

April 18, 1944.

C. DEPEW

2,346,913

ELECTRON DISCHARGE DEVICE

Filed Oct. 15, 1941

2 Sheets-Sheet 1

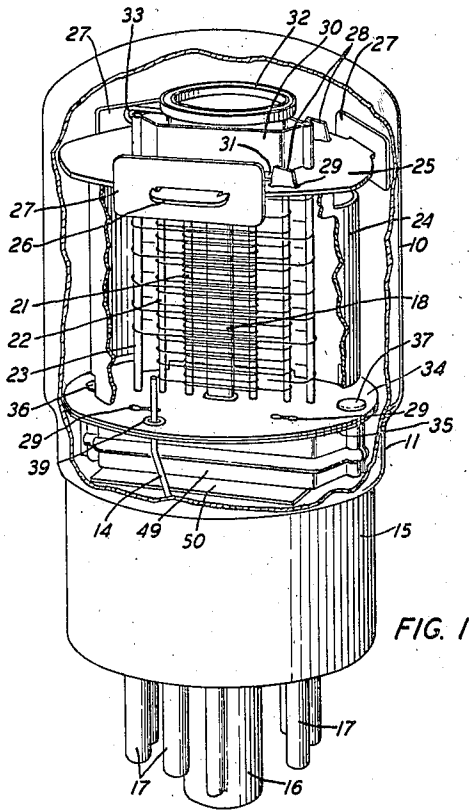


FIG. 1

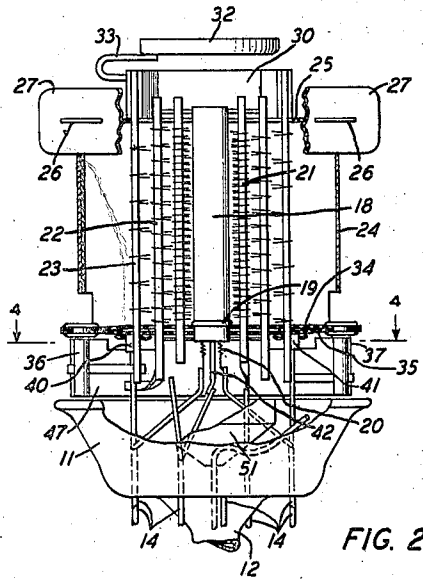


FIG. 2

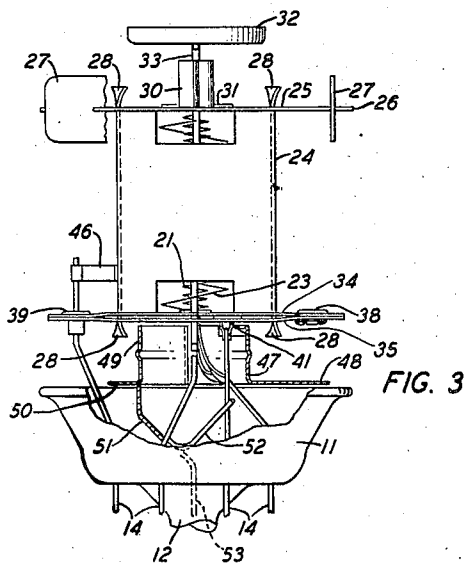


FIG. 3

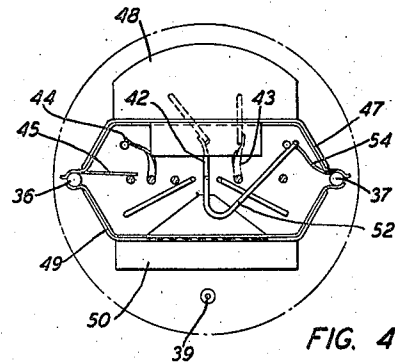


FIG. 4

INVENTOR  
C. DEPEW

BY

Walter C. Kiesel  
ATTORNEY

April 18, 1944.

