Aug. 2, 1960 C. F. RODRIGUEZ ET AL 2,947,897

ELECTRON GUN STRUCTURE

Filed Jan. 8, 1958

Fig. 1

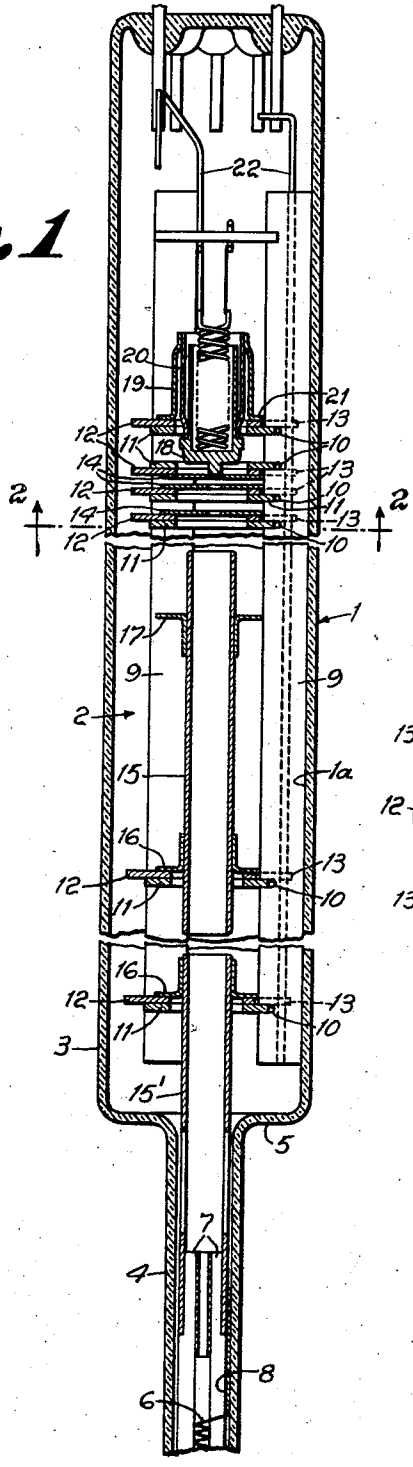
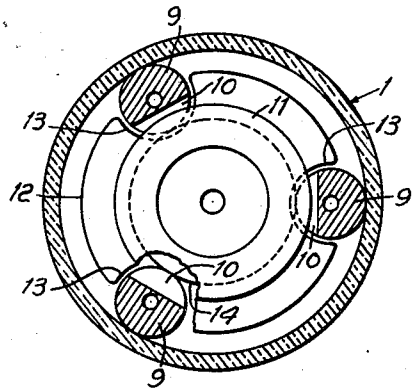


Fig. 2



Inventors
CONRAD F. RODRIGUEZ
MILNER W. WALLACE
By Alfred C. Hill
Agent

United States Patent Office

2,947,897

Patented Aug. 2, 1960

2,947,897

ELECTRON GUN STRUCTURE

Conrad F. Rodriguez, Pompton Lakes, and Milner W. Wallace, Westwood, N.J., assignors to International Telephone and Telegraph Corporation, Nutley, N.J., a corporation of Maryland

Filed Jan. 8, 1958, Ser. No. 707,818

6 Claims. (Cl. 313—82)

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

In electron discharge devices, elements which make up the electron gun structure must be handled with great care to insure that the relative positions of the elements one to the other are accurately maintained so that the device is operative after assembly.

This is particularly true with respect to traveling wave tubes in that elements of the tube must be maintained in axial and radial alignment to insure proper operation of the device. While all the elements of a traveling wave tube must fulfill the alignment criterion, the problem of accurate alignment is most often met, with difficulty, in the electron gun structure wherein several elements must cooperate to first produce a beam, focus it and then possibly accelerate it in a desired manner without introducing deleterious effects. Because of the criticalness with which these elements must be aligned, small miscalculations or small movements of these elements may introduce serious errors and lead to such effects as beam interception, beam defocusing and burn-out of the electrode elements.

As the advantages of electron discharge devices become more widely known and as broader applications for such devices are being made, the problem of achieving accurate alignment of tube elements in mass production assumes an important place. Former techniques often required the use of skilled workmen to accomplish complicated fabrication techniques with a consequent expenditure of time and money. Recently, however, attempts have been made to simplify the structure and fabrication of electron guns to make them more amenable to mass-production techniques. One such scheme proposes the use of ceramic members, of accurately machined pieces, having a plurality of shoulders, flanges, and complicated inside-outside grinding operations to form reference surfaces which when properly assembled and secured together comprise a means for accurately positioning electrode members in axial and radial alignment. While such a scheme is definitely a step in the art, it is not the ultimate in simplicity and still may be objected to in that the fabrication technique requires a relatively skilled person for machining of parts and assembly of these parts.

