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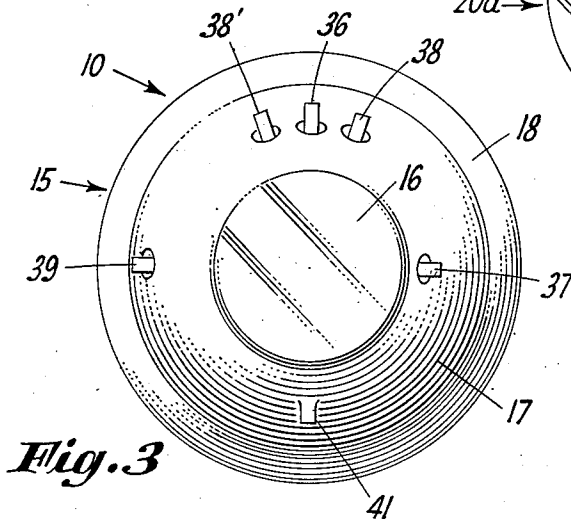
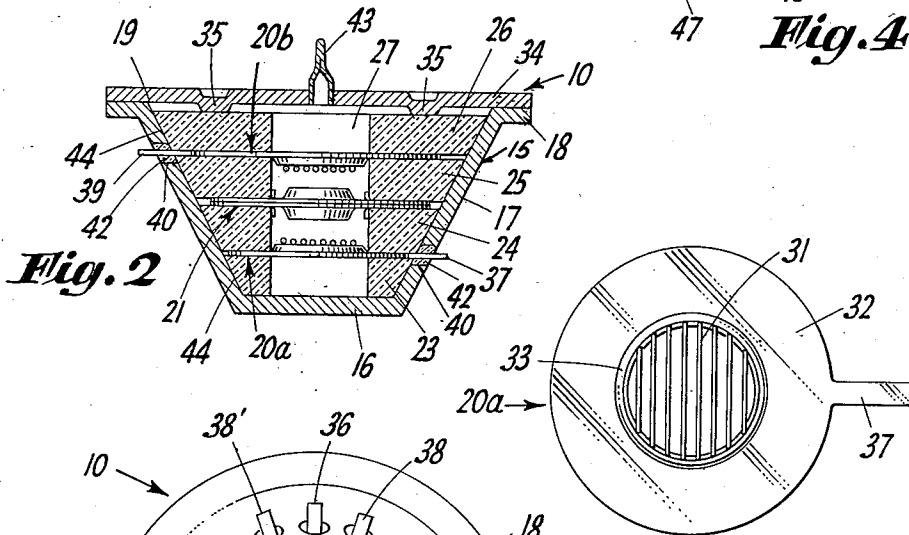
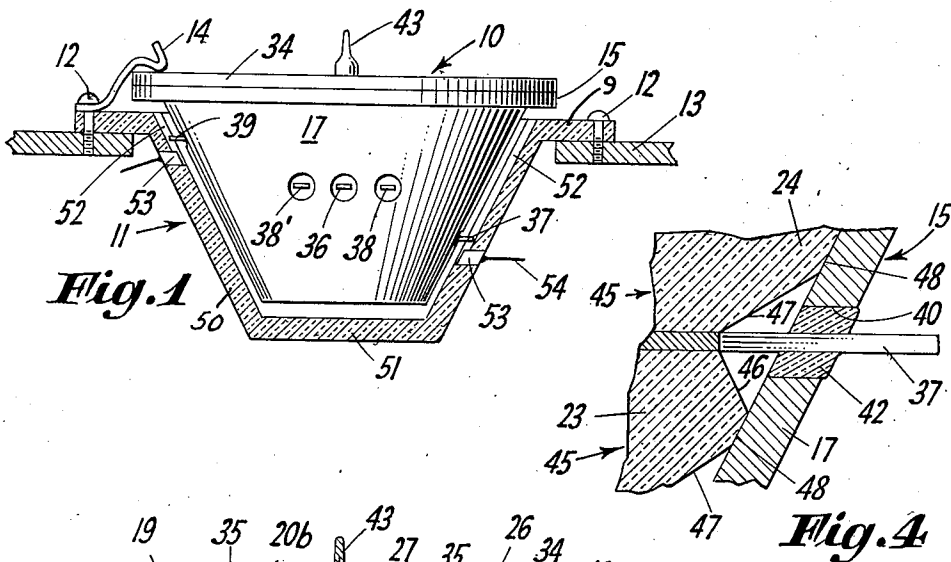
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2,808,528

