

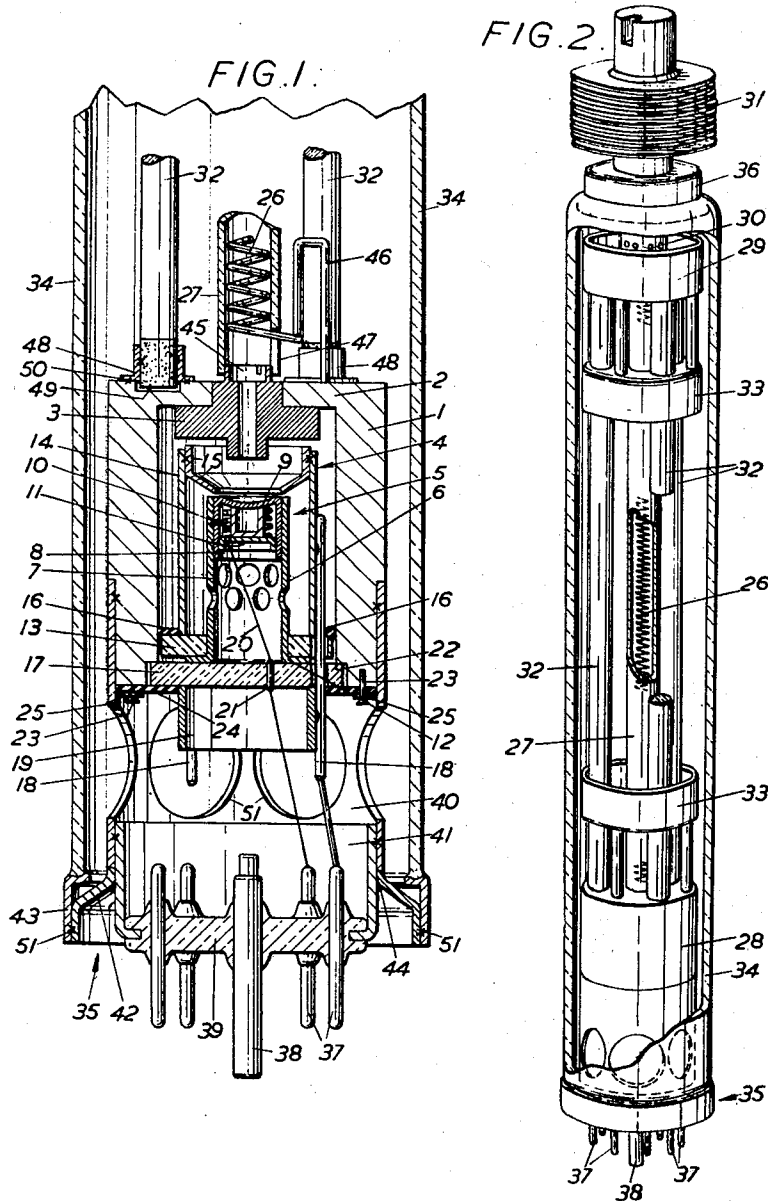
Feb. 4, 1958

P. F. C. BURKE

2,822,492

ELECTRON DISCHARGE DEVICES

Filed Aug. 10, 1954



Inventor  
P. F. C. BURKE  
By *Philip M. Bolton*  
Attorney

1

2,822,492

## ELECTRON DISCHARGE DEVICES

Peter Francis Conway Burke, London, England, assignor to International Standard Electric Corporation, New York, N. Y., a corporation of Delaware

Application August 10, 1954, Serial No. 448,850

Claims priority, application Great Britain October 14, 1953

2 Claims. (Cl. 313-82)

The present invention relates to an electron gun of the kind which is contained within a ferromagnetic pole piece which also constitutes or is integral with the anode of the electron gun.