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

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 for an electron discharge device 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 a rectilinear beam path; 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 an envelope having a given inner diameter, a plurality of insulating rods each having a given diameter disposed lengthwise of said envelope and bearing against the inner surface of said envelope at circumferentially spaced points thereabout and a plurality of electrode elements having portions thereof disposed transversely with respect to said envelope and bearing against said insulating rods. The insulated rods are maintained in their spaced circumferential relationship by rod retaining elements disposed transversely of said envelope and in coupled relationship with said portions of each of said electrode elements, and electrode supporting members are disposed transversely of said envelope and mounted on said insulating rods in coupled relationship with each of said rod retaining elements. The inner surface of said envelope, said insulating rods, said electrode supporting members, and said rod retaining elements cooperate to radially position said electrode elements coaxially of the longitudinal axis of said envelope and to axially position said electrode elements in spaced relation along the longitudinal axis of said envelope.

Another feature of this invention is the utilization of elongated electrodes having radial flange portions of precision diameter which bear against the insulating support rods to radially support said elongated electrode elements coaxially of the longitudinal axis of the envelope.

Still another feature of this invention is the utilization of an envelope composed of dielectric or metal material having a precision bore inner diameter, precision diameter insulating rods and precision diameter disc-like electrodes to accurately maintain the radial alignment of the electrodes with respect to the longitudinal axis of the envelope.

Still another feature of this invention is the utilization of notches longitudinally spaced along the insulating rods to mount the electrode supporting members thereon and to accurately maintain the axially spaced alignment of the electrodes relative to each other.

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 cross-sectional view taken along line 2—2 of Fig. 1.

Referring to Figs. 1 and 2, there is disclosed therein an electron gun composed of a plurality of elements each of which cooperate in accordance with the principles of this invention to establish the desired radial and axial alignment of electrodes. Vacuum envelope **1**, which may be glass, metal, of ceramic, is composed of two portions **3**, **4** both of which have a precision inner diameter coaxial of the longitudinal axis of envelope **1** along which it is desired to project an electron beam. Envelope portion **3** contains substantially all of the electron gun structure **2**, while portion **4** of smaller diameter, which is joined to portion **3** by necked-down portion **5**, is adapted to contain the slow-wave structure **6**, illustrated as a helical transmission line, and slow-wave structure supporting rods **7**, and electromagnetic wave coupling means **8**.

In accordance with the principles of this invention, the electrodes of electron gun **2** are positioned radially and axially by the following support arrangement. Insulating

rods 9, which may be of ceramic, sapphire, or glass, are disposed parallel to the longitudinal axis of the electron discharge device, substantially 120° apart and in frictionally engaging relationship with the inner surface 1*a* of envelope 1. Insulating rods 9 have a precision diameter and contain radial retaining slots 10 appropriately spaced therealong to provide longitudinal spaced relation between the various electrodes. Slots 10 are accurately dimensioned in width and are adapted to receive electrode supporting elements 11 in close fitting relationship such that no play exists in directions parallel to the longitudinal axis of the tube. Electrode supporting elements 11 are thin annular discs made of stainless steel or some other suitable conductive material located transverse to the longitudinal axis of the tube. Rod retaining elements 12 are likewise thin annular discs of stainless steel or other suitable conductive metal having semi-circular portions 13 cut out of its periphery, spaced 120° apart, said semi-circular cut-out portions 13 adapted to engage the insulating rods 9 which are likewise spaced 120° apart. Elements 12 serve to maintain rods 9 in their circumferential spaced relationship. Elements 11 and 12 are spot-welded, brazed or otherwise fastened together.

Rod retaining elements 12 and electrode supporting elements 11 cooperate with different type electrode elements having portions transverse to envelope 1 to establish the axial and radial position of the electrode. Three different electrode elements are shown in Fig. 1. One type of electrode element is disc-like electrodes 14, of conductive material, apertured to permit beam transmission with appropriate dimensions to introduce the desired electrical effects such as focusing and/or acceleration of the electron beam. Each of electrodes 14 may be considered as the portion disposed transversely of envelope 1. Electrodes 14 are formed, such as by a stamping operation, to have precision inner and outer diameters. The precision outer diameter of electrodes 14 in conjunction with the precision diameters of rods 9 and precision inner surface of envelope 1 disposes electrodes 14 in proper radial position, that is, coaxial of the longitudinal axis of envelope 1. Thus, the outer diameter of electrodes 14 is one of the major dimensions for radial positioning of the electrodes of the electron gun. The circumference of electrodes 14 bears against rods 9, and electrodes 14 are held in their axially spaced as well as radial positions by being secured to element 12. It will be observed that the outer diameter of electrodes 14 plus two times the diameter of rods 9 equals the inner diameter of envelope 2.