ELECTRON DISCHARGE DEVICE AND MOUNTING

Filed Nov. 1, 1952

2 Sheets-Sheet 1



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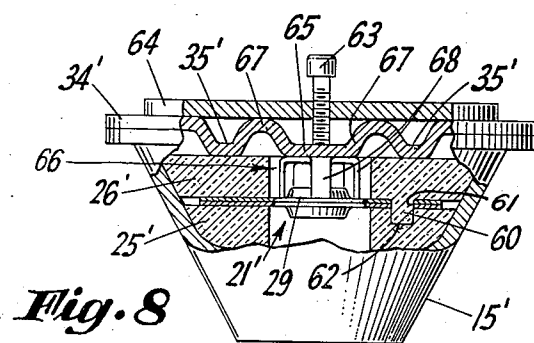
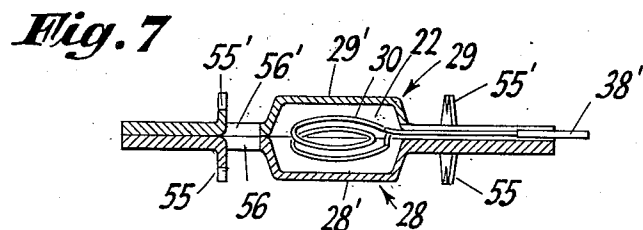
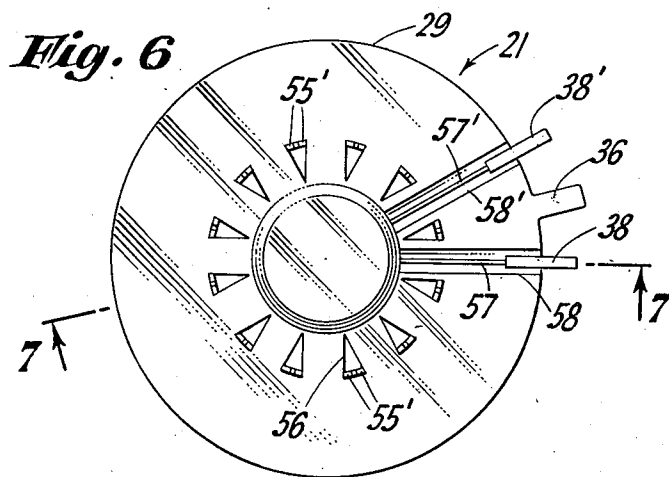
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# ELECTRON DISCHARGE DEVICE AND MOUNTING

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2 Sheets-Sheet 2



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2,808,528

## ELECTRON DISCHARGE DEVICE AND MOUNTING

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6 Claims. (Cl. 313-257)

The present invention relates to electrical apparatus, and more particularly to a new and improved unitary assembly for an electron discharge device and a mounting for said device.

Various types of electron discharge devices exist which have depending prongs or pins adapted to be received in complementary clips of suitable sockets. These electrical discharge devices are relatively expensive to construct, since the manufacturing process requires numerous assembly steps, each usually necessitating a high degree of skill and dexterity. Further, during checking, handling, and storing, the vacuum tubes can be readily damaged, since the depending pins prevent the formation of a compact unit which can be handled without requiring special care. Finally, when the vacuum tubes are being used in an electrical apparatus, the tubes usually project substantially from their respective mountings or sockets and can be easily knocked out of there by jarring or an accidental blow. Often, upon being subjected to a blow of great intensity, either through inadvertence or negligence, the vacuum tubes may be damaged beyond repair.

Accordingly, it is an object of the invention to provide an improved unitary assembly of an electron discharge device and a mounting therefor which will be free from at least some of the above mentioned disadvantages.