**C. DEPEW**

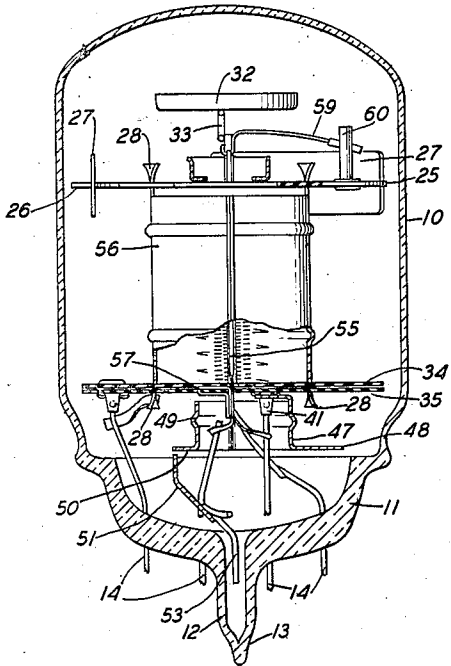
2,346,913

## ELECTRON DISCHARGE DEVICE

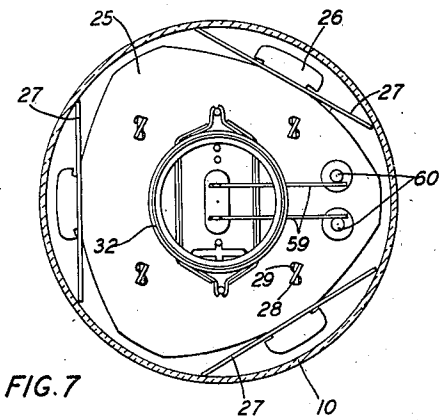
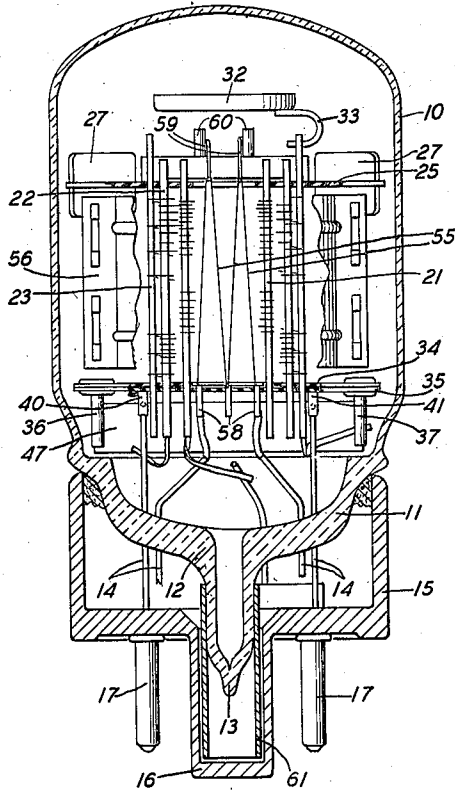
Filed Oct. 15, 1941

2 Sheets-Sheet 2

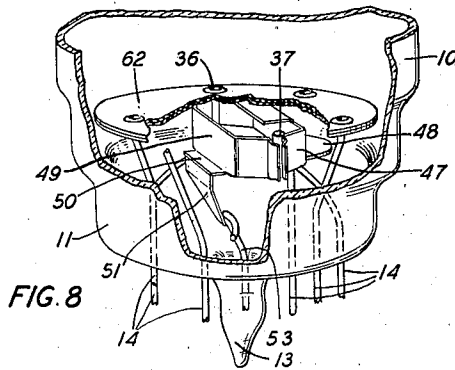
**FIG. 5**



**FIG. 6**



**FIG. 7**



**FIG. 8**

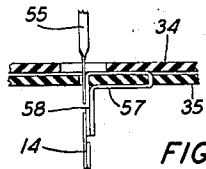


FIG. 5A

*INVENTOR*  
*C. DEPEW*

BY

Walter C. Kiesel

*ATTORNEY*

## UNITED STATES PATENT OFFICE

2,346,913

## ELECTRON DISCHARGE DEVICE

Charles Depew, Oakland, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application October 15, 1941, Serial No. 415,017

15 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices and more particularly to unitary assemblies for the support of multielectrodes in such devices.

