements 5 in axial and radial alignment by forcing electrode elements 4 and spacing elements 5 against gun barrier electrode element 6.

In Fig. 1 the retaining spring 9 is shown as a compression spring aligned parallel to the longitudinal axis of the inner surface 2 of dielectric envelope 3 and coiled about stem pin 10 with one extremity butting against the inner surface of the end of dielectric vacuum envelope 3 removed from reference surface 7. The other extremity of retaining spring 9 butts against the topmost of electrode elements 4, and equal and opposite forces are applied against the inner surface of the end of dielectric vacuum envelope 3 and the topmost of electrode elements 4. Stem pin 10 which pierces the end of dielectric vacuum envelope 3 also pierces the topmost of electrode elements 4 and its extremity 11 is fastened by spotwelding or soldering or some other suitable technique to the flat surface of the topmost of electrode elements 4. In this manner, stem pin 10 maintains the proper alignment of compressive retaining spring 9 and simultaneously acts as a means for applying an appropriate voltage to the topmost of electrode elements 4. Thus, the force applied by compressive retaining spring 9 is transmitted through the electrode elements 4 and through spacing elements 5 to cause these elements to be firmly held together in such a way that when the annular open end of dielectric vacuum envelope 3 is mated with the circumferential annular groove 8 of gun barrier member 6, a spacing element 5 and the adjacent gun barrier reference surface 7 are strongly butted against each other and the established radial and axial alignment is maintained. From the foregoing, it may be seen that only one reference surface (surface 7) is required for axial alignment and only one surface (surface 2) for radial alignment. The complete vacuum envelope for a traveling wave tube is, of course, formed by sealing the tube 3' which contains the helix element to the side opposite reference surface 7 of gun barrier element 6. Lest this statement be construed as a limitation of the present invention, it should be pointed out that gun barrier element 6 need not be an element of a traveling wave tube but may be a solid member which actually completes the vacuum envelope and could be adapted for use in klystrons and lighthouse tubes where electrode alignment is still very critical.

Appropriate voltages may be applied to electrode elements 4 by other means than described above, one of which is shown in Fig. 1. Stem pin 12 has attached thereto a flexible lead 13, a continuation of which passes, parallel to the longitudinal axis of the inner surface 2, through several of electrode elements 4. The continuation of lead 13 is insulated from said electrode elements 4 by a ceramic insulating rod 14 and fastened at the extremity thereof to the flat surface of the appropriate one of electrode elements 4.

In Fig. 2, the inner surface 15 of dielectric envelope 3 contains portions or shoulders 16 of different diameters and shoulders 16 act as projections from surface 15 transverse of the longitudinal axis of inner surface 15 and are adapted to engage electrodes of slightly larger diameters than the diameters of shoulders 16. The electrode elements 17 are annular apertured discs of stainless steel or other suitable conductive material having a given diameter such that they will circumferentially engage the suitable inner surface of dielectric envelope 3 having the same diameter for radial positioning thereof. An electrode element having a diameter d_1 would, therefore, circumferentially engage a portion of inner surface 15 having a diameter D_1. The shoulders 16, of varying diameter, permit only the insertion of electrode elements 17, each of which not only has a diameter larger than the adjacent shoulder but also has a diameter equal to the diameter of the surface between shoulders. The distance between shoulders 16 provides for the axial spacing of electrode elements 17.

Although it is not necessary for all applications, gun barrier element 18, when used as an electrode such as in traveling wave tubes, must be machined to have surface 19 perpendicular to the longitudinal axis of inner surface 2 and spaced an exact distance from the nearest of electrode elements 17. Gun barrier element 18 contains a circumferentially disposed groove 20 which is adapted to receive the annular open end of dielectric vacuum envelope 3 to aid in accomplishing the desired spacing thereof from the nearest of elements 17.

Resilient retaining means 21 attached to stem pin 22 may be a spring in tension which in cooperation with wire 23 and insulating bushing 24 extends through one or more of electrodes 17 and is fixedly attached by spotwelding or other suitable technique at the extremity of wire 23 to one of the electrodes 17. In this manner, an electrode element 17 has a force applied to it which causes it to bear against one of the shoulders 16 on the inner surface of dielectric envelope 1 to maintain the established electrode element position and permits the application of the appropriate voltage to the electrode.