Conventional types of vacuum tube structures have other disadvantages as well. For example, a "mount" is employed within the tube and comprises a skeletal frame of wires and insulating spacer sheets which are used to support the various electrodes in spaced relationship. The skeletal structure of the mount is assembled by welding a large number of small parts together in a series of steps and requires facile manipulations by a series of skilled operators. The assembled mount structure is supported within the envelope by a number of supporting wires extending through the wall of the envelope and requiring further skilled manipulations by operators for assembly and connection to the mount assembly. Structures such as these suffer from a number of disadvantages such as lack of rigidity, with resultant tendencies toward vibration and microphonism, as well as high cost of assembly due to the extensive use of hand labor.

Another object of the invention, therefore, is the provision of an assembly for an electrical discharge device which is well adapted for mass production by automatic machinery or by simplified assembly line methods.

It is still another object of the invention to provide a vacuum tube which can be manufactured in a manner requiring relatively few assembly steps, each easily performed and requiring only ordinary skill.

Another object of the invention is the reduction of structural weaknesses in the mount with a view to improved reliability and reduced microphonism in the vacuum tube in which it is incorporated.

It is a further object of the invention to provide an electron discharge device which is adapted to withstand

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jarring and the effects of shock during handling, storage, and during use in an electrical apparatus.

A still further object of the invention is to provide an electrode assembly which takes up a relatively small space when employed in an electrical apparatus and contributes materially to a compact formation in constructions where space limitations are critical.

It is still another object of the present invention to provide a vacuum tube which can be processed at relatively high temperatures during exhaust, thus providing a superior vacuum and a faster processing schedule.

A still further object of the invention is to improve the precision of construction of electron discharge devices.

It is a still further object of the invention to facilitate the construction and mounting of a vacuum tube in a manner insuring adequate protection against damage and permitting rapid dissipation of the heat developed by the vacuum tube during operation.

It is another further object of the invention to provide a vacuum tube which, by its construction, will be able to withstand heat shock due to high ambient temperatures.

The foregoing objects, and others which may appear from the following description are attained in accordance with the principles of this invention by the provision of an electron discharge device having a frusto-conical exterior configuration which is adapted to be conformably received in a complementary mounting member. The electron discharge device includes a cup-shaped retaining member in which a plurality of electrodes separated by insulating spacer members are stacked. Each of the electrodes and spacers may be inserted in the retaining member by automatic machinery or by simple hand motions. Individual connecting members projecting through hermetically sealed apertures in the retaining member provide electrical connections to the electrodes. The contacts or connecting members are spaced about the periphery of the retaining member and project outwardly for engagement with complementary contacts of a socket. The tube contacts are preferably given characteristic spacings so as to serve as a key for designating the various electrodes of the discharge device, facilitating orientation of the device in a socket and permitting ready identification of the electrodes in a manner similar to that already used in conventional vacuum tubes.

The mounting member or socket is provided with slots or recesses which are properly spaced to receive the projecting contacts of the discharge device. The spacing between the respective contacts and their associated slots is made irregular to conform to the contact configuration of the discharge device to be received, thereby assuring proper connection of the various tube elements with the circuitry associated with the socket. Further, the dimensions of the mounting member are preferably selected to conform with the outer dimensions of the tube so that the tube when inserted will be fully received and supported with no parts projecting beyond its margins.

In the actual assembly of the electron discharge device, the spacer members and electrodes may be dropped into the cup-shaped envelope in succession, where, due to the taper of the envelope, they are guided into their proper positions, the individual connecting members being caused to project through the peripherally spaced openings. Thereafter the assembly is exhausted and hermetically sealed.

The present invention may be more fully understood by reference to the following detailed description taken in conjunction with the accompanying drawings wherein:

Fig. 1 is an elevational view in partial cross-section of a preferred embodiment of the invention, showing the electron discharge device partially received in a mating socket;

Fig. 2 is a view in vertical cross-section of the electron discharge device of Fig. 1;

Fig. 3 is a bottom view of the electron discharge device of Fig. 2;

Fig. 4 is an enlarged fragmentary sectional view of an alternative embodiment of the electron discharge device of Fig. 2;

Fig. 5 is a plan view of a grid suitable for use in the electron discharge device of Fig. 2;

Fig. 6 is a plan view of a cathode suitable for use in the electron discharge device of Fig. 2;

Fig. 7 is a view in cross-section of the cathode of Fig. 6; and

Fig. 8 is a view in elevation with parts shown in section of an alternative embodiment of the invention.

