Nov. 24, 1942. J. P. LAICO 2,303,166

ELECTRON DISCHARGE DEVICE

Filed Jan. 21, 1941

FIG. 1

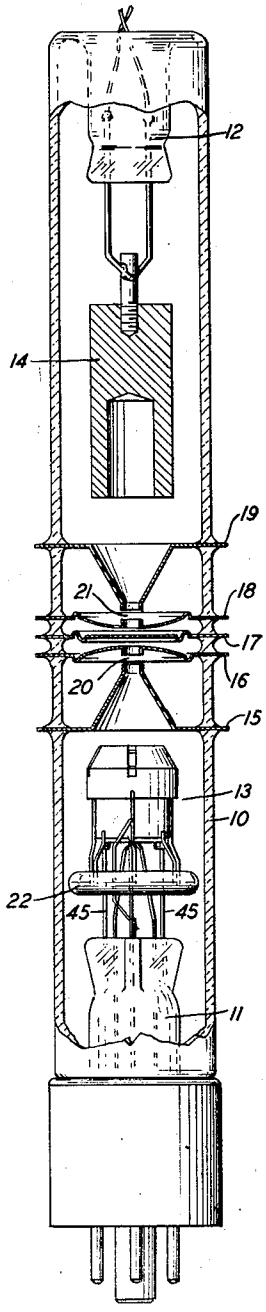


FIG. 2

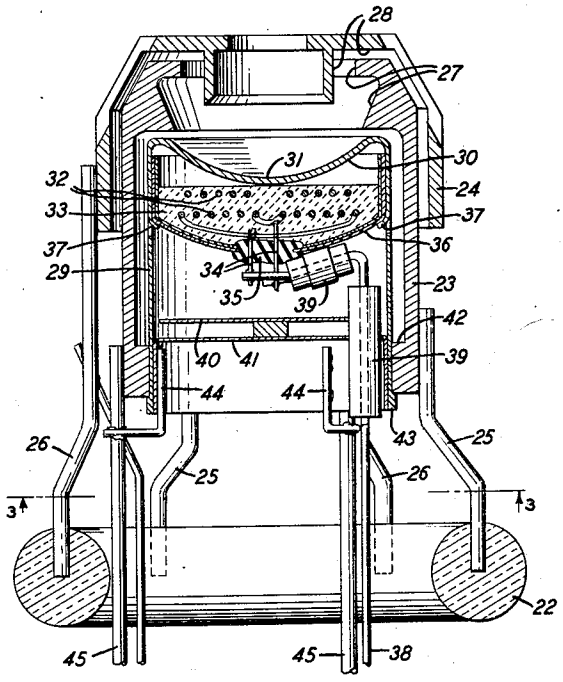
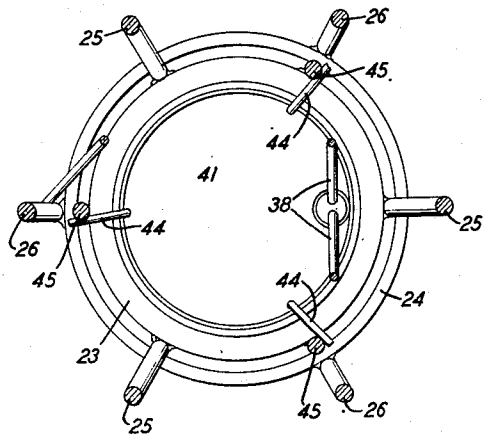


FIG. 3



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ELECTRON DISCHARGE DEVICE

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3 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices and more particularly to electrode systems, commonly referred to as electron guns, for such devices of the beam type.

