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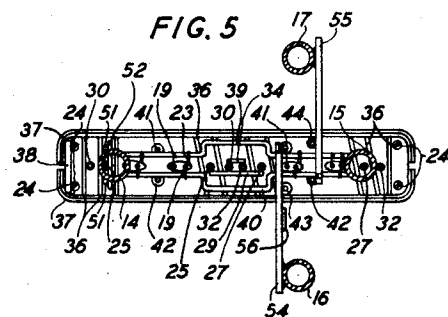
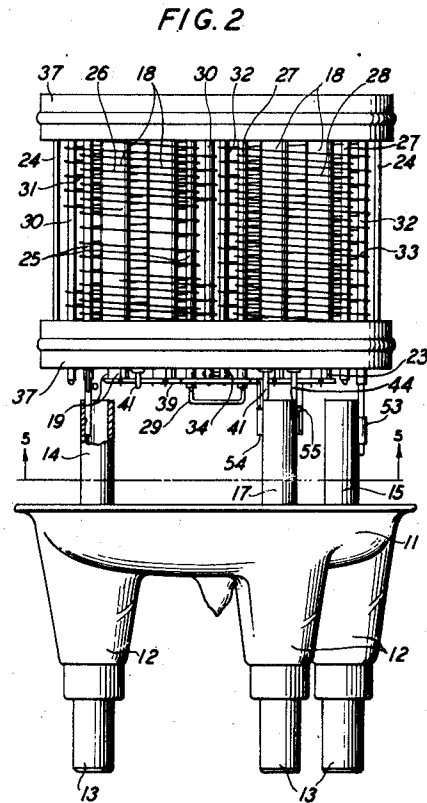
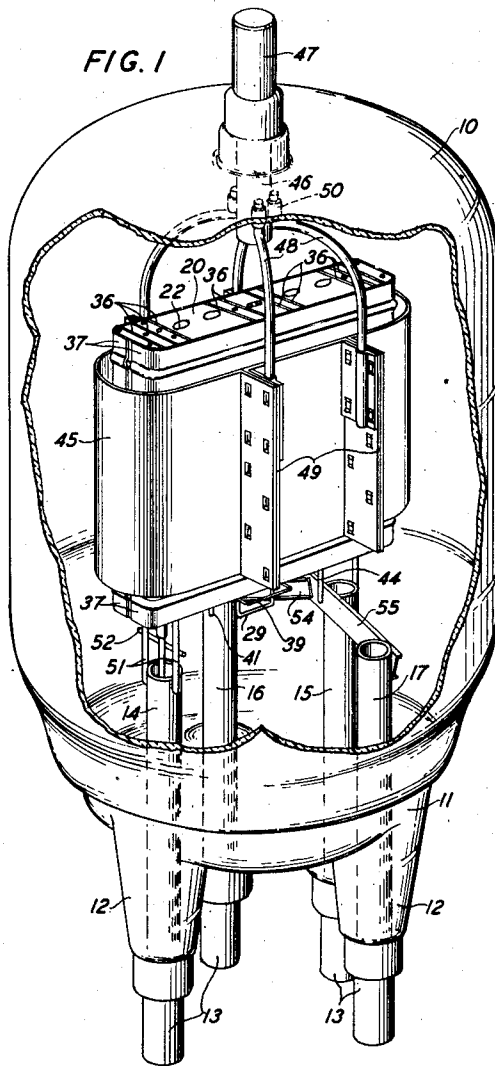
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2,356,112