An object of the invention is to reduce capacitance effects between the input and output electrodes in unitary assemblies.

Another object of the invention is to rigidly support the electrode unit in an enclosing vessel and eliminate torsional strains communicated to fragile electrode elements closely associated in the unit.

A further object of the invention is to efficiently shield the control-grid conductor below the unit from the high potential conductor attached to the anode and segregate the separate fields of these conductors so that the efficiency rating of the device for various frequency bands may be improved.

In accordance with this invention, these objects are attained in an electron discharge device comprising an electrode unit or mount having a plurality of cooperating electrodes assembled between transverse insulating spacer members. The lower spacer member is formed of double layers rigidly connected together, the double layer spacer providing the main supporting base for the unitary assembly in which rigid supports extending from the stem of the device and independent from the electrodes are anchored therein by metallic members which do not project through the top layer and, therefore, high insulation resistance is maintained between the electrodes. This arrangement facilitates the mounting of the unit in the vessel by supports rigidly secured in the base insulating spacer, but shielded from the emission path between the electrodes. Furthermore, these supports are offset from the diametrical line in the base insulator occupied by the various electrode supports, so that they are sufficiently distributed to insure high insulation paths between the electrode connections in the base insulator.

Another feature of the invention relates to a shielding enclosure of the conductor for the control-grid electrode adjacent the stem from the high potential conductor for the anode. In this arrangement, specifically disclosed in connection with a molded dish type stem in which the leading-in conductors are sealed in a circular boundary in the stem, the terminating ends of the electrode supports projecting toward the stem are surrounded by a shield collar having transverse shelf portions which shield the leading-in conductor for the control-grid from the anode projections in the lower insulating spacer.

Another feature of this construction is the introduction of an auxiliary side shield member which, in conjunction with a portion of the surrounding shield collar, forms a barrier separating the anode conductor in the stem from the control-grid conductor so that low capacity between the two conductors is secured and back coupling is reduced. This arrangement affords an efficient assembly in which both the anode and control-grid leading-in conductors may be mounted in the stem with the other electrode conductors with a minimum of detrimental effects and avoids the alternative of providing a leading-in conductor at the top of the vessel, where it is sometimes inconvenient in the assembly and manufacture of the device.

A further feature of the invention relates to the support of a filamentary type cathode or emitter in the unitary structure, whereby spaced shielded clips are mounted between the double layer base insulator to facilitate the support and attachment of the sections of the filamentary cathode to the clips below the surface of the insulating spacer. This arrangement insures a low resistance contact between the leading-in wires and the filament and increases the useful emission area between the electrodes so that higher efficiency may be attained.

These and other features and advantages of the invention will be more clearly understood from the following detailed description taken in connection with the accompanying drawings.

Fig. 1 is a perspective view of an electron discharge device embodying this invention and is shown with a portion of the vessel broken away to illustrate the assembly of the internal electrodes of the device.

Fig. 2 is a view in elevation, partly in section and partly broken away, of the electrode assembly unit made in accordance with this invention in combination with the stem of the vessel.

Fig. 3 is a side view in elevation of the unit of Fig. 1 showing the relationship of the shielding arrangement to the conductors in the stem.

Fig. 4 is a plan view of the lower section of the unit taken on the line 4—4 of Fig. 2 showing the disposition of the shields and conductors with respect to the electrodes.

Fig. 5 shows a modified form of the invention, partly in cross section, with the unit shown in side elevation.

Fig. 5A is an enlarged detail view in cross section of the connection of the filament to the clip supports as used in Fig. 5.