Electron guns for beam discharge devices comprise, in general, a cathode and one or more electrodes in cooperative association with the cathode for concentrating the electrons emanating from the emissive portion thereof into a beam and, in some cases, for controlling the intensity and velocity of the electron beam. Effective and efficient concentration of these electrons and sensitive and accurate control of the beam entails the use of electrodes of special forms and the mounting thereof in fairly critical physical relation with the cathode and with one another. Hence, the construction of an efficient, high quality electron gun has involved exacting and detailed work with consequent expense. When such a gun becomes inoperative, due in most cases to failure of the cathode, considerable expense is incurred in replacing the gun in the device in which it is incorporated or in rebuilding the gun with the view of again utilizing component parts thereof.

Objects of this invention, therefore, are to simplify the construction of multielectrode electron guns and to expedite the construction and repair thereof.

In one illustrative embodiment of this invention, an electron discharge device comprises a cathode including a metallic member a portion of which is coated with electron emissive material, a heater element for the cathode, and a pair of electrodes in cooperative relation with the cathode for concentrating the electrons emanating therefrom into an electron beam.

In accordance with one feature of this invention, the electron gun is fabricated as a unitary assembly from which the cathode and the heater element are readily removable as a unit and this unit and one of the electrodes are provided with cooperating means whereby the unit or a similar one may be inserted into the assembly and automatically positioned so that the requisite exact relation of the cathode with respect to the other elecrodes of the assembly is realized.

The invention and the foregoing and other features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawing in which:

Fig. 1 is an elevational view mainly in section of an electron beam discharge device including an electron gun constructed in accordance with this invention;

Fig. 2 is an enlarged sectional view of the electron gun, included in the discharge device shown in Fig. 1; and

Fig. 3 is an end view of the electron gun taken along plane 3—3 of Fig. 2.

Referring now to the drawing, the electron discharge device shown in Fig. 1 is of the velocity variation beam type and comprises an elongated, evacuated enclosing vessel 10 of vitreous material and having inwardly extending, axially aligned stems 11 and 12 at opposite ends thereof. An electron gun, designated generally as 13 and described in detail hereinafter, is mounted on the stem 11 and a recessed anode or target electrode 14 is mounted on the other stem 12 in axial alignment with the electron gun 13.

Monuted between the electron gun 13 and anode or target electrode 14 are a plurality of centrally apertured electrodes 15 to 19, inclusive, in axial alignment with the electron gun 13 and in energy translating relationship with the electron beam flowing between the electron gun and the anode or target electrode. As shown clearly in Fig. 1, the electrodes 15 and 16 define a gap 20 and the electrodes 18 and 19 define a second gap 21, at which gaps energy may be imparted to or taken from the electron beam through the agency of external circuits, not shown, suitably associated with the various electrodes. Each of the electrodes 15 to 19, inclusive, includes an annular disc portion extending through the side of the enclosing vessel 10 and hermetically sealed thereto. The electrodes may be provided with annular corrugations, as illustrated in the electrodes 16, 17 and 18, to allow accurate relative positioning thereof during assembly of the device and to prevent deleterious disturbance of this relation by expansion and contraction of the electrodes due to variations in the temperature thereof during construction and operation of the device.

The electron gun 13, as shown clearly in Fig. 2, is constructed as a unitary assembly the foundation of which is an insulating ring 22, for example, of glass. This assembly comprises a pair of rigid, cylindrical beam forming electrodes 23 and 24, for example of a magnetic material such as steel, mounted one within the other and supported in exact coaxial relation by a plurality of rigid supports 25 and 26, respectively, embedded in the insulating ring 22, the electrodes 23 and 24 having surfaces 27 and 28, respectively, of predetermined configuration and in

predetermined space relation such as described for example, in the application, Serial No. 328,826, filed April 4, 1940, of Arthur L. Samuel and Carlyle V. Parker.