ELECTRON DISCHARGE DEVICE

Filed March 27, 1943

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

FIG. 4

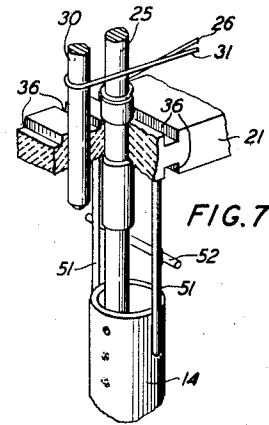
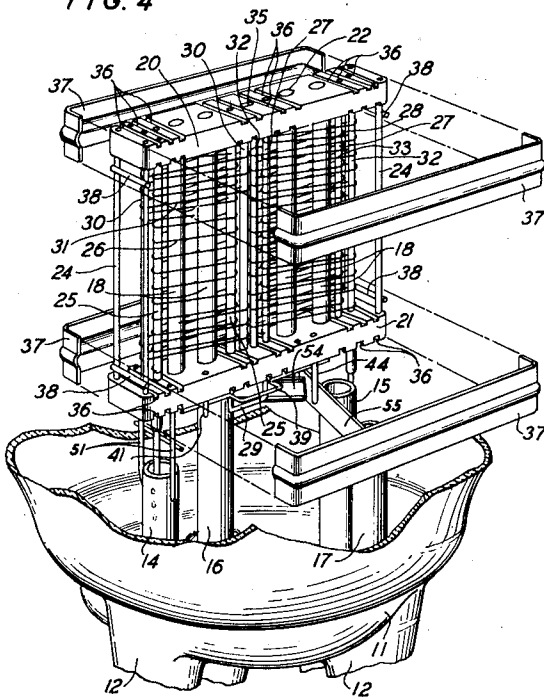


FIG. 7

FIG. 6

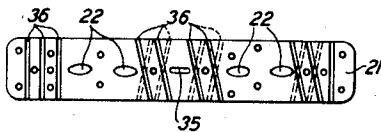


FIG. 6A

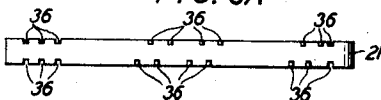
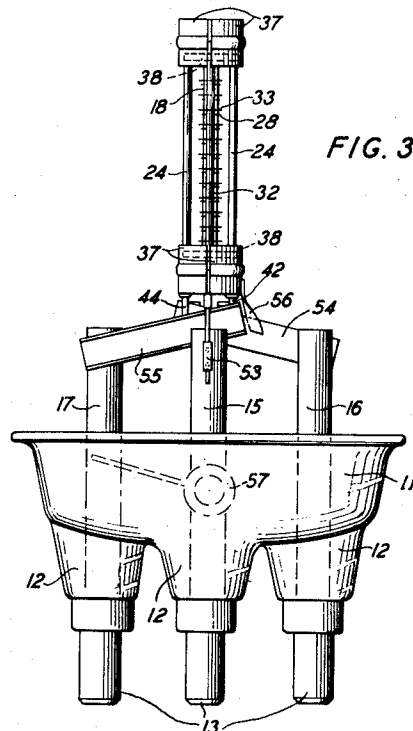


FIG. 3



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ELECTRON DISCHARGE DEVICE

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12 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices and more particularly to such devices utilized to generate a high power output in the high frequency range.

In order to increase the power factor in electron discharge devices, it is necessary to increase the size of the electrodes or compromise by increasing the number of electron emitting electrodes to supply the maximum flow of electrons to obtain an equivalent power output. In either case difficulties arise due to the increased mass of the electrode assembly, which is susceptible to shocks or vibrations, which endanger the stability of operation or cause such distortion of the electrodes in the mounting assembly as to permanently reduce its efficiency or render the device unfit for practical purposes. Furthermore, the increase in the number of electron emitters requires greater dimensional changes for the helical auxiliary electrodes such as wire wound grids, which surround the emitters, so that the fine wire grids are easily subjected to warping or distortion under the high temperatures extant in the device. Another difficulty is the preservation of high leakage resistance across the insulating spacer members between the multiple electrodes of the mount. In addition the length of the supply conductors extending to the various electrodes should be held to a minimum in order to match the device with other cooperating apparatus in a definite high frequency range for which it is designed.

An object of this invention is to overcome these difficulties and disadvantages and produce a highly efficient device capable of attaining high power output with a minimum of loss.

Another object of the invention is to increase the mechanical stability of the electrode mount in the device without introducing electrostatic and dielectric losses to decrease the electrical efficiency of the device.

A further object of the invention is to facilitate the compact assembly of the multiple electrodes into a mount which will readily withstand excessive shocks and vibrations without endangering the interspatial relation between the electrodes.

Another object of the invention is to strengthen the support of the electrode mount in the device without introducing extraneous coupling elements between the electrodes and the supply conductors.

A further object of the invention relates to the improvement of the leakage resistance across the insulating spacer members without reducing the strength thereof.