Fig. 6 shows the device of Fig. 5 in cross sec-

tion to clearly illustrate the assembly of the unit and its support from the stem.

Fig. 7 is a plan view of the top of the device of Fig. 5 showing the support of the unit in the vessel; and,

Fig. 8 is a perspective view of a modified arrangement of the support of the unit in the vessel, the unit being omitted to simplify the disclosure.

Referring to the drawings, and particularly to Figs. 1 and 2, a device of this invention is embodied in a multielectrode assembly enclosed in a bulbous vessel 10 fused to the rim of a molded or precast dish-type stem 11 provided with an outwardly extending tubulation 12 through which the device is evacuated to provide a high vacuum within the vessel and which is sealed off at 13, as shown in Fig. 5, to maintain the low pressure condition in the device. A plurality of leading-in wires or conductors 14 are sealed in the bottom of the stem in a circular boundary about the tubulation 12 and the stem is mounted in or cemented to a cup-shaped base 15, of insulating material, having an integral indexing stud 16 centrally projecting therefrom and a plurality of terminal prongs or pins 17 corresponding to the number of conductors in the stem which are attached thereto, for example, by solder, the pins surrounding the index stud and spaced in the base in the same relation as the conductors in the stem.

The electrodes are mounted beyond the stem 11 in a unitary assembly and include an oval-shaped indirectly heated cathode 18 having a bead 19 formed thereon to limit the movement of the cathode in a downward direction, the cathode enclosing an insulated heater element 20. The cathode is surrounded by a helical control grid 21, a screen grid 22, and a suppressor grid 23 in successive relation, each being supported by pairs of upright rods attached to the helices. A substantially rectangular-shaped anode 24 surrounds and encloses the cathode and grids to complete the multielectrode elements involved in the assembly. The cathode and grids are spaced in coaxial relation by a top spacer disc 25, of mica, having apertures across one diameter to accommodate the cathode and the grid supports and provided with integral ears 26 projecting from the periphery, which support transverse flexible mica plates 27 which have their ends in contact with the inner wall of the vessel 10 to support the upper end of the unitary assembly against shock and vibration. The anode 24 is provided with upwardly extending projections 28 which pass through distributed apertures 29, of figure 8 formation, the projections 28 after passing through the disc 25 being twisted to lock the projections in the disc. The ends of the grid supports extending through the upper spacer disc 25 are shielded electrostatically from the anode projections in the disc by a shielding collar 30, formed of two cooperating metallic pieces, attached to the long supports of the suppressor grid 23, the shield having outwardly extending flanged portions 31 which are in contact with the top surface of the spacer disc 25. The suppressor grid and shield also support a grooved getter ring 32 by a hairpin-shaped wire 33, so that the ring is mounted transverse to the axis of the unit with the grooved portion of the ring directed toward the top or dome of the glass vessel.

The electrodes are held in their cooperating relation at the bottom of the unit by a double

layer spacer element formed of a pair of circular mica discs 34 and 35 in juxtaposed relation which are clamped together by a pair of rivets 36 and 37, which extend downwardly toward the stem from the periphery of the disc at oppositely disposed points in alignment with the apertures for the cathode and grids across one diameter of the disc. The double layer spacer element is also provided with clamping eyelets 38 and 39 positioned near the periphery of the disc in oppositely disposed relation across the disc transverse to the position of the rivets 36 and 37. The anode is also provided with downwardly extending projections 28 which enter the symmetrical-shaped apertures 29 therein and the projections are twisted in the same manner as described in connection with the upper projections of the anode to rigidly secure the spacer element to the unit.

