

**April 7, 1953**

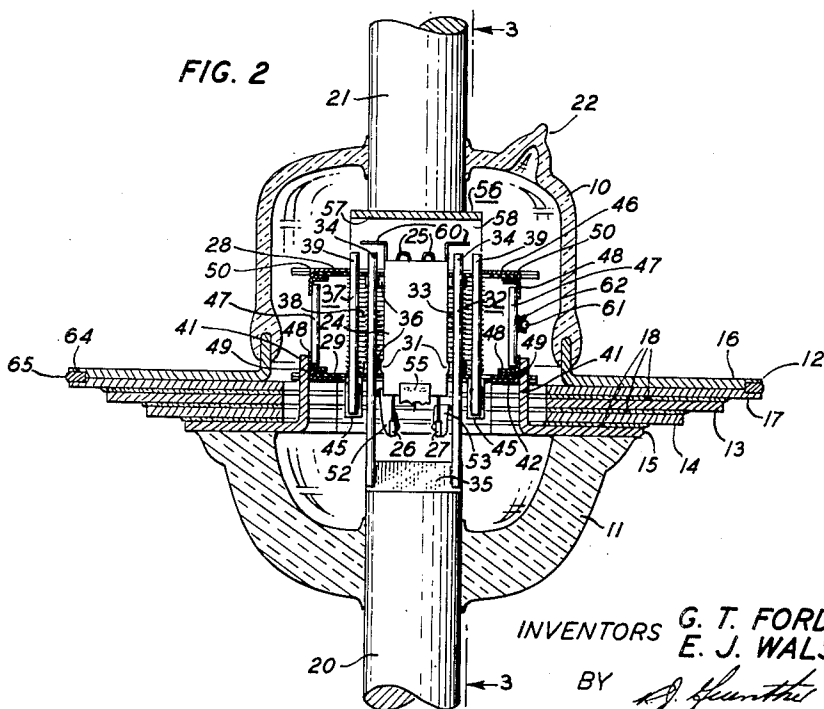
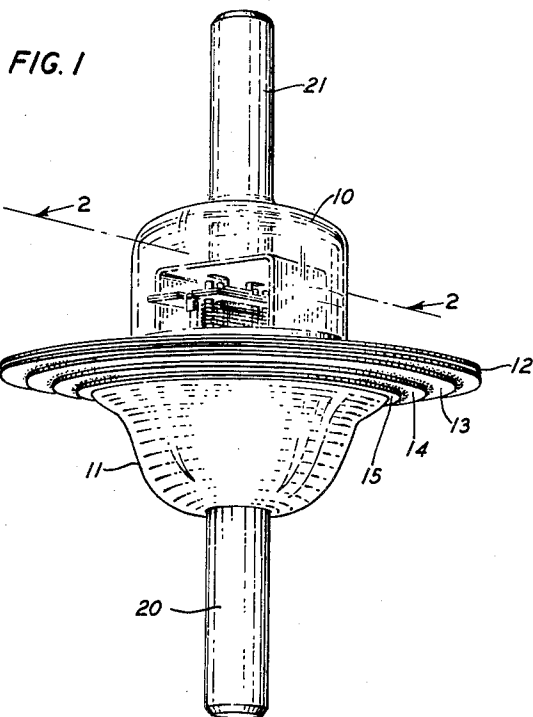
G. T. FORD ET AL