During the manufacture of an electron discharge device it is necessary, at some stage after assembly, to raise all electrodes to an elevated temperature in order to get rid of any gas adsorbed on the surfaces of the electrodes. On the other hand, the electrodes must be maintained in accurate alignment and spacing from one another, for which purpose it is customary to employ various mica washers in which locating apertures can be accurately punched, and whose thickness can be carefully controlled. Particularly, however, when comparatively large masses of metal, such as the pole piece containing the electron gun structure, are included inside the envelope of the device, the temperature at which the electrodes must be maintained during outgassing is such that mica tends to evolve a considerable amount of gas through partial disintegration and tends to warp. On the other hand, ceramic materials, which would comfortably withstand such temperatures, are not easily provided with accurately located holes such as required for centering electrodes. Ceramic washers may, however, be provided with accurately ground surfaces.

In the present invention the use of mica is kept to a minimum, a single thin mica washer being retained for centering purposes and another, which could be replaced, if desired, by metal, being used as a resilient locking means. Ceramic washers are used to secure the electrodes together in accurate axial position.

According to the present invention there is provided an electron gun comprising an indirectly heated cathode, a focusing electrode and a centrally apertured anode contained within a surrounding ferromagnetic pole piece integral with the said anode, the said cathode and focusing electrode being aligned coaxially with the said anode by means of a single mica centering washer and being secured to the said pole piece and spaced axially from the anode by means of a first and a second ceramic washer, one of the faces of the said second ceramic washer being accurately planar and engaging with a seating in the said pole piece.

An embodiment of the invention will be described with reference to the accompanying drawings, in which:

Fig. 1 shows a cross-section through an embodiment of the invention for use in travelling wave tubes, and

Fig. 2 shows the general appearance of the tube of which the electron gun of Fig. 1 forms a part.

Referring now to Fig. 1 of the accompanying drawings, the gun comprises a magnetic shield and pole-piece 1 having an integral front closure member which receives a copper anode 3; the anode 3 co-operates with a focusing electrode 4 and an indirectly heated cathode 5 which are mounted within the member 1 in the manner to be described below. The cathode is constructed with a cylindrical skirt 6 provided at its lower end with holes 7 whose purpose is to reduce the conduction of heat from the

2

cathode. The upper end of the cathode skirt 6 carries an internal cylindrical member 8 welded thereto. The member 8 is closed at its upper end by an integral concave end cap 9 which is coated with electron emissive material. A heater assembly 10 which butts against the end of the cap portion 9, is mounted on an inverted cup 11 which fits inside and is welded to the cathode skirt 6. A description of the remainder of the gun construction can most conveniently be made by describing the method of assembly of the gun.

The lower end of the cylindrical cathode skirt 6 is spun out to form a circular flange 12. After assembly of the cathode and heater a first ceramic washer 13 is placed over the skirt 6 to seat against the flange 12; the washer is a loose fit within the pole piece. The focusing electrode 4 comprises a cylindrical skirt 14 and an insert 15, which are not, at this stage, assembled together. The skirt 14 is placed around the cathode upon the ceramic washer 13 and a tightly fitting mica centering washer 16, which is a close fit within the pole piece 1, is placed around the skirt 14 against the ceramic washer 13. With the aid of a centering jig the cathode and focusing electrode skirt 14 are made coaxial with one another. A second ceramic washer 17, of larger diameter than 13, is placed beneath the flange 12 of the cathode skirt. The face of washer 17 which contacts the flange 12 is ground accurately planar. A set of tie rods, 18, of which two are shown in the drawing, are passed through clearance holes in the washers 13 and 17 and, at this or some convenient prior stage, are welded to the skirt 14. A metal tube 19, fitting snugly within the set of tie rods 18, is placed against the lower side of the ceramic washer 17, and the assembly of cathode 5, focusing electrode skirt 14 and washers 16, 13 and 17 are clamped together. While so clamped the rods 18 are welded to the tube 19, so securing this assembly. The centering jig between cathode and skirt 14 is removed and the insert 15 is fitted. With the aid of shims, the insert 15 is correctly spaced above the cathode cage 9, in which position it may project slightly above the top of skirt 14, and the two focusing electrode portions are welded together. It should be mentioned that one end of the heater is welded to a convenient point on the cathode skirt 6 and the other leg is connected, as indicated at 20, to a rod 21 sealed in the ceramic insulator 17.