The double spacer element at the lower end of the assembly is provided to form a rigid base for the unit or mount of the electrodes and to facilitate the support of the mount from rigid conductors extending from the stem which are not direct continuations of the electrodes. This is accomplished by providing a pair of blind eyelets 40 and 41 which are attached to the lowermost spacer disc 35 in offset relation with respect to the diametrical line of apertures through which the grid supports extend. Since the eyelets do not extend through the uppermost spacer disc 34 they are shielded from the effective electrode area and therefore do not introduce any disturbing influence to the electron transit path between the cathode and anode. The blind eyelets 40 and 41 in their offset relation in the spacer element are in alignment with two of the conductors 14 extending through the stem, so that the eyelets are directly attached to these conductors without bending or distorting the conductors and the unit is rigidly supported without strain or stress being applied to any of the individual electrodes. The eyelets 40 and 41 may be embedded in the base insulator to insure their rigid connection instead of being clamped between separate discs.

The cathode is attached to one of the conductors by a flexible metallic strip 42 attached to the cathode termination below the double spacer element so that in combination with the bead 19 on the opposite side of the spacer element, the cathode is prevented from reciprocal movement in the mount. The heater element 20 is attached to two inwardly bent conductors, the control grid is connected to an inwardly bent conductor by a flexible strap 43, the screen grid is connected to one of the rigid straight conductors secured to the blind eyelet 40 by a flexible strap 44 and the suppressor grid is connected to the rivet 36 by a strap 45. This arrangement minimizes the effects of shocks or jarring of the device being communicated to the fragile electrodes, since the flexible couplings between the conductors and the electrodes tend to dissipate the effect of sudden jars and accordingly the critical spacing between the cooperating electrodes is maintained uniform and the electrical characteristics of the device are preserved to achieve the highest efficiency in the operation of the device throughout its life. Another conductor is bent outwardly and extends through the eyelet 39 and is welded thereto to lend additional support to the unit and this conductor is secured to the anode by a flexible strap 46 above the double spacer element.

In order to protect the conductors in the stem

and the projecting ends of the electrodes below the double spacer element and decrease the capacitance effects between the high potential field of the anode and the field of the control-grid, an electrostatic shielding barrier is provided on the lower end of the assembly to segregate these fields. This is accomplished by providing a shield member 47 having inwardly bent end portions which are welded to the rivets 36 and 37 to surround one side of the electrode extensions projecting through the spacer element. The shield section 47 is also provided with a flanged ledge 48 at the lower edge, which extends outwardly toward the lip of the cup-shaped stem 11 and forms an effective shield between the conductors in the stem and the twisted projections 28 of the anode. A similar shield member 49 provided with a short flanged ledge 50 is supported from the rivets on the opposite side of the conductors to completely surround the extensions of the electrodes projecting through the spacer element. An auxiliary shield 51 of triangular formation has a portion in alignment with the shield 49 and an inwardly bent portion directed toward the tubulation 12 in the stem, the auxiliary shield 51 being supported by a conductor 52 welded to one of the rigid rods projecting toward the blind eyelet 41. This conductor is provided with a downward extension 53, which enters the tubulation 12 to extend the shielding effect beyond the entrance of the tubulation. The surrounding shield members 47 and 49 are also connected to the rigid rod attached to the blind eyelet 41 by a flexible strap 54 so that a suitable potential may be applied to the suppressor grid through the shield and the strap 45. It will be seen that the control-grid conductor in the stem is electrostatically segregated from the high potential conductor for the anode to reduce the plate to control-grid capacitance.

In another embodiment of the invention, as shown in Figs. 5, 6 and 7, the support of the unit and the shielding features of the conductors in the stem are the same as heretofore described, but in addition the invention contemplates the support of a filamentary type cathode in association with the multi-electrodes of the unit to increase the overall length of the emission area and to facilitate the mounting of the cathode and decrease the internal resistance of the supporting connections with respect to the cathode. In this arrangement, a pair of inverted V-shaped filaments 55 are mounted in the center of the unit and are surrounded by the three grids 21, 22 and 23 and a substantially rectangular-shaped anode formed of two half sections 56 which are clamped together on the flanged portions thereof and secured to the spacing insulators 25, 34 and 35 by twisted extensions 28 the same as described in the previous form.