**2,634,384**

THERMAL STRUCTURE FOR ELECTRON DISCHARGE DEVICES

Filed Dec. 1, 1950

3 Sheets-Sheet 1



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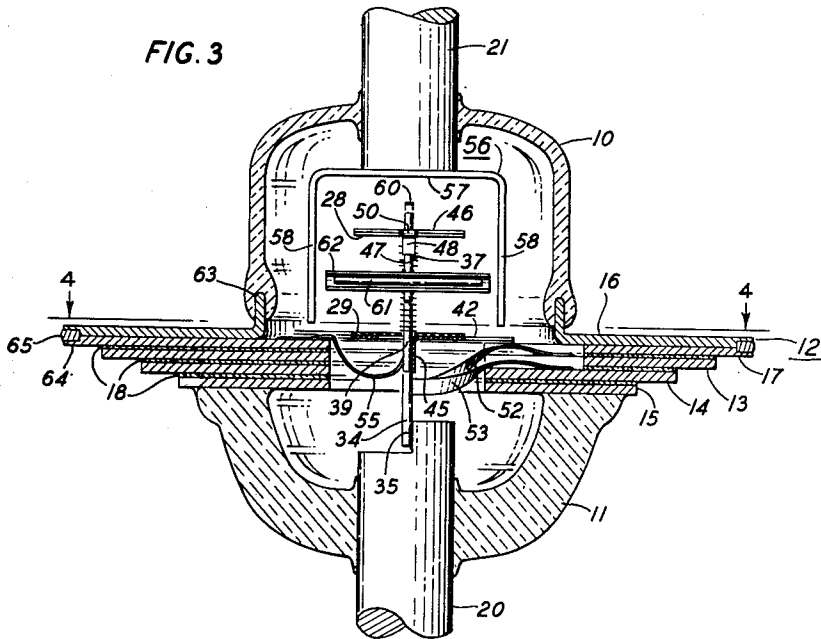
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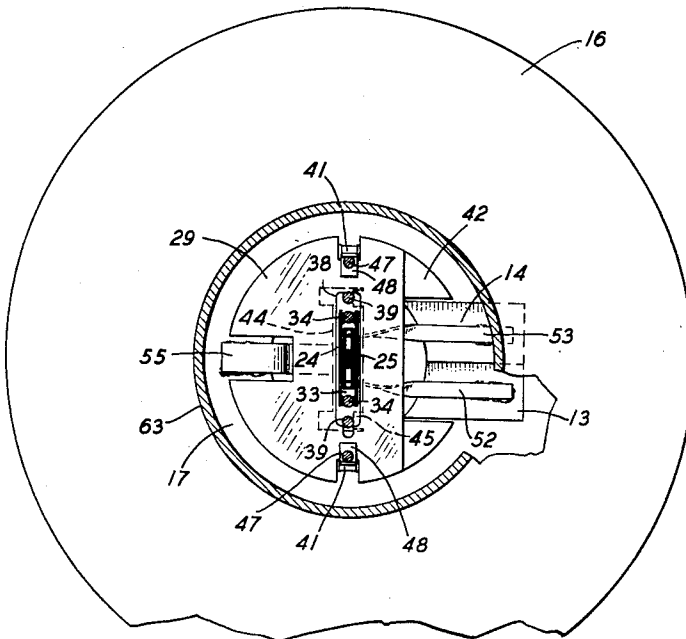
THERMAL STRUCTURE FOR ELECTRON DISCHARGE DEVICES

Filed Dec. 1, 1950

3 Sheets-Sheet 2



**FIG. 4**



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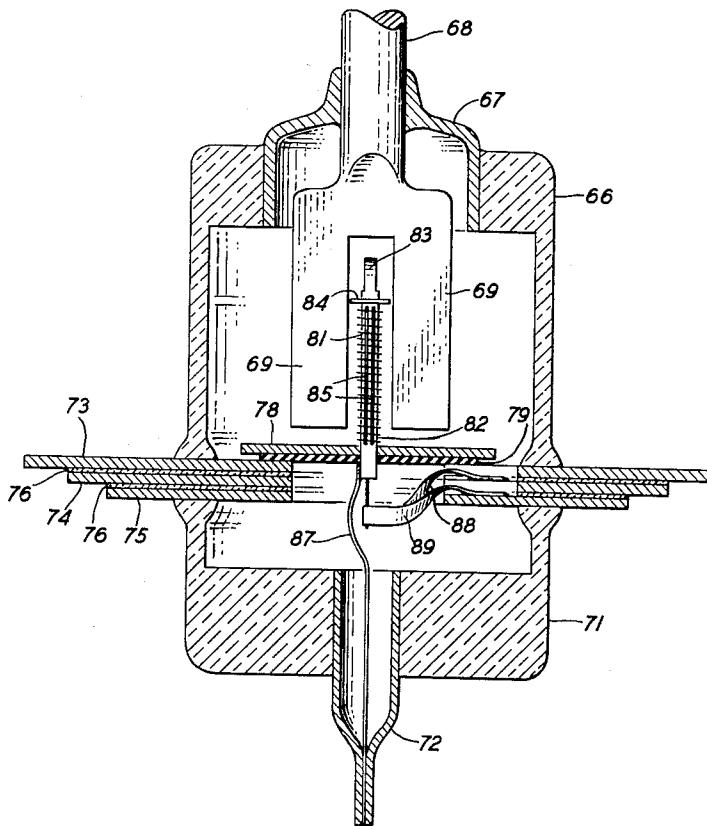
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THERMAL STRUCTURE FOR ELECTRON DISCHARGE DEVICES