The completed cathode and focusing electrode assembly may now be inserted within the pole-piece 1, to which the anode 3 has already been secured. The insulator 17 seats against a circular shoulder 22 provided in the cylindrical wall of pole-piece 1, so positioning the cathode and focusing electrode assembly axially with respect to the anode, while the mica centering washer 16, fitting tightly inside the pole-piece, ensures that the gun electrodes are accurately coaxial. A plurality of metal pins 23 is secured in any convenient manner to the pole-piece 1 so as to project from the underside thereof. A mica washer 24 having holes corresponding with the pins 23 is now placed in position over the lower end of the pole-piece so as to bear against the lower surface of the ceramic insulator 17, which latter is of a thickness such as to project slightly beyond the lower surface of pole-piece 1. Eyelets 25 are placed over the pins 23, pushed against the washer 24 and welded to the pins. The ceramic washer 17 is thus held in position by the resilience of the washer 24.

It will be seen that the electron gun avoids the use of mica except for the single thin centering washer and the retaining washer 25, for which latter, if desired, a resilient metal washer could be substituted. The axial positioning and clamping of the electrodes together is accomplished with the aid of ceramic washers of relatively uncritical dimensions. Although designed primarily for the travelling wave tube which will now be described,

and having certain additional members for connection therewith, the electron gun described above is eminently suitable for use with other applications where a magnetically shielded gun is required, as, for example, in klystron tubes.

Fig. 2 shows a travelling wave tube containing a helix 26 supported in a glass tube 27 between an electron gun 28, the same as shown in Fig. 1, and a sleeve member 29, which in turn is mounted upon an extension 30 of an electron collector electrode which, in the drawing, is obscured by other parts. The collector electrode is provided with a cooler 31. The sleeve member 29 and the electron gun 28 are secured together by means of three ceramic rods 32 to form a unitary assembly including a further pair of sleeve members 33. The sleeve members 29 and 33 form parts of quarter wave chokes when the tube is inserted into its associated apparatus; in addition to its other functions the gun 28 also serves as part of a wave guide choke.

The tube has a glass envelope 34 secured to end caps 35 and 36 respectively. The electron collector electrode is secured to the end cap 36, while the end cap 35 is in two parts, shown more clearly in Fig. 1, one of which is sealed to the glass envelope and the other of which carries conventional valve pins 37 and a socket locating spigot 38 sealed in a glass base insert 39 (Fig. 1) and forming an extension of the structure of the electron gun 28. In assembly of the travelling wave tube, the gun, helix and sleeve member assembly is inserted into the envelope 34 until the sleeve member 29 seats upon the tube 30. The two parts of the metal end cap 35 are then hermetically joined together.

Referring now once again to Fig. 1, the pole piece 1 is provided with a cylindrical skirt 40 which is welded to it. The lower end of the cylindrical skirt 40 receives and has welded to it a metal cup 41 sealed into the glass insert 39. The cup 41 is hermetically sealed to a flange 42 which is spun out to fit inside an outer end cap member 43, to which is sealed the glass envelope 34. Whereas the other joints may be ordinary spot welds, a ring weld or the like, as indicated at 44, is employed to join members 41 and 42, as these members, together with the glass insert form part of the end cap 35 closing the envelope of the discharge device.