The filament sections are anchored in the lower double spacer element by a plurality of blind folded metallic clips 57, shown more clearly in Fig. 5A, which extend through apertures in the lowermost disc 35, the clips having parallel portions on opposite sides of the disc 35 and their free end 58 being welded together in alignment with the position of the filamentary sections 55. This permits the extension of the filamentary sections through the spacer discs 34 and 35, where the twisted ends of the filament sections are welded to the ends 58 of the clips to rigidly secure the filaments in position and to increase the effective emissive length of the filament. The metallic clips are shielded by the uppermost spacer disc 34 from the effective emission area of the filament so that sputtered coating material from

the filament cannot be deposited on the clips to affect the resistance characteristics of the device. Furthermore, the clips are insulated from the turns of the various grids between the filament and anode to overcome short-circuit paths between these elements. Another feature of the clips is the added effect of shielding produced in the short gap between the edge of the collar shield 49 and the adjacent control grid 21. The filamentary sections are supported under tension at the top of the unit by a pair of flexible springs 59 which have hooked portions engaging the hights of the filament sections and are anchored to upright rivets 60 arranged in parallel relation near one edge of the top mica spacer 25. As shown in Fig. 6, the control-grid conductor extending from the stem to the electrode termination in the base 15 is also effectively shielded from the anode conductor by a grounding shield 61 which surrounds the tubulation 12 and extends into the indexing stud 16 on the base, the shield being attached to the rigid conductor connected to the blind eyelet 41. This arrangement continues the effect of the shielding from the termination of the central conductor 53 within the tubulation so that there is no gap in the shielding barrier between the control-grid and anode conductors.

The complete shielding effect of the conductors in the stem may be practiced in accordance with this invention independent of the low capacitance support of the unit and the particular clip arrangement for supporting the filamentary cathode. This is shown in Fig. 8 which illustrates a modified arrangement of the lower support of the unit but without the unit assembly therein since it is obvious that the electrodes may be mounted from suitable spacer elements as previously described or in any other suitable manner. In this arrangement a lower spacer disc 62 of the electrode unit is directly supported by conductors in the stem, for instance, by eyelets, secured in the disc, and the cooperating shield members 47, 49 and 51 may be assembled in relation to the disc 62 intermediate the anode conductor which is exterior to this shielding assembly and the other conductors in the stem which are coupled to extensions of the electrodes extending within the shielding assembly.

Various other modifications of the invention will be, of course, readily suggested to those skilled in the art to which this invention appertains and such modifications are intended to be within the scope of the invention as defined in the appended claims.

What is claimed is:

1. An electron discharge device comprising an enclosing vessel having a stem, a unitary electrode mount supported therein including a plurality of electrodes, a spacing insulator member at one end of said electrodes, a pair of juxtaposed spacing insulator members at the opposite end of said electrodes, a pair of supports extending from said stem, a plurality of conductors in said stem for certain of said electrodes, means anchored between said juxtaposed insulator members and attached to said supports, and connectors joining other electrodes in said mount to said supports.

2. An electron discharge device comprising an enclosing vessel having a stem, a unitary electrode mount supported therein including a plurality of electrodes, a spacing insulator at one end of said electrodes, a pair of juxtaposed spacing insulators at the opposite end of said electrodes, supports for said electrodes mounted along one diameter of said insulators, a pair of

supports extending from said stem, a plurality of conductors in said stem connected to certain of said electrodes, means anchored between said juxtaposed insulators in offset relation with respect to said supports mounted along one diameter, said means projecting toward said stem for receiving said straight supports, and connectors bridging the gap between adjacent electrodes and said supports.

3. An electron discharge device comprising an enclosing vessel having a stem, a unitary electrode mount supported therein including a plurality of electrodes, a spacing insulator disc on one end of said electrodes, a pair of juxtaposed insulating spacer discs on the opposite end of said electrodes, means clamping said discs together, a pair of metallic eyelets held between said discs in offset relation, a pair of supports extending from said stem, said supports being connected to said eyelets, a plurality of conductors in said stem connected to certain of said electrodes, and a shield member surrounding said supports and said eyelets and supported by said clamping means.