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3 Sheets-Sheet 3

FIG. 5



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## UNITED STATES PATENT OFFICE

2,634,384

THERMAL STRUCTURE FOR ELECTRON  
DISCHARGE DEVICES

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Application December 1, 1950, Serial No. 198,598

12 Claims. (Cl. 315—52)

1

This invention relates to electron discharge devices and, more particularly, to an envelope and lead-in structure for such devices.

In high gain, broad-band electron discharge devices operable at high frequencies, such as are employable in mobile radio equipment, it is desirable to reduce the lead inductance of each internal element to a minimum. This allows for more efficient operation of the device. It is also desirable to have sufficient capacitance between certain of the individual elements of the device to provide advantageous by-pass condenser action.

Thus, in the operation of such devices, one electrode of the device may be connected to ground. If the device is a tetrode, the cathode may advantageously be grounded; and, similarly, if the device is a triode, it may advantageously be employed with grounded-grid circuits. In order to attain efficient and stable operation, it is advantageous to have a certain minimum capacitance between certain of the various internal elements of the device and the grounded electrode.

Priorly, minimum by-pass capacitances have been obtained by external circuit elements or by internal elements which are relatively large and cumbersome. In minute electron discharge devices, space becomes of importance, and large by-pass capacitance elements internal of the tube envelope become objectionable. However, it is difficult, if not impossible, to attain all these capacitances in prior art structures without consuming a considerable amount of valuable space.

Further, in certain electron discharge device applications, it is desirable not only to have a certain minimum value for these capacitances between the elements of the device but, in fact, to predetermine the capacitance within well-defined limits.

It is, therefore, one object of this invention to reduce the inductance of the leads of elements of electron discharge devices.

It is another object of this invention to provide greater than a minimum capacitance between certain of the elements of the device, thereby defining by-pass condensers between these elements.

It is a further object of this invention to simplify the construction of electron discharge devices of the above-mentioned type.

It is a further object of this invention to improve the envelope of electron discharge devices and to provide an envelope easily positioned in and electrically connected to a mating socket or holder.

It is a still further object of this invention to

2

improve the operation of electron discharge devices.

These and other objects of this invention are achieved in accordance with one specific embodiment of this invention in which the envelope of an electron discharge device comprises a plurality of discs accurately positioned adjacent each other but insulated from each other. Each of the discs is internally connected to an element of the electron discharge device.

In one particular illustrative embodiment of this invention, a tetrode, such as may advantageously be employed in grounded cathode operation, comprises a large cathode lead-in disc which extends through and constitutes a portion of the envelope of the device. Serially closely adjacent thereto but insulated from each other are similar low inductance lead-in discs for the two cathode heater leads and for the screen electrode. By-pass capacitances are thus defined by the lead discs extending through and comprising a portion of the envelope of the device between the cathode heater leads and the screen electrode to the grounded cathode.

In this specific illustrative embodiment of this invention, the low inductance lead-in discs, which both define capacitances and are themselves the terminals of the device, are of decreasing size, thereby enabling the device to be facily seated in a cooperating socket which makes connection to the discs and thereby to the various internal elements of the device.

In another particular illustrative embodiment of this invention, a triode, such as may advantageously be employed in grounded-grid operation, includes low inductance lead-in discs extending through and comprising a portion of the envelope and defining the terminals for the control electrode and the heater leads.

