Nov. 8, 1938. J. HIRMANN 2,135,941

ELECTRODE STRUCTURE

Filed April 9, 1935

Fig. 1

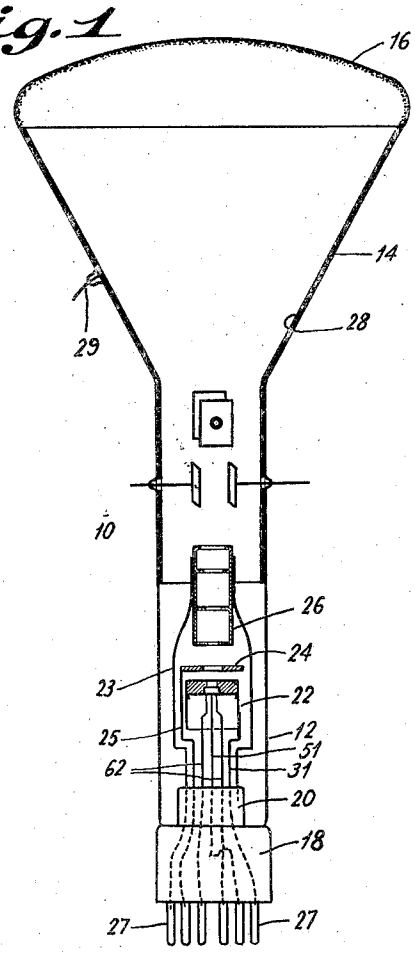



Fig. 2

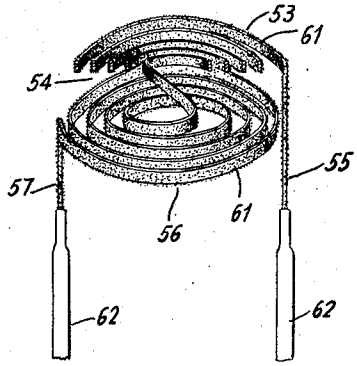
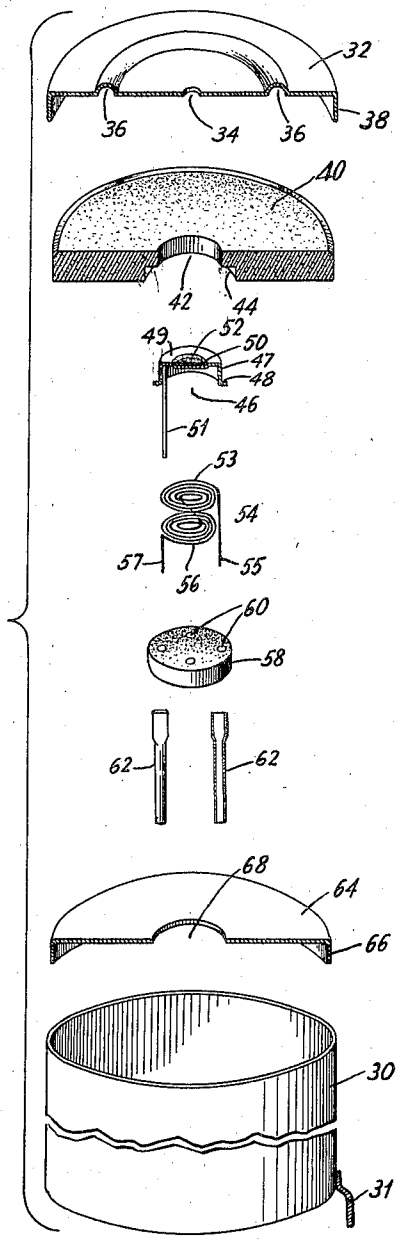



Fig. 3

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2,135,941

## ELECTRODE STRUCTURE

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4 Claims. (Cl. 250—27.5)

My invention relates in general to cathodes for use in electron discharge tubes and more particularly to indirectly heated cathodes and means for supporting such cathodes within an electronic device of the cathode ray type.

Indirectly heated cathodes are well known in the prior art and usually comprise a tubular member having one end thereof closed. The closed end is then usually coated with a material capable of producing thermionic emission and for such purposes a coating of barium and/or strontium carbonates is very satisfactory.

During the process of exhaust and activating, these carbonates are normally broken down into the oxides from which a stream of electrons may be drawn. Such cathodes are utilized to an advantage in Braun or so-called cathode ray tubes where an electron beam of high density is desired. In this connection it is customary to provide a heater element within the cathode sleeve which may be connected to a source of direct or alternating current. It has been found, however, that when an alternating current is used a ripple will sometimes occur in the output of the tube, in that the variation in the supply causes a pulsating stream of electrons to be given off at the active cathode surface. It has therefore been customary to utilize direct current for such cathode ray tubes.