The unitary assembly includes also a cathode including a cylindrical cup-shaped metallic member 29, the base 30 of which is arched inwardly and conforms to a segment of a sphere and the surface 31 of the base being coated with a material having good thermionic emission characteristics. Mounted within the cathode and in proximity to the base 30 thereof is a heater element which includes a pair of relatively wide diameter heater coils 32 embedded in an insulating, preferably ceramic, mass 33. The end portions 34 of the heater coil are sealed in an insulating bead 35 in an aperture in a metallic cup-shaped member 36 fitted within the cathode and locked in position by tabs 37 struck from the body of the cathode. Heating current to the coil 32 is supplied through leading-in conductors 38 sealed in the stem 11 and spaced from one another by insulating sleeves 39. As shown in Fig. 2, the heater coil comprises two similar parts oppositely wound, in order that, when energized, it will not produce a magnetic field deleteriously affecting the fields adjacent the cathode surface 31.

As shown in Fig. 2, the cup-shaped member 36 is constructed of two or more layers in order to conserve the heat produced by the heater coil. Conservation of this heat is provided also by a pair of metallic baffles 40 and 41 joined to one another in spaced relation and one of which is secured to the cathode as shown.

The cathode and heater unit is slidably insertable into the inner electrode 23 through an annular flange or guide 42 on the electrode 23, which locates the unit in exact coaxial relation with the electrode 23, the cathode being provided with an annular stop 43 which abuts the lower end of the electrode 23 and locates the cathode heater unit whereby the requisite exact spacing of the emissive surface 31 with respect to the surfaces 27 and 28 is established automatically when the cathode-heater unit is inserted into place. This unit is held in position by a plurality of rigid relatively thin wires 44 secured to the baffle 41 and to rigid metallic uprights 45 affixed to the electrode 23 and sealed in the stem 11. The uprights 45 are embedded in the stem 11 and constitute the supports for the electron gun.

If the electron gun should become inoperative, as by failure of the emissive surface 31 or of the heater element, the electron gun together with the stem 11 on which it is mounted may be removed as a unit from the enclosing vessel by cutting the wall of the enclosing vessel at a region in the vicinity of the stem 11. The wires 38 and 44 may then be severed and the cathode-heater assembly withdrawn as a unit. A similar cathode-heater assembly is then inserted into the electrode 23 and, as has been noted hereinabove, this assembly will be positioned accurately so that the requisite exact spacing of the emissive surface 31 of the cathode with respect to the surfaces 27 and 28 is realized readily. It will be noted that this replacement of the cathode and heater is accomplished without affecting the relation of the beam forming electrodes 23 and 24.

Although a specific embodiment of the invention has been shown and described, it will be understood, of course, that it is only illustrative and that various modifications may be made therein without departing from the scope and spirit of this invention as defined in the appended claims.

What is claimed is:

1. An electron gun for electron discharge devices comprising a foundation member, a pair of cooperating electrodes mounted on said foundation member and fixed in spaced relation thereby, one of said electrodes including a cylindrical portion, a unitary assembly extending within and slidably fitted in said cylindrical portion and including a cathode and a heater element therefor, and cooperating means on said one electrode and said assembly for positioning said assembly longitudinally with respect to said one electrode.

2. A unitary electron gun assembly for electron discharge devices comprising an annular insulating member, a pair of coaxial electrodes the inner of which has a cylindrical portion provided with an inwardly extending flange, means extending from said insulating member and supporting said electrodes in fixed relation, a unitary assembly insertable within said inner electrode and coaxial therewith, said assembly including a cathode member having a cylindrical portion slidably fitted within said flange and provided with a stop for abutting said flange to locate said assembly longitudinally with respect to said inner electrode, and wire means secured to one of said electrodes for locking said assembly in position.

3. A unitary assembly for electron discharge devices comprising a stem, a pair of coaxial electrodes the inner of which has a cylindrical portion provided with an inwardly extending annular flange, rigid means supporting said inner electrode from said stem, an insulating member fixedly supporting from said inner electrode, rigid means mounting the other of said electrodes from said insulating member, a cathode member having a cylindrical portion slidable in said annular flange and provided with an annular stop adapted to abut said flange when said cathode is inserted through said flange, a heater element mounted within said cathode member, and a plurality of rigid wires secured to said first rigid means and to said cathode member and locking said cathode member in position within said inner electrode.

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