It is, therefore, one feature of this invention that the envelope of an electron discharge device comprise a plurality of closely spaced discs extending therethrough and to which elements of the device are electrically connected. Advantageously, the discs may, in fact, support and position certain of the elements within the device. In accordance with this feature, low inductance lead-in connections for the elements of the device are attained.

It is a further feature of this invention that the discs be closely positioned adjacent each other and insulated from each other, whereby interelement by-pass capacitances are defined. In accordance with this feature, the discs are advantageously spaced from each other by a dielectric material which seals directly to the discs,

3

such as powdered glass. More specifically, it is a feature of this invention that the spacing between the discs be of the order of a few mills.

It is a further feature of this invention that the discs extending through the envelope and comprising a portion of the envelope of an electron discharge device may be of decreasing diameter.

A complete understanding of this invention and of these and other features thereof can be attained from consideration of the following description and the accompanying drawing, in which:

Fig. 1 is a perspective view of an electron discharge device illustrative of one specific embodiment of this invention;

Fig. 2 is a sectional view of the device of Fig. 1 taken along plane 2—2 of Fig. 1;

Fig. 3 is a sectional view of the device of Fig. 1 along line 3—3 of Fig. 2;

Fig. 4 is a sectional view of the device of Fig. 1 along line 4—4 of Fig. 3; and

Fig. 5 is a sectional view of an electron discharge device illustrative of another specific embodiment of this invention.

Referring now to the drawing, the illustrative embodiment shown in Fig. 1 comprises an electron discharge device having an envelope including an upper stem or bulb portion 10, a lower stem or bulb portion 11, and a plurality of discs 12, 13, 14 and 15 situated between the two stem portions 10 and 11. The uppermost disc 12, as best seen in Figs. 2 and 3, comprises two sections 16 and 17. The discs are advantageously of different diameters, the diameter increasing progressively from the bottom disc 15 adjacent the lower stem portion 11 to the uppermost disc 12 adjacent the upper stem portion 10. A thin layer of an insulating and dielectric material 18, such as a powdered glass or glaze, is sealed between the discs 12, 13, 14 and 15. The accurate spacings of the discs from each other may be obtained by positioning insulating spacers between the discs, the spacers being of a material having an expansion characteristic compatible with that of the glass or glaze employed between the discs, as further disclosed in the application of E. J. Walsh, Serial No. 198,597, filed December 1, 1950. Ribs or support cores may also extend through apertures in the discs between the upper and lower stem portions 10 and 11 of the envelope to strengthen the seals between the discs, as is also more fully disclosed in the above-mentioned application.

An electrode terminal pin 20 extends centrally through the lower glass portion 11 of the envelope of the device of Fig. 1, and an anode terminal pin 21 extends through the upper glass portion 10. An exhaust tabulation 22, as best seen in Fig. 2, is sealed in the glass portion 10 or the device may advantageously be exhausted through a hollow anode pin 21.

Within the envelope thus defined by the stem portions 10 and 11 and the discs 12, 13, 14 and 15, separated from each other and sealed to each other by the interspersed insulating material 18, may be positioned the various electrodes and other elements of the electron discharge device. In the illustrative embodiment disclosed in Fig. 1, the electrodes constituting a tetrode are positioned within the envelope thus defined, but this invention is not to be considered in its broad aspects as limited to any particular number of electrodes or arrangement thereof. As best seen in Fig. 2, the electrode unit comprises a flat hol-

4

low cathode 24 having a heater element 25 therein. The heater element 25 has tabs 26 and 27, one at each end, just beneath the cathode 24. The cathode itself is supported between an upper insulating support 28 and a lower insulating support 29, both of which may advantageously be of mica and which are themselves advantageously supported in the device as explained further below. The cathode 24 also may have embossments 31 on its sides adjacent the lower support 29 to position the cathode 24 between the supports 28 and 29, as is known in the art.