Referring now to Fig. 1, the electron discharge device or vacuum tube 10, of frusto-conical shape is conformably received in mounting member or socket 11. Socket 11 is illustrated as retained on fragments 13 of a suitable chassis associated electrical apparatus by screws 12. Resilient keepers or clips 14 (of which one is illustrated) are secured to the mounting member 11 by appropriate screws 12, and are adapted to engage the upper surface of the tube 10 and to maintain it firmly in place in the mounting member 11.

As illustrated in the drawing, the discharge device 10 includes a cup-shaped, frusto-conical retaining member 15 having a circular bottom wall 16, and an upwardly and outwardly flaring supporting wall 17 which terminates in a laterally extending flange 18. The flange 18 bounds an open mouth 19 of retaining member 15 through which the various elements of the tube 10 are inserted.

Arranged transversely within the retaining member 15 are a plurality of electrodes 20a, 20b and 21 which are maintained in parallel spaced relationship by insulating spacer members 23 to 26 inclusive. Each of the spacers is formed as a truncated cone having a central bore 27 and is fabricated of a refractory insulating material. A suitable material is an alumina-silica-magnesia compound of the type commercially known as "Alsimag." The thicknesses of the various spacer members 23 to 26 determine the spacing between the various electrodes and should be selected in consideration of the desired vacuum tube electrical characteristic. As shown, four spacer members of the same thickness are employed to maintain three disc-like electrodes 20a, 20b, 21 spaced and parallel to each other. Throughout the figures the thickness of the various parts and their size has been exaggerated to more clearly bring out the materials and proportions actually employed.

For the purposes of illustration, the tube 10 has been shown in the form of a triode having a cathode 21, grids 20a, 20b (which may be tied together to serve as one electrode), and having its anode surfaces provided by the metal envelope 15 and envelope closure member 34.

As shown in Figs. 6 and 7, the cathode 21 comprises a pair of formed complementary sheet metal members 28, 29 which are shaped and joined together to define a central space 22 within which a heater element 30 is positioned. The outermost, opposite, exterior surfaces 28', 29' adjacent space 22 of the respective members 28, 29 are coated with a material which is capable of emitting electrons when the members 28, 29 are heated by the heater element 30 and so form the active cathode surfaces. In addition, the members 28, 29 are provided with downwardly and upwardly projecting ears 55, 55' respectively, which serve to define opposite, outwardly projecting rings for engaging the walls of the bores 27 of the adjacent spacer members 24, 25 respectively, to insure proper positioning of the cathode assembly 21 within the discharge device. The ears 55, 55' are preferably struck from members 28, 29 and leave triangular openings 56, 56' which serve to reduce the conduction of heat from the cathode 21 to the spacer assembly. Further, the V-shaped openings 56, 56' are aligned with each other, and provide communication between the upper and lower portions of the central cham-

ber defined by the spacer member bores 27 to facilitate exhaust of the discharge device.

Electrical connection to the cathode structure 21 is provided by an integral, radially projecting connector tab 36, and to the heater element 30 by radial conductors 57, 57' connected to radially projecting contacts 38, 38'. The radial heater conductors 57, 57' are received in radially extending slots 58, 58' formed in member 29, and are preferably fixed in position by a suitable insulating bonding material (not shown).

The grids 20a, 20b are also of a construction adapted to facilitate automatic positioning relative to the spacer members upon being dropped into the retaining member 15. Specifically (see Fig. 5) each grid or control electrode includes a central wire or mesh portion 31 joined to a marginal rim or disc 32 by annular shoulder 33. When the grid electrode is inserted in the retaining member 15, the protruding shoulder 33 fits within bore 27 of the adjacent spacer member, thereby insuring proper positioning of central wire portion 31 relative to the bore and continued maintenance of that proper position.