At the other end of the electron gun a thin annular projection 45 on the anode 3 is partially inserted in one end of the helix support tube 27. The annular projection 45 is a tight fit inside the tube 27 and is slotted for resiliency. A generally U-shaped antenna probe 46, is also secured to the end face of the pole piece 1 and is joined to the end of the helix 26, which is conveniently brought out through a slot 47 cut in the end of the glass tube 27. The ceramic rods 32, which secure together the assembly of electron gun, the helix and the several sleeve members, have flanged sleeves 48 welded to plated areas adjacent their ends. The plated ends of the rods 32 projecting beyond the sleeves 48 are loose fits in respective shallow recesses 49 let into the pole piece; after the electrode assembly has been aligned in a suitable jig the flanges of the sleeves 48 are welded to the pole piece face portion 2 as indicated at 50.

Connecting wires between the electron gun and the lead-out pins 37 can conveniently be welded to the pins, access being provided by means of holes 51, whose main purpose is to reduce the heat conductivity between the electron gun structure and the glass insert 39, so that the latter is not overheated during the outgassing process.

After assembly of the travelling wave tube electrode structure upon the electron gun 28, as mentioned before,

the assembly is slid into the envelope 34 from the gun end of the tube until the sleeve member 29 (Fig. 2) engages with the tube 30 attached to the electron collector electrode. The two metal end cap members 42 and 44 are then hermetically sealed together with a ring of suitable hard solder by heating the joint locally by radio frequency induction from a single turn of copper. To avoid damage to the glass seals the heat is applied for only a very short time, about 0.2 to 0.4 second. The travelling wave tube is evacuated by means of a metal exhaust tubulation, which is not visible on the drawings, secured in a boss projecting from the collector electrode on the opposite side to the tube 30. Finally the cooler 31 is secured to this boss over the exhaust tubulation.

While the principles of the invention have been described above in connection with specific embodiments, and particular modifications thereof, it is to be clearly understood that this description is made only by way of example and not as a limitation on the scope of the invention.

What I claim is:

1. An electron gun comprising: a hollow cylindrical pole piece of ferromagnetic material; a centrally apertured anode closing one end of the said pole piece, an annular step in the internal bore of the said pole piece at the other end thereof; a cathode having a cylindrical skirt terminating in a circular flange, a first ceramic washer of predetermined thickness on the anode side of said flange, said first washer being of smaller diameter than the internal bore of the said pole piece and a second ceramic washer having an accurately planar face and which is of larger diameter than the bore of the said cylindrical pole piece but of smaller diameter than the said annular step on the other side of said flange, resilient means secured to the said pole piece for holding said second ceramic washer against the step in said pole piece; a focusing electrode comprising a cylindrical skirt surrounding the said cathode and seated on the said first ceramic washer; a thin mica centering washer fitting closely between the skirt of the said focusing electrode and the internal wall of the said pole piece; a hollow metal cylinder seated against the said second ceramic washer on the side remote from the anode; and a plurality of tie rods, passing through clearance holes in the two said ceramic washers secured at one end to the said cylindrical skirt of the focusing electrode and at the other end to the said hollow metal cylinder to clamp together the said ceramic washers, the focusing electrode and the said cathode.

2. An electron gun according to claim 1 in which the said pole piece comprises a hollow cylindrical skirt in the end of which is mounted, hermetically sealed thereto, a member having sealed therein a plurality of valve pins providing conventional valve base connecting means to electrodes of the said electron gun and a surrounding metal flange adapted for sealing to an annular metal end cap member sealed to a glass envelope to surround the electron gun.

#### References Cited in the file of this patent

#### UNITED STATES PATENTS

|           |             |               |
|-----------|-------------|---------------|
| 2,202,588 | Kniepkamp   | May 28, 1940  |
| 2,510,267 | Tolson      | June 6, 1950  |
| 2,540,621 | Johnson     | Feb. 6, 1951  |
| 2,608,668 | Hines       | Aug. 26, 1952 |
| 2,683,831 | Skehan      | July 13, 1954 |
| 2,687,490 | Rich et al. | Aug. 24, 1954 |
| 2,740,913 | Majkrazak   | Apr. 3, 1956  |