4. An electron discharge device comprising an enclosing vessel having a stem, a unitary electrode mount supported therein including a plurality of electrodes, insulating spacing members at opposite ends of said electrodes, a plurality of conductors in said stem for certain of said electrodes, metallic eyelets embedded in one of said spacing members in offset relation to a medial diameter thereof but projecting toward said stem, said eyelets having a head portion completely enclosed by said spacer members, and supports extending from said stem rigidly embraced by said eyelets.

5. An electron discharge device comprising a vessel having a stem, rigid conductors sealed in said stem, an electrode mount within said vessel including spaced insulating members and a plurality of electrodes supported therebetween, a supplemental insulating member adjacent one of said spaced members, a plurality of metallic supports extending through said supplemental member and abutting against one surface of said adjacent member, said supports being connected to some of said conductors, and means clamping said insulating members together to fixedly position said supports in said mount.

6. An electron discharge device comprising an enclosing vessel having a dish stem, a plurality of lead-in conductors extending therethrough in a circular boundary, an electrode mount supported beyond said stem including a plurality of electrodes spaced in cooperating relation by transverse disc spacers, a metallic shield supported by said mount and surrounding the extensions of most of said electrodes projecting through the lowermost disc spacer, said shield having transverse extending portions forming a barrier between said conductors and at least one of said electrodes, one of said conductors extending exterior to said shield and being connected to one of said electrodes of said mount, connections between the extensions of said other electrodes and said other conductors within said shield, and a side shield cooperating with said metallic shield interposed between said exterior conductor and said other conductors.

7. An electron discharge device comprising an enclosing vessel having a dish stem, a plurality of lead-in conductors extending therethrough in a circular boundary, an electrode mount supported beyond said stem including a plurality

of electrodes spaced in cooperating relation by transverse disc spacers, a metallic shield supported by said mount and surrounding the extensions of most of said electrodes projecting through the lowermost disc spacer, said shield having transverse extending portions forming a barrier between said conductors and said electrodes, one of said conductors extending exterior to said shield and being connected to one of said electrodes of said mount, connections between the extensions of said other electrodes and said other conductors within said shield, a side shield cooperating with said metallic shield and interposed between said exterior conductor and said other conductors, said side shield being out of contact with said metallic shield, and a connector attached to one of said shielded conductors and supporting said side shield.

8. An electron discharge device comprising an enclosing vessel having a dish stem, a plurality of lead-in conductors extending therethrough in a circular boundary, an electrode mount supported beyond said stem including a plurality of electrodes spaced in cooperating relation by transverse disc spacers, one of said conductors extending directly through the lowermost spacer and attached to one of said electrodes, shielding means interposed between said one conductor and the remaining conductors adjacent said stem and being supported by said mount, and connections between said other electrodes and said remaining conductors within said shielding means.

9. An electron discharge device comprising an enclosing vessel having a dish stem, a plurality of lead-in conductors extending therethrough in a circular boundary, an electrode mount supported beyond said stem including a plurality of electrodes spaced in cooperating relation by transverse disc spacers, one of said conductors extending directly through the lowermost spacer and attached to one of said electrodes, shielding means interposed between said one conductor and the remaining conductors adjacent said stem and supported by said mount, said means having portions forming a substantial barrier between said remaining conductors and said mount in paths leading out from said stem, and individual connections between said other electrodes and said remaining conductors.