A first or control electrode 32 comprises a plurality of lateral wires 33 wound around a frame comprising two side rods 34 and end straps 35. The electrode 32, which may advantageously be fabricated in accordance with the application Serial No. 52,020, filed September 30, 1948, encompasses the cathode 24. The side rods 34, in the particular illustrative embodiment disclosed in the drawing, are secured to the terminal pin 20, as by being welded to a central surface 35 cut in the pin 20, as best seen in Fig. 3. The control electrode 32 is in turn encompassed by a screen electrode 37 also comprising a plurality of lateral wires 38 wound around two side rods 39.

In accordance with features of this invention, the electrode mount may advantageously be supported by the discs extending through and forming a portion of the envelope of the device. Thus, in the embodiment disclosed in Fig. 1, as best seen in Fig. 2, the bottom disc 15 has formed integral therewith a plurality of fingers 41 which are bent perpendicular to the plane of the disc 15 and extend axially in the device. These fingers 41 are secured to and support a thin metal plate 42, having an aperture 43 therein through which the electrodes of the device extend. The lower support member 29, which is preferably of mica, is positioned on top of the plate 42 and secured thereto, extending across the aperture 43. As best seen in Fig. 2, the plate 42 has two fingers 45 depending therefrom, the side rods 39 being secured thereto. The disc 15 is thus electrically connected to the screen electrode 37 through the plate 42 and defines a low inductance lead-in terminal therefor.

The upper insulator support 28 is similarly secured to a thin metal plate 46 which has a central aperture therein through which the cathode and electrodes extend. The upper plate 46 is supported from the lower plate 42 by two side rods 47 each secured to thin L-shaped metal tabs 48, in turn secured to narrow portions 49 and 50 of the thin metal plates 42 and 46, respectively, which are bent around the insulator supports 29 and 28, respectively, as best seen in Fig. 2 with respect to the upper plate 46 and insulator 28. The electrode mount, comprising the upper and lower insulators, cathode, heater, and electrodes can thus be entirely supported in accordance with this invention by one of the disc terminals extending through and forming a portion of the envelope of the device.

The screen electrode 37 in the specific embodiment of this invention illustrated in the device of Fig. 1 is electrically connected to the lowest disc 15 and the control electrode to the control electrode terminal pin 20 extending through the lower bulb portion 11. The heater 25 is advantageously connected to the disc terminals 13 and 14 as by tabs 52 and 53 extending from the short tabs 26 and 27, respectively, attached to the heater ends. As best seen in Figs. 3 and 4 the lower metal plate 42 has a wide open portion at

5

one side thereof and the lower section 17 of the upper disc 12 has a mating cut-out portion to allow the tabs 52 and 53 to be placed flat on the discs 13 and 14, respectively. As best seen in Fig. 4 the disc 13 itself has a cut-out portion to allow passage of the tab 53 to the lower disc 14.

The cathode is similarly secured by a tab 55 to the lower portion 17 of the disc 12, the lower metal plate 42 also having a cut-out portion to allow passage of the tab to the disc. While not necessarily limited thereto, the tabs 52 and 53 and tab 55 are advantageously secured to their respective disc terminals at opposite sides of the device.

The anode 56 of the device may be a U-shaped plate having a central portion 57 secured to the anode terminal pin 21 and side portions 58 extending opposite the flat portions of the cathode 24, the side or active portions 58 being spaced from the screen electrode 37, as best seen in Figs. 1 and 3. The central portion 57 of the anode 56 is electrostatically shielded from the control electrode 32 by thin flat integral extensions 60 of the sides of the cathode 24 which are bent over between the upper ends of the control electrode side rods 34 and the central portion 57 of the anode 56, as best seen in Fig. 2.

A getter 61 is advantageously positioned in a trough 62 secured to one of the outer side rods 47.

In the fabrication of the illustrative embodiment of this invention shown in Figs. 1 through 4, the device is advantageously assembled as three distinct units. These units are the electrode and cathode assembly, the lower stem portion and concentric discs, and the upper stem portion. The electrode and cathode assembly is secured to the lower stem portion by securing, as by brazing or welding, the fingers 41 of the disc 15 to the L-shaped members 48 secured to the bottom plate 42 and to the outer side rods 47. The tabs 52, 53 and 55 are then advantageously secured to their respective lead-in discs and the control electrode side rods 34 to the control electrode terminal pin 20 in the base of the lower stem portion 11.