Still further objects of the invention are to reinforce the mount assembly and to utilize the reinforcing components as continuations of the supply conductors.

These objects are attained in accordance with

this invention, by the assembly of an electrode mount which includes a plurality of electron emitting electrodes arranged in parallel and pairs thereof are surrounded by wire wound grids coupled together in series relation and mounted between insulating blocks which combine all the elements into a unitary assembly. The blocks are attached to frame members which increase the rigidity of the mount or unit and electrostatic shield members surrounding the blocks are efficiently attached to the frame to limit the electron field to the anode which surrounds the mount.

A feature of this construction is the connection of the respective grid electrodes in the mount to two parallel rigid conductors in the vessel directly in line with opposite ends of the longitudinal dimension of the mount.

Another feature of the invention relates to the consolidation of the multiple connections of the cathodes and internal heater elements to parallel bus wires extending across one end of the mount and the coupling of the wires directly to transverse rigid conductors in the vessel to increase the supporting strength of the mount. This arrangement includes channel bracing strips which increase the stability of the unit and provide transverse supports to readily withstand lateral shocks applied to the enclosing vessel.

A further feature of the invention relates to increasing the insulation paths between the multiple electrodes across the length of the insulating blocks by diagonal slots extending across the width of the block on opposite sides thereof, the slots on one side extending in an opposite direction to the slots on the other side. This arrangement reduces leakage current between the respective electrodes and also reduces to a minimum the weakening of the blocks due to the slots therein.

These and other features and advantages of the invention will be more easily understood from the following detail description when considered with the accompanying drawings:

Fig. 1 is a perspective view of an electron discharge device embodying the features of this invention, the enclosing vessel being broken away to illustrate the detail assembly of the electrodes in the vessel.

Fig. 2 is a view in elevation showing the unitary mount of electrodes supported on the stem with the remainder of the vessel and the anode removed.

Fig. 3 is a side view of the structure shown in Fig. 2 and illustrates the cross-bracing supports of the mount.

Fig. 4 is another view of the mount in perspective with the shielding strips in exploded relation to the mount.

Fig. 5 shows a bottom plan view of the struc-

tural assembly and the connections of the electrodes to the conductors taken on the line 5—5 of Fig. 2.

Figs. 6 and 6A show the details of the slotted insulator blocks and the relation of the slots on opposite surfaces thereof; and,

Fig. 7 is an enlarged perspective view of the coupling of one of the electrodes to a conductor with a portion of the lower insulating block broken away to show the details of the assembly.

Referring to the drawings and particularly to Figs. 1 and 2, the high power electron discharge device made in accordance with this invention, comprises an enclosing vessel 10, sealed to a molded dish stem 11 which is provided with a plurality of tubular or conical shaped sleeve portions 12 which depend from the closed end thereof in aligned pairs, one pair of sleeve portions being offset from the axis of the stem to bring them in closer relationship to one of the other sleeve portions and to isolate the remaining sleeve portion in aligned relation to the latter, whereby this portion is segregated from the remaining portions to provide a high insulation path across the surface of the stem. Each tubular portion is provided with a cylindrical cup terminal 13 having the lip thereof hermetically sealed to the edge of the hollow portion 12. A pair of heavy walled tubular metallic conductors 14 and 15, preferably of nickel, are rigidly seated in a pair of terminals 13 and extend longitudinally within the vessel 10 and a similar pair of tubular conductors 16 and 17 are seated in the remaining terminals. This arrangement of conductors segregates the terminals of the various electrodes of the device and provides a rigid base for the mounting of the electrode assembly in the vessel.

In order to attain a high power output in the device of this invention, a plurality of oval-shaped cathode sleeves 18 are grouped in pairs in aligned relation across one diameter of the vessel and are provided with the usual internal heater elements which are embedded in insulating sleeves fitted within the cathode sleeves, the heater elements having terminations 19 extending from the bottom of each cathode and the external surface of the cathode sleeve being coated with electron emissive material, such as barium and strontium oxides. The groups of cathode sleeves 18 and the associated insulated heater elements therein are held in linear relation by end insulating blocks 20 and 21 which are provided with oval-shaped apertures 22 to engage opposite ends of the cathodes, the heater terminations 19 extending through the lower insulating block 21 and the cathode sleeves being provided with a metallic connector 23 which also extends below the lower block. The insulating spacer blocks or members 20 and 21, which are of rectangular form, to adequately support the various elements of the discharge device are rigidly secured together by corner posts 24 which together with the insulating blocks form a substantially rigid frame support for the aligned cathodes and other cooperating electrodes associated therewith to consolidate the electrodes into a unitary mount and maintain the electrodes in uniform space relation.