Elongated cylindrical electrodes 15 and 15', which may be used as drift tubes, are representative of still another type of electrode element having a portion disposed transversely of envelope 1 which may be supported and positioned in accordance with the teachings of this invention. Electrodes 15 and 15' are disposed in the proper radial position by flanged portion 16 coupled adjacent one end thereof. Flanged portion 16 may be a separate piece brazed or otherwise secured to electrodes 15 and 15' or may be formed from the same piece of stock as are electrodes 15 and 15'. Regardless of how made, flanged portion 16 extends radially from electrodes 15 and 15' to be transverse of envelope 1. The outer diameter of portion 16 is such as to bear against rods 9 to establish the radial location of electrodes 15 and 15'. Portion 16 is fastened to element 12 to assure the axial location of electrodes 15 and 15'. In certain instances electrodes 15 and 15' may be of such a length that the end removed from portion 16 should be supported radially to assure that the entire electrode is not swayed from its required alignment in its intended use. Therefore, adjacent the other end of electrode 15 may be secured or otherwise formed a second flanged portion 17 which will properly engage rods 9 to assure that the entire length of electrode 15 is maintained in the desired radial position. Another expedient to maintain electrodes 15 and 15' in the proper radial position throughout their length is to insert the other end of the electrodes into envelope portion 4 as illustrated in connection with electrode 15'. The other end of electrode 15' is fastened to the ends of rods 7 or the diameter of envelope portion 4 may be of such a value as to engage the other end of electrode 15'.

A third electrode element having a portion disposed transversely of envelope 1, which is supported and aligned in accordance with the principles of this invention, is illustrated in connection with cathode 18. Cathode 18 extends through the centrally disposed apertures of elements 11 and 12 and is held in its proper radial alignment by cylinder 19 which acts as a heat shielding member. Cylinder 19 is fastened at one end to the cathode 18 support member 20 while the flanged portion 21 has the required given diameter to engage rods 9 for proper radial positioning of cathode 18.

The various elements of electron gun 2 are assembled outside of envelope 1 on jigs which establish the desired axial and radial alignments. Therefore, after assembly the gun is inserted in envelope 1 such that the inner surface 1*a* of envelope 1 will maintain the established alignments in operation. The entire gun assembly is rigidly held in position by tube stem voltage lead-in wires 22 which prevent any movement of the gun structure relative to envelope 1.

While we have described above the principles of our 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 our invention as set forth in the objects thereof and in the accompanying claims.

We claim:

1. In an electron gun, an electrode support arrangement comprising a cylindrical envelope, a plurality of notched insulating rods each having a given diameter disposed lengthwise of said envelope and having a flush contact along their full length against the inner surface of said envelope at circumferentially spaced points thereabout, an electrode element having a portion thereof disposed transversely with respect to said envelope and bearing against said insulating rods the transverse dimension of said electrode element plus two rod diameters being substantially equal to the diameter of said envelope, a rod retaining element disposed transversely of said envelope and in coupled relationship with said portion of said electrode element and said insulating rods, and an electrode supporting member disposed transversely of said envelope and mounted on said insulating rods in coupled relationship with said rod retaining element, the inner surface of said envelope, said insulating rods, said electrode supporting member, and said rod retaining element cooperating to position said electrode element longitudinally along and coaxially of the longitudinal axis of said envelope.

2. A device according to claim 1, wherein said electrode element includes a beam focussing electrode comprising an apertured disc element and the outer surface thereof bears against said insulating rods, said rod retaining element having cut-out portions adapted to engage the insulating rods respectively.

3. A device according to claim 1, wherein said electrode element includes an electron drift tube aligned with said beam focussing electrode and at least one flanged cylindrical ring extending radially therefrom to bear against said insulating rods.

4. A device according to claim 1, wherein said electrode element includes a drift tube and bracing means for the drift tube comprising a flanged cylinder disposed adjacent one end thereof to bear against said insulating rods and to couple said drift tube to said rod retaining element.

5. A device according to claim 4, wherein said drift tube includes a flanged ring integral therewith adjacent the other end thereof to bear against said insulating rods to cooperate in coaxially positioning said elongated electrode.

6. In an electron gun, an electrode support arrangement comprising a cylindrical envelope, a plurality of insulating rods notched along their length each having a given diameter disposed lengthwise of said envelope and in flush contact lengthwise the inner surface of said envelope at circumferentially spaced points thereabout, a cathode, an electron beam focussing electrode element having a portion thereof disposed transversely with respect to said envelope and bearing against said insulating rods, a rod retaining element disposed transversely of said envelope and in coupled relationship with said portion of said electrode element and said insulating rods, said rod retaining element having a plurality of circumferentially spaced indentations to determine the circumferential spacing of said rods said elements fitting into the notched rods, and an electrode supporting member disposed transversely of said envelope in coupled relationship with said rod retaining element and mounted on said insulating rods by means of circumferential

portions of said member which overlap said indentations, the inner surface of said envelope, said insulating rods, said electrode supporting member, and said rod retaining element cooperating to position said electrode element longitudinally along and coaxially of the longitudinal axis of said envelope the outer diameter of the electrode element plus twice the diameter of the rods being equal to the inner diameter of the cylindrical envelope.

References Cited in the file of this patent

UNITED STATES PATENTS

2,183,309	Fleschsig et al.	Dec. 12, 1939
2,219,111	Nicoll	Oct. 22, 1940
2,290,748	Hergenrother	July 21, 1942
2,596,508	Phillips et al.	May 13, 1952
2,784,340	Coulson	Mar. 5, 1957
2,800,603	Bryant et al.	July 23, 1957