The upper stem portion 10 is advantageously fabricated with the upper disc 16 of the cathode lead-in terminal 12 sealed thereto, as by being sealed to a circular ridge 63. After the electrode assembly is secured and connected to the lower stem portion and the disc terminals, the upper stem portion is placed over the lower stem portion, the disc 16 being on top of the disc 17, and the device sealed by securing the discs 16 and 17 together, as by welding or brazing. The discs 16 and 17 advantageously have mating cut-out portions in their peripheries forming a groove 64 in which a ring or rings of brazing solder 65 may be placed, the solder 65 sealing the discs together following the brazing operation. The device can then be evacuated and the exhaust tubulation 22 sealed.

An appreciation of the size of the particular illustrative embodiment of this invention described above can be obtained from the following spacings:

Inches

Between the cathode and control electrode... .0025  
Between the control and screen electrode... .0174  
Between the screen electrode and anode... .100

Further the thin layer 13 of glass or other dielectric material capable of sealing to the disc terminals may advantageously be of a thickness

6

of the order of a few mils or even less, depending on the by-pass capacitance desired.

In this particular illustrative embodiment of this invention, capacitances are thus defined between the cathode, which may advantageously be connected in the circuit to ground, and the heater leads and screen electrode. These capacitances are thus by-pass condensers built into the envelope of the device and provide the desired capacitances between the elements of the device for proper, efficient, and stable operation. The particular internal elements to be connected to the various discs will depend primarily upon the circuit arrangement with which the device is in cooperable relationship. Thus in accordance with this invention the particular element to which the capacitances are referred, which in this case is the disc 12 and thus the cathode 24, and the seriate arrangement of the capacitances can be varied in various embodiments of this invention, in accordance with the circuit desiderata which make it desirable that certain inter-element capacitances are either of a certain predetermined value or above a certain minimum value. In each case, however, these inter-element capacitances are defined by seriatly arranged discs, closely spaced adjacent each other but insulated from each other by a dielectric which seals the discs together, the discs forming a portion of the envelope of the device and extending therethrough and the discs also providing the low inductance terminals for the internal elements of the device.

Further, in accordance with this invention, certain of the discs may be segmented, the segments thereof insulated from each other, each segment thus being connected to an internal element of the device and defining a by-pass capacitance between that element and another element within the device. Thus the specific illustrative embodiment of Figs. 1 through 4 may be varied by having but three disc terminals seriatly arranged and comprising a portion of the envelope of the device, the middle terminal being in two equal segments, each of which is connected to one of the ends of the cathode heater.

In the particular illustrative embodiment shown in Figs. 1 through 4, the upper and lower stem or bulb portions 10 and 11 are both advantageously of glass, though other envelope materials or combinations of materials may be employed, as is known in the art. And the sides of the cathode 24 opposite the active anode portions 58 advantageously have coated thereon an electron emissive coating, such as of barium and strontium oxides.

Referring now to Fig. 5, there is shown another specific illustrative embodiment of this invention comprising a triode such as may advantageously be employed in grounded grid or control electrode operation. The electron discharge device there illustrated comprises an upper bulb portion 66, advantageously of glass, having a metal cup 67 secured centrally thereto. An anode terminal pin 68 extends through the metal cup 67, the pin having formed integrally therewith a U or horseshoe-shaped anode with side portions 69 extending into the device. A lower bulb portion 71, also advantageously of glass, has a hollow metallic tubing 72 located centrally therein, the tubing being the exhaust tubulation of the device and also the cathode terminal pin. Positioned between the upper and lower bulb portions and comprising with them the envelope of the device are three metallic discs 73, 74 and 75 separated from each other

by a thin layer 76 of an insulating material, such as a powdered glass or glaze. The disc 73 may be advantageously of a larger diameter than the disc 74 which in turn is advantageously of a larger diameter than the disc 75 to fit one particular mating socket that may be employed. However, the discs may also be of equal diameter.