Traversing the open mouth 19 of the retaining member 15 (see Fig. 2) is a closure member or cover 34 which is welded or otherwise hermetically bonded to retaining member flange 18, and which, when taken with the retaining member 15, forms the hermetically sealed envelope of the discharge device. The cover 34 is preferably formed with inwardly projecting bosses 35, which press against the stack of spacer member and electrodes, 20 to 26 inclusive, when the cover 34 is joined to the retaining member 15. These inward projections 35 serve to retain the electrodes and spacers in firm, assembled relation and may be made (by themselves, or together with cover 34) to have sufficient resilience to accommodate any expansions occurring during processing and operation of the tube. Instead of the bosses 35, a resilient member, such as a coil spring, may be interposed between cover 34 and the adjacent underlying spacer member 26 to maintain close association of the electrodes and spacers, thereby insuring unvarying electrode spacing.

Arranged in coplanar relation with the electrodes 20a, 20b and 21 are the radially projecting contacts 37, 39, 36, 38 and 38'. The grid contacts 37, 39 are secured to, or formed integrally with, the marginal portions of the respective grid discs 20a, 20b, while the heater contacts 38, 38' are connected to the radial conductors 57, 57' of cathode 21. Similarly, connection is made to cathode 21 through contact or tab 36. These contacts, which are, in effect, continuations of their respective electrodes project through suitable openings 40 in the flared wall 17 of the retaining member 15. Directly connected to the retaining member or anode 15 and projecting laterally thereof is a further contact 41 (which may be omitted when it is more desirable to directly contact the anode wall).

Various openings 40 are arranged at locations spaced above the bottom wall 16 of the retaining member 15 to receive the contact of the electrode which is maintained at the same location or level upon assembly of the spacer members and electrodes. In order that the envelope will be air tight, insulating beads 42, which may be of glass, are sealed around the respective connectors and onto the edges of openings 40.

Pinched-off metal exhaust tube 43 (Fig. 2) is included in these illustrations of the invention to demonstrate one manner in which an exhaust connection may be made to the tube. Obviously it could be located elsewhere on the discharge device, or could be dispensed with entirely if the exhaust and sealing operations are to be conducted in a bell jar.

In assembling the discharge device 10, the spacer members 23 to 26 and the electrodes 20, 20' and 21 are dropped or inserted into the retaining member 15 in the proper sequence, taking care that the various protruding

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contact members pass through the proper openings in shell 15. Each part, as it is inserted, will fall readily into position against its neighbor, guided there by the slope of wall 17 of the retaining member. The spacer members 23 to 26 are aided into proper position by the similar action of their tapered outer peripheries 44 against the complementary inner surface of the wall 17, and when seated, are laterally supported by wall to wall contact. After stacking the electrodes and spacer members, the tube 10 is sealed by the addition of cover 34 and the insulating beads 42, and then exhausted through the tubulation 43.

In Fig. 4 there is shown an alternative embodiment of the tube structure in which the spacer members 23 to 26 of Fig. 2, with uniformly sloping tapered outer peripheries 44, are replaced by spacer members 45 in which peripheral portions of the spacer members 45 are cut away or bevelled to provide conic surfaces 46, 47 arranged to angles to the outer conic surfaces 48. The outer conical surfaces 48 are adapted to accurately position the spacer member in retaining member 15 as before, while the peripheral conic surfaces 46, 47 provide a clearance space around the contact 37 and its associated seals 42. The addition of these peripheral conic surfaces also facilitates guiding the electrodes contact 37 into the adjacent opening 40 during the operation of insertion.

The socket or mounting member 11 (see Fig. 1) has as its principal elements the tapered wall section 50, supported on an associated chassis 13 by flange 9, and bottom plate 51. If desired, the rate of thermal dissipation from the discharge device 10 may be increased by finning the outer surfaces of the mounting member 11 or by providing, by means of an added wall, a chamber through which a cooling medium may be circulated. Since the socket member 50 is complementarily shaped to fit the outer surface of the tube closely, good heat transfer between the tube and the socket is provided. The heat dissipation may be effectively increased by making the socket shell of metal, rather than the insulating material as illustrated, but then contacts 53 must be electrically isolated from it, as for example, the electrical connectors 37, etc. are insulated from the discharge device retaining member 11.