Another means for maintaining the established positions of electrode elements 17 and simultaneously applying a voltage to the electrodes is accomplished by providing a spring 25, parallel to the longitudinal axis of inner surface 15 in compression, which in cooperation with stop 26, insulating bushing 27, and stem pin 28, forces electrode elements 17 against shoulders 16. Stem pin 28 which pierces one end of dielectric vacuum envelope 3 extends through insulating bushing 27 to be fastened by spotwelding or other suitable techniques to another electrode to apply an appropriate voltage thereto.

The various elements of electron gun 1 are assembled by inserting the various elements in proper order in a stacked arrangement, by performing a few simple fastening steps and by finally brazing the annular open end of the dielectric vacuum envelope to the annular circumferential groove in the gun barrier member.

While I have described above the principles of my invention 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 to the scope of my invention as set forth in the objects thereof and in the accompanying claims.

I claim:

1. In an electron gun, an electrode support structure comprising a dielectric vacuum envelope including an inner surface having at least one given inner diameter, a plurality of electrode elements disposed to circumferentially contact said inner surface to radially position said electrodes coaxially of the longitudinal axis of said envelope, means to space adjacent elements of said electrode elements along said longitudinal axis to thereby

axially position said electrodes and means in cooperating relationship with said envelope to retain said electrode elements in the established radial and axial position.

2. The electrode support structure according to claim 1, wherein said axial spacing means includes a plurality of annular dielectric cylinders.

3. The electrode support structure according to claim 1, wherein said axial spacing means includes a plurality of shoulders extending inwardly from said inner surface in transverse relation to the longitudinal axis of said inner surface and spaced therealong.

4. The electrode support structure according to claim 1, wherein said retaining means includes a resilient member disposed parallel to the longitudinal axis of said inner surface coupled at one extremity to said envelope and coupled at the other extremity to an electrode.

5. The electrode support structure according to claim 4, wherein said resilient member is a spring in compression to fixedly maintain said electrodes against spacing elements.

6. The electrode support structure according to claim 4, wherein said resilient member is a spring in tension to fixedly maintain said electrodes against said spacing elements.

7. The electrode support structure according to claim 1, wherein said retaining means includes an element disposed at one extremity of said electron gun having a reference surface transverse of the longitudinal axis of said inner surface and in contact with one of said spacing means and a resilient member fixedly disposed parallel to the longitudinal axis of said inner surface between the other end of said envelope and one of said electrode elements to cause said resilient member to hold said electrode elements and said spacing means against said reference surface.

8. The electrode support structure according to claim 1, wherein said retaining means includes a resilient member for each of said electrode elements fixedly disposed parallel to the longitudinal axis of said inner surface between one end of said envelope and respective ones of said electrode elements and a plurality of shoulders integral with and disposed in transverse relation to the longitudinal axis of said inner surface, said resilient member cooperating to hold respective ones of said electrode elements against corresponding ones of said shoulders.

9. In an electron gun, an electrode support structure comprising a dielectric vacuum envelope having a given inner diameter, a plurality of electrode elements having a given outer diameter disposed transverse of the longitudinal axis of said inner surface and circumferentially contacting the inner surface of said dielectric envelope for radial alignment of said electrode elements, a plurality of dielectric spacers having a given height disposed transverse to the longitudinal axis of said inner surface and in substantially loose fitting relationship with said inner surface of said dielectric envelope, each of said spacers being disposed between adjacent ones of said electrodes for axial alignment of said electrode elements, a reference member disposed transverse of the longitudinal axis of said inner surface and in parallel contacting relationship with one of said spacers, said reference member containing a circumferential depression adapted to receive one extremity of said dielectric envelope, a retaining means fixedly disposed between one of said electrodes and the other extremity of said dielectric envelope to maintain the radial alignment of said electrodes and the axial position of said electrodes with respect to said reference member.

10. In an electron gun, an electrode support structure comprising a dielectric vacuum envelope having an inner surface including a plurality of shoulders each of a different given diameter spaced longitudinally therealong and extending in transverse relation to the longitudinal axis of said inner surface, a plurality of electrode elements each having an outer diameter corresponding to one of said different given diameters, said electrode elements being disposed transverse of the longitudinal axis of said inner surface and circumferentially contacting the inner surface of said envelope at the corresponding one of said shoulders for radial alignment of said electrode elements and in abutting relationship with one of said shoulders of smaller diameter to establish the axial alignment of said electrode elements, and a plurality of retaining means fixedly disposed between each of said electrodes and one end of said envelope to maintain said electrode elements against their respective shoulder and hence maintain the radial and axial position of said electrodes.

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