Such tubes usually have associated with the cathode and in close proximity therewith an electron beam control device usually termed a control grid. In tubes of the prior art it has in many instances been exceedingly difficult to manufacture this type of structure, in that very accurate cathode control grid spacing must be utilized to maintain uniformity between tubes and obtain high electron beam densities for given operating conditions.

Thus it is shown by Knoll in his co-pending case having Serial No. 627,927, filed September 21, 1932, that it is advantageous to have the grid cathode spacing at no greater distance than that determined by the control grid aperture. Inasmuch as it is desirable to provide small aperture sizes, it is necessary to resort to very close element spacing.

It is therefore an object of my invention to provide an indirectly heated cathode for use in electron discharge devices which is non-inductive.

It is a further object of my invention to provide a cathode which may be rigidly located with respect to the surrounding electrodes.

It is a still further object of my invention to provide a cathode which may be located adjacent one or more surrounding electrodes and at a predetermined distance therefrom.

It is a still further object of my invention to provide a cathode having high heat concentration and low heat loss.

My invention possesses numerous other objects and features which will be set forth in the following description of my invention. It is to be understood that I do not intend to limit myself to the particular modification shown, as I may adopt variant embodiments of my invention within the scope of the appended claims.

Broadly considered, my invention embodies the feature of providing a more suitable cathode and cathode-supporting structure for use in cathode ray tubes. More particularly it provides a heater-cathode combination having low inductive effects, low thermal expansion, high heat concentration, and fixed and rigid position with respect to the other elements of the tube. Such cathodes made in accordance with my invention may be utilized in sundry applications in addition to that described in connection with a cathode ray tube. Thus, it is equally applicable to X-ray tubes and electron beam tubes of all descriptions.

The novel features which I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, will best be understood from the following description of a specific embodiment when read in connection with the accompanying drawing, in which

Figure 1 is a view of a cathode ray tube utilizing the invention;

Figure 2 is a greatly enlarged perspective sectional view of the heater of my invention; and

Figure 3 is a view of the component parts comprising the heater, cathode, control grid, and element spacers.

In detail the cathode ray tube shown in the drawing as Fig. 1 comprises an evacuated vessel 10 which usually takes the form of a neck section 12, a frusto-conical section 14 terminated by a substantially plane surface or end section 16. A base 18 is provided to which connections may be taken from the re-entrant stem 20 supporting the cathode grid assembly 22, the apertured accelerating electrode 24, and the beam limiting and focusing anode 26. Operating voltages are supplied to electrodes 24 and 26 by way of the conductors 23 and 25, which like all other conductors, connect with the pins 27 in the supporting base 18. A further electron focusing and accelerating electrode 28, frequently referred to as a second anode, may be provided on the neck

and frusto-conical section 14 of the tube 10. Operating voltages are supplied to electrode 28 by way of the connection 29. The control grid-cathode assembly 22 comprises a series of parts which are shown in more detail by Figures 2 and 3.

Referring now more particularly to Figures 2 and 3 of the drawing, a cylindrical shield member 30 is closed at one end by the disc 32, serving as the control grid element of the tube to which suitable control voltages are applied by way of conductor 31 which makes connection with the cylindrical portion 30, for example, and by a spot weld where desired. The disc 32 is provided with an aperture 34 therein through which the developed electron stream passes. To strengthen the disc member 32 it is surrounded by the reinforcing rib 36. The flange 38 may be suitably welded or otherwise fastened to the cylinder 30 in such a manner that the flange 38 is within the cylinder and the plane of the disc 32 is even with the upper edge of the cylinder. An insulating spacer 40 having an aperture 42 and recessed shoulder 44 is so proportioned that it will snugly fit within the disc 32.

The cathode 46 comprises a cylindrical shell portion 47 closed at one end and having the open end flared into a flange portion 48. The closed end 49 is provided with a recess 50 into which may be placed by spraying, dusting or other convenient means a layer of alkaline earth carbonates for the purpose of forming the thermionically active surface 52. The outside diameter of the cathode flange 48 is so proportioned as to rest firmly within the recess 44 in the insulating spacer 40. It will be evident that the axial distance between emission surface 52 and the inner surface of the disc 32 will depend on the relative design dimensions of the spacer 40 and cathode 46. Such a construction will naturally obviate the necessity for skill in mounting such an assembly within a thermionic tube wherein this distance of grid-cathode spacing is critical.