An internal plate or disc 78 is positioned from the uppermost disc 73 by an insulator support 79, but is electrically connected to the disc 73, as by rivets, not shown, extending through the internal disc 78, the insulator support 79, and the envelope disc 73. The internal disc 78 in turn supports the control electrode 81 of the device, which may advantageously be an inverted U-shaped frame 82 having a narrowed central portion 83 to extend through an aperture in an upper insulator cathode support 84 positioned between the two depending arms 89 of the anode. Transverse fins 85 may advantageously extend from the U-shaped electrode frame 82 to aid in cooling the electrode.

The cathode, not seen in Fig. 5, is advantageously a flat hollow cathode similar to cathode 24 of the device of Figs. 1 through 4 and is positioned between the upper cathode support member 84 and the support member 79, both of which may advantageously be of mica, within the U-shaped electrode frame 82. The side portions of the cathode facing the depending arms 89 of the anode advantageously have coated thereon an electron emissive coating, as is known in the art. A flat tab 87 extends from the cathode into the exhaust tubulation 72, to which it is secured on the closing off exhaust tubulation 72 following evacuation of the device.

A heater element, not shown, extends within the cathode and has its two ends connected by tabs 88 and 89 to the terminal discs 74 and 75. In this particular embodiment of this invention, the three terminal discs 73, 74 and 75 thus provide low inductance leads for the heater and the control electrode and define by-pass capacitances between the heater ends and the control electrode, which may advantageously be grounded during the operation of the device.

It is to be understood that the above-described arrangements are illustrative of the application of the principles of the invention. Various other arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. An envelope for an electron discharge device comprising an upper bulb portion, a lower bulb portion, a plurality of concentrically aligned annular disc-shaped terminals sealed between said upper and lower bulb portions, a thin layer of a vitreous material interposed between said disc-shaped terminals and sealing said terminals in close proximity to each other, the spacing between said terminals being of the order of a few mils, whereby said vitreous material forms the dielectric of capacitances defined by said closely spaced disc-shaped terminals.

2. An electron discharge device comprising an envelope, a plurality of electrode elements within said envelope, a plurality of flat annular members comprising a portion of said envelope and extending therethrough, said elements being electrically connected to said flat annular members, and vitreous sealing layers of a few mils thickness between said annular members, said annular members being closely adjacent each other

and defining capacitances between said elements.

3. An electron discharge device comprising an envelope, means defining an electrode assembly including a plurality of electrical elements within said envelope, and a plurality of conducting annular members concentrically aligned and forming a portion of said envelope, said elements being separately connected to said annular members, and a layer of insulation of less thickness than said members between said annular members and sealed thereto, said annular members defining capacitances between said elements.

4. An electron discharge device comprising an envelope, said envelope comprising an upper bulb portion, a lower bulb portion, a plurality of concentrically aligned disc-shaped lead-in terminals serially sealed between said bulb portions, and insulating means between substantially all of the adjacent surfaces of said terminals and sealing said terminals in close proximity to each other, an electrode assembly within said envelope including a plurality of electrical elements, and means electrically connecting said elements to said lead-in terminals, said lead-in terminals defining capacitances between said elements.

5. An electron discharge device in accordance with claim 4 including means secured to one of said terminals and supporting said electrode assembly.

6. An electron discharge device comprising an upper bulb portion, a lower bulb portion, a plurality of concentrically aligned disc-shaped lead-in terminals sealed between said bulb portions, insulating means between said terminals and sealing said terminals to each other in close proximity to each other, said bulb portions, terminals, and insulating means defining an envelope, an anode, cathode, cathode heater means, and electrode all within said envelope, and means electrically connecting said cathode, cathode heater means, and said electrode to said terminals, said lead-in terminals defining capacitances between said cathode, heater means, and electrode.

7. An electron discharge device in accordance with claim 6 wherein said insulating means is a thin layer of a vitreous material and the spacing between said disc-shaped terminals is of the order of a few mils.