At spaced intervals around its periphery, the socket member 11 is provided with slots 52 (which may be thought of as lying in planes passing through the axis of the socket) for the reception of the projecting contacts of the tube. The cross-sectional dimensions of each slot 52 are selected to provide clearance for the projecting tube pins as they are received by the socket, the length of each slot 52 being determined by the distance between the associated contact and the under side of tube flange 18. Supported at the lower end of each slot 52 is a simple metal contact 53 which may be connected by suitable lead wire 54 to an appropriate source of potential or to components of the associated electrical circuit. The spacing of the slots 52 is selected in accordance with the peripheral spacing of the contacts 36, 37, 38, 38', 39 and 41. Where dimensional tolerances of the socket and the tube are not closely controlled, resort may be had to spring loaded contacts or clips in lieu of the rigid socket contacts 53. Similarly, the slots 52 need not extend to the flange of the socket, as shown, but may be limited so as to define an elongated recess tapering upwards to meet the outward flare of the inner socket surface, and providing thereby a recess permitting bringing the tube and socket contacts together.

Referring now to Fig. 8, there is shown an embodiment of the invention, in a discharge device which omits the upper grid of Fig. 2, which provides for positioning the cathode relative to other electrodes thereby avoiding the necessity to pay close regard to initial variations in cathode to grid spacing as determined by the accuracy of formation of the interposed spacer. Specifically, the

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cup-shaped shell 15' contains and supports a plurality of electrodes and spacers disposed generally as disclosed above, but in which the cathode structure 21' is supported by the uppermost spacers 25', 26'. Spacer 26' is provided with a number of depending integral protrusions 60 (only one is illustrated) which extend through complementary openings 61 formed in the cathode structure 21' (such as the openings 56, 56' in Fig. 7 for example) into complementary recesses provided in the adjacent spacer 25'. As is apparent, the shape of the integral protrusion 60 and the complementary recesses 62 may be varied to obtain any desired mating configuration, but preferably for forming to the apertures in the cathode 21. The cooperating indentations and protrusions of adjacent spacers may be used on all the spacers and permit the electrodes to be lined up independently of the configuration of the central bores 27 of the spacers. The use of these complementary parts results in more positive positioning of all of the internal components of the completed electron discharge device.

Arrangement of the cathode structure 21 as shown in Fig. 8 permits adjustment of cathode spacing by movement of screw 63. The adjustment screw 63 is threaded through screw mounting plate 64 which is welded to closure member 34' at its extremities and passes over the yieldable central closure member section 65. The depressed central section 65 is surrounded by an annular ridge or corrugation 67 pressed into the metal of which the closure member is formed, the deformation thus provided serving as a flexible coupling between the rigid outer portions of the closure member. Bosses 35' (which may, alternatively, be a circular corrugation) are provided in the outer portion of the closure member and press against the electrode and spacer assembly to hold it together, as before. A spider or coupling member 66 is fastened by welding or other suitable joining technique to the under side of diaphragm section 65 and has depending legs 68 which press against the top (or back) of cathode 21. The legs 68 number at least three and are disposed to transmit downward thrust from the diaphragm uniformly to the cathode. An inverted cup of poor thermal conductive material may be substituted for the spider. Inasmuch as the central, active portion 29 of the cathode is supported by the disc formed of metal sheets (28 and 29, as illustrated in Fig. 8) a yieldable structure exists. Pressure exerted downward on the diaphragm 65 by screw 63 will be transmitted through the spider 66 to the cathode, causing it to move downward, closer to the electrodes which are disposed below it.