A heater element 54 having a current carrying leads, 55, 57 is wound as hereinafter described and so proportioned as to fit within the cathode 46. The design dimensioning of this heater is such that it will lie between the insulating spacer 58 and the inner surface of the cathode when the spacer rests on the flanged edge 42 of the cathode. The leads 55, 57 pass through the holes 60 in the spacer 58 and are fastened within the terminals 62 formed preferably of nickel tubing.

A disc 64 provided with a flange 66 and aperture 68 has an outside diameter equal to that of flanged disc 32, the aperture being of smaller diameter than that of spacer 58, but sufficient to pass the cathode lead 51 and heater leads, 55, 57. The disc 64 may be fastened to the cylinder 30 in a manner similar to which the disc 32 was fastened thereto except that the disc is pressed firmly against the spacer 58 retaining the cathode flange 48 against the recessed surface 44 and the spacer 40 against the disc 32.

In accordance with my invention the heater assembly 54 comprises as mentioned before, a double spiral winding comprising two helices continuous at their center to form a single winding. This coil may most conveniently be formed of a single wire of suitable size and length to provide a given current capacity under any given operating voltage. More specifically this heater comprises an upper spiral 53, one end of which is bent to form a lead 55. The opposite end of the upper spiral, that is the center portion, is bent at an angle to the plane of the helix thus forming a link between the upper spiral and a lower spiral 56. The wire is then spiraled turn for turn under the upper helix to form the lower helix 56. The lower spiral 56, wound in opposite direction turn for turn with respect to the upper spiral 53 terminates at the opposite end by bending to form the heater lead 57.

The heater coil thus provided is then coated with insulating material 61 applied by spraying with or dipping in a suitable insulating compound such as aluminum-oxide mixed with a suitable binder. Following the coating process and providing aluminum-oxide is used, the heater may be fired at a temperature of approximately 1700° C. to sinter the aluminum oxide insulation.

It is evident that such a construction will result in an equalization of the magnetic field set up in the two halves of the coil and that the total external magnetic field will approximate zero. It has been found that in such a coil as that described little or no inductive effect is noted in the operation of the tube when an alternating current source is used for supplying the heating current.

What is claimed as new and desired to be secured by Letters Patent is the following:—

1. An electron discharge device comprising an enclosing vessel, a stem, a cathode, and electron beam modulating electrode, and an anode, said cathode enclosing a heater comprising a single continuous conductor forming two spirals of wire positioned in adjacent parallel planes in close proximity, the turns of one spiral being wound in opposite direction to the turns of the other spiral and in non-inductive relation thereto and a pair of perforated members so positioned relative to the cathode as to support the cathode in compression.

2. An electron discharge device including an enclosing vessel, a cathode, and an anode, said cathode being supported in compression between two perforated members, one of said members lying between said cathode and anode and a perforated electrode member carried upon the perforated member intermediate the cathode and anode, said last named electrode being adapted to have impressed therein a variable potential for modulating a beam of electrons emanating from said cathode.

3. In a cathode ray tube, a cylindrical member closed at one end, an electron emitting material supported within the central portion of said closed end and carried upon the outer surface thereof, an insulating member having a flanged central aperture, said insulating member being adapted to be positioned to surround substantially the said cylindrical member supporting said emitting material and prevent longitudinal movement thereof, a second cylindrical member having an internal diameter corresponding to the diameter of said insulating member so that said insulating member is adapted to be positioned within the said cylindrical member, an end closing member for said second named cylindrical member, said closing member having a central aperture of a diameter substantially smaller than the aperture in the insulating member arranged to close the end portion of said last named cylindrical member and house thereby the insulating member and the cylinder supporting the electron emitting material and prevent longitudinal movement thereof, a non-inductive heater element supported within said first-named cylinder for heating the electron emitting material supported thereby so that when current is applied to the

heating member the electron emitting material emits electrons, and an insulating ring positioned also within said first-named cylindrical member for positioning the said heating element within said cylinder.

4. An electrode assembly comprising a substantially cylindrical member closed at one end and provided with an aperture centrally located with respect to the closed end thereof, an insulating ring member supported within the closed end portion of the closing member for the cylinder, said insulating member also being provided with an aperture axially aligned with respect to the aperture in the end closing member for the cylinder, an electron emitting surface supported by the said insulating member and positioned within the apertured portion thereof, and a non-inductive heating means for heating the said electron emitting surface supported also within the cylindrical member and located substantially axially with respect to the apertures in the end closing member of the insulating member and the electron emitting member.

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