8. An electron discharge device comprising an upper bulb portion, an anode terminal pin extending through said upper bulb portion, a lower bulb portion, an electrode terminal pin extending through said lower bulb portion, a plurality of planar lead-in terminals sealed between said bulb portions, insulating means sealed between said lead-in terminals, said lead-in terminals being positioned closely adjacent each other, anode means supported by said anode terminal pin, a first electrode means supported by said electrode terminal pin, a cathode, cathode heater means, second electrode means, means supporting said cathode, cathode heater means, and second electrode means from one of said planar lead-in terminals, and means connecting said cathode, cathode heating means, and second electrode means to said planar lead-in terminals, said terminals defining capacitances between said cathode, cathode heating means, and said second electrode means.

9. An electron discharge device comprising a lower bulb portion, a first disc-shaped lead-in terminal sealed to said lower bulb portion, an

upper bulb portion, a second disc-shaped lead-in terminal sealed to said upper bulb portion, a pair of disc-shaped lead-in terminals positioned between said first and second terminals, said terminals being concentrically aligned and being positioned closely adjacent each other, a thin layer of glass sealed between said terminals, a first terminal pin extending through said upper bulb portion, a second terminal pin extending through said lower bulb portion, insulating support means, means supporting said insulating support means from said first disc-shaped terminal, a flat hollow cathode positioned by said insulating support means, a tab electrically connecting said cathode to said second disc-shaped terminal, a cathode heater within said cathode, tabs electrically connecting the ends of said heater to said pair of disc-shaped terminals, a first electrode encompassing said cathode, said electrode including side rods secured to said electrode terminal pin, a second electrode encompassing said first electrode, said second electrode including side rods, a plate secured to said insulating support means and electrically connected to said first disc-shaped terminal, said plate having dependent fingers, said second electrode side rods being secured to said fingers, a U-shaped anode enveloping said second electrode and secured at the base of said U to said anode terminal pin and integral extensions of said flat cathode electrostatically shielding said anode, whereby said disc-shaped terminals define capacitances between said cathode, cathode heater, and second electrode.

10. An electron discharge device in accordance with claim 9 wherein said first disc-shaped terminal has the smallest diameter of said disc-shaped terminals and said diameters increase in ascending order until said second disc-shaped terminal and the spacing between said terminals is of the order of mils.

11. An electron discharge device comprising an upper bulb portion, a lower bulb portion, three disc-shaped lead-in terminals sealed between said portions, insulating means between said terminals sealing said terminals to each other in close proximity to each other, terminal means extending through each of said bulb portions, a cathode electrically secured to one of said terminal means, an anode electrically secured to the

other of said terminal means, a control electrode electrically secured to one of said disc-shaped terminals, and a cathode heater electrically connected between the others of said disc-shaped terminals, said disc-shaped terminals defining capacitances between said control electrode and said heater.

12. An electron discharge device comprising an upper bulb portion, a U-shaped anode secured to said portion and extending therethrough, a lower bulb portion, a metal exhaust tubulation extending through said lower portion, three disc-shaped lead-in terminals sealed between said bulb portions, a thin layer of glass between said disc-shaped terminals and sealing said terminals to each other in close proximity to each other, the thickness of said layer being of the order of a few mils, a first insulating support member and an inner disc member secured to the uppermost of said disc-shaped terminals, a flat hollow cathode supported by said first insulating support member and extending between the arms of said U-shaped anode, a tab electrically connecting said cathode and said exhaust tubulation, a U-shaped electrode frame supported by said inner disc member and enveloping said cathode, the bottom of said U being flattened, a second insulating support member fitting over said flattened bottom and also positioning said cathode, a helical control electrode wound around said electrode frame, fins extending from the arms of said U-shaped electrode frame member, a cathode heater within said cathode, and tabs electrically connecting the ends of said heater with the other of said disc-shaped terminals, said disc-shaped terminals thus defining capacitances between said electrode and said heater.

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#### REFERENCES CITED

The following references are of record in the file of this patent:

#### UNITED STATES PATENTS

| Number    | Name               | Date          |
|-----------|--------------------|---------------|
| 2,043,733 | Brasch et al. .... | June 9, 1936  |
| 2,428,661 | Fitzmorris .....   | Oct. 7, 1947  |
| 2,460,141 | McArthur .....     | Jan. 25, 1949 |