While the foregoing describes the preferred embodiments of the invention, it will be apparent to those skilled in the art that many variations may be made in the structural detail of the inventions. For example, the envelope of the tube may be made of materials other than metal, if anodes analogous to the disc electrodes already shown are employed. Similarly the insulating spacers may be adapted to accommodate many different electrode combinations, varied from those disclosed both in number and in configuration as tube characteristic requirements demand. So too, the shape of the retaining member need not be conic, but may be pyramidal or in the form of a truncated polyhedron so long as the tapered wall is, in some degree, preserved. Accordingly, it is intended that the below appended claims be construed in keeping with the spirit of the invention rather than as specifically set forth above.

I claim:

1. An electron discharge device comprising a hermetically sealed envelope containing a number of planar electrodes and disc-like spacers, said envelope including a cup-shaped, frusto-conical retaining member and a closure member sealed across the opening of said retaining member, said retaining member having a number of spaced openings in its wall, said electrodes being transversely disposed in said retaining member and maintained

in predetermined, superposed, spaced, and insulated relationship by said spacers, each of said electrodes having a conductor extending through one of said spaced openings and hermetically sealed therein.

2. An electron discharge device comprising a hermetically sealed envelope containing a number of electrodes and spacers, said envelope including a cup-shaped, frusto-conical retaining member and a closure member sealed across the opening of said retaining member, said retaining member having a number of spaced openings in its wall, said electrodes being transversely disposed in said retaining member and maintained in predetermined, superposed, spaced, and insulated relationship by said spacers, each of said electrodes having a conductor extending through one of said spaced openings and hermetically sealed therein, said closure member bearing against said superposed electrodes and spacers, whereby said electrodes and spacers are retained in stacked engagement.

3. An electron discharge device having a hermetically sealed envelope including a frusto-conical, cup-shaped retaining member, said retaining member having an opening at its larger end and a closure member sealed across said opening, a number of spacers contained within said envelope and disposed along and substantially transverse to the axis of said retaining member, said spacers extending from one side of said retaining member to the other, and a number of planar electrodes maintained in spaced, insulated relationship along said axis by said spacers.

4. An electron discharge device having a hermetically sealed envelope including a frusto-conical, cup-shaped retaining member having an opening at its larger end and a closure member sealed across said opening, a number of substantially frusto-conic insulating spacers disposed along and substantially transverse to the axis of said retaining member, the outer peripheries of said spacers resting against the inner surface of said retaining member, and a number of planar electrodes maintained in spaced, insulated relationship along said axis by said spacers.

5. An electron discharge device having a hermetically

sealed envelope including a frusto-conical, cup-shaped retaining member having an opening at its larger end and a closure member sealed across said opening, a number of substantially frusto-conic insulating spacers disposed along and substantially transverse to the axis of said retaining member, the outer peripheries of said spacers resting against the inner surface of said retaining member, said spacers having central apertures cooperating to form a bore along said central axis, and a number of planar electrodes maintained in insulated, spaced relationship across said bore by said spacers.

6. An electron discharge device having a hermetically sealed envelope including a frusto-conical, cup-shaped retaining member, said retaining member having an opening at its larger end and a closure member sealed across said opening, a number of substantially frusto-conic insulating spacers disposed along and substantially transverse to the axis of said retaining member, the outer peripheries of said spacers resting against the inner surface of said retaining member, said spacers having central apertures cooperating to form a bore along said central axis, and a number of planar electrodes maintained in insulated, spaced relationship across said bore by said spacers, said electrodes having projections extending along the axis of the tube and engaging surfaces of said spacers.

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

##### UNITED STATES PATENTS

|           |              |               |
|-----------|--------------|---------------|
| 2,048,129 | Loughridge   | July 21, 1936 |
| 2,222,668 | Knoll        | Nov. 26, 1940 |
| 2,419,578 | Litton       | Apr. 29, 1947 |
| 2,419,757 | Binneweg     | Apr. 29, 1947 |
| 2,441,792 | Brian        | May 18, 1948  |
| 2,459,487 | Beggs        | Jan. 18, 1949 |
| 2,629,066 | Eitel et al. | Feb. 17, 1953 |

##### FOREIGN PATENTS

|         |           |               |
|---------|-----------|---------------|
| 111,890 | Australia | May 13, 1939  |
| 694,956 | Germany   | Aug. 12, 1940 |
| 167,268 | Australia | Dec. 11, 1950 |