10. An electron discharge device comprising an enclosing vessel having a dish stem with a central outwardly extending tubulation, a plurality of conductors extending therethrough in a circular boundary about said tubulation, an electrode mount within said vessel including a plurality of electrodes and insulating spacer members at opposite ends thereof, a plurality of metallic eyelets held in shielded relation to said electrodes in the lowermost spacer member, certain of said conductors being directly connected to said eyelet to support said mount from said stem, another conductor extending toward the periphery of said mount and being directly connected to one of said electrodes, a surrounding shield member carried by said mount and enclosing the extending portions of the remaining electrodes in said mount, connections between said electrode extending portions and the remaining conductors in said stem, and a shield member cooperating with said surrounding shield member and separating said peripherally extending conductor from the remaining conductors, said latter shield member being supported by a shield extension projecting centrally through said tubulation.

11. An electron discharge device comprising an

enclosing vessel, an electrode unit supported therein, said unit involving a plurality of electrodes including a filamentary emitter, a top spacer element and a bottom spacer element extending transverse to said electrodes, said bottom elements being formed of juxtaposed layers held together, a plurality of metallic strap members parallelly arranged in said bottom element, said strap members being folded around portions of one layer and held between said layers, the ends of each of said strap members extending downwardly and being joined together in a plane transverse to the axis of said vessel, the terminations of said emitter extending through said layers and being attached to said strap members, and tension supporting means on said top spacer element engaging said emitter.

12. An electron discharge device comprising an enclosing vessel, an electrode unit supported therein, said unit involving a plurality of electrodes including a filamentary emitter, a top spacer element and a bottom spacer element extending transverse to said electrodes, said bottom element being formed of juxtaposed layers held together, a plurality of metallic clips bound between said layers and extending downwardly in a plane transverse to the axis of said vessel, said emitter having its ends secured to said clips below said layers, and a tension spring extending from said top spacer element and engaging said emitter to maintain said emitter in an axial plane.

13. An electron discharge device comprising an enclosing vessel, an electrode unit supported therein, said unit involving a plurality of electrodes including a filamentary emitter, a top spacer element and a bottom spacer element extending transverse to said electrodes, said bottom element being formed of juxtaposed layers held together, a plurality of metallic clips having folded portions lying on opposite sides of one of said layers and the other layer shielding one of said portions, said clips also having angular bent portions extending away from said shielding layer, said emitter having its ends carried by said bent portions, and conductors in said vessel attached to said bent portions.

14. An electron discharge device comprising an enclosing vessel having a molded dish stem, a plurality of conductors sealed therein in a circu-

lar boundary, a unitary electrode mount beyond said stem including a cathode, an anode, and a plurality of grids between said cathode and anode, spacing discs at opposite ends of the electrodes, an auxiliary insulating disc, a pair of metallic eyelets secured thereto in offset relation, clamping means securing said auxiliary disc to one of said spacing discs so that said eyelets are shielded from the electrode transit path, a rectangular-shaped shield member surrounding said eyelets and being supported by said clamping means, certain of said conductors in alignment with said eyelet being attached thereto within said shield, another conductor extending exterior to said shield and connected to said anode, and a triangular-shaped shield mounted below said shield member intermediate said conductor for the anode and said conductors aligned with said eyelets.

15. An electron discharge device comprising an enclosing vessel having a molded dish stem, a plurality of conductors sealed therein in a circular boundary, a unitary electrode mount beyond said stem including a cathode, an anode and a plurality of grids between said cathode and anode, spacing discs at opposite ends of the electrodes, an auxiliary insulating disc, a plurality of metallic clips centrally embracing said auxiliary disc, said clips having portions shielded by the adjacent spacing disc nearest said electrodes and other angular portions projecting toward said stem, said cathode having its ends secured to said angular portions below said auxiliary disc, metallic eyelets secured to said auxiliary disc, a shield member surrounding said eyelets and supported by said mount, certain of said conductors in alignment with said eyelets being attached thereto within said shield, another conductor exterior to said shield being connected to said anode, other conductors in said stem being connected to said cathode clips and one of said grids, connections between the remaining grids and said aligned conductors, a stem shield interposed laterally between said conductor for the anode and said other conductors, and a wire connector supporting said stem shield from one of said aligned conductors, said connector forming a shield extension projecting into the stem cavity.

CHARLES DEPEW.