As shown in Fig. 2, a pair of copper support rods 25 extend between the upper and lower insulating blocks on opposite sides of one pair of cathodes 18, the rods supporting a helically wound wire grid 26. A similar pair of rods 27 are mounted on opposite sides of the other pair of cathodes 18 and support a wire grid 28, the two

grids being in aligned relation with respect to the dual pairs of cathodes 18 and being connected together at the center portion by a jumper wire 29, as shown in Figs. 2 and 5, these grids being connected in series relation to function as a single control electrode which is immediately adjacent the emissive surfaces of the multiple cathodes of the mount. A pair of upright rods 30 extend in parallel relation between the insulating blocks 20 and 21 outside of the boundary of grid 26 and support a helically wound grid wire 31 which is uniformly spaced from the cathodes 18 and the lateral grid winding 26. A similar pair of rods 32 extend between the insulating blocks outside the boundary of grid 28 and support a grid winding 33 thereon which is spatially disposed with respect to grid 28 and the respective cathodes to insure uniform space relation between all the electrodes in the specified group. The two grids 31 and 33 are joined together at the center by a strap 34, as shown in Fig. 5. The copper grid supports are held against longitudinal movement in the lower insulating block 21 by welding nickel sleeves around the rods on opposite sides of the block. The upper ends of the grid rods are slidably movable in the insulating block 20, to permit expansion and contraction of the grids, thereby preventing distortion thereof due to temperature changes. The central elongated slot 35 in the block, as shown in Fig. 6, also permits the larger diameter grids 31 and 33 to expand laterally to prevent distortion thereof. Another advantage of this construction is the dual assembly of the grids and the coupling thereof in aligned relation, to reduce distortion of the lateral wires of the grids due to the shortening of their breadth, since the long expanse of fine lateral wire extending from one end of the mount to the other would impose considerable strain on the delicate wires which would result in distortion and non-uniform spacing in the lateral wires thereby altering the characteristics of the device.

The relatively close space relation of the cathodes and grid supports in the end insulating blocks of the mounting limits the insulation resistance across the surface of the blocks between adjacent electrodes and particularly between the closely spaced grid support rods of different electrodes. In order to increase the leakage path between these electrodes, the spacer blocks 20 and 21 are provided with slots or grooves 36 which extend across the short dimension of the blocks on opposite sides thereof between the closely spaced adjacent electrodes thereby lengthening the path therebetween and offering a discontinuous surface to conductive material which may be precipitated thereon. Of course, the slots reduce the cross-section of the spacer blocks. This disadvantage may be overcome by cutting the slot diagonally, where permissible, as shown in Figs. 6 and 6A, the slots on one surface being in an opposite direction to the slots on the opposite surface so that the weakness of the blocks is limited to a point along the longitudinal center thereof. The cross location of the slots in the blocks therefore materially reduce damage to the blocks by torsional stresses which might produce cracks or fractures resulting in broken insulators and consequent misalignment of the electrodes. The edges of the blocks are protected from bombardment by electrostatic shields 37, formed of nickel strips, bent around the edges of the insulating blocks and welded to the frame rods 24 by tie wires 38.

The multiple cathodes and their respective heater elements are connected in parallel to a pair of bus wires 39 and 40, as shown in Fig. 5, which are rigidly affixed to the bottom of the lower insulating block 21, the bus wire 39 being supported by a pair of studs 41 and the wire 40 being supported by studs 42. One end of each heater termination of the cathodes is connected to the bus wire 39 and the other heater termination 19 of each cathode is connected to the bus wire 40, while each cathode strap 23 of the cathode 18 is connected to the bus wire 39, the cathodes being connected in multiple at the same potential as one side of the heater circuit of the heater elements. The lower insulator is also provided with a supporting stud 43 in aligned relation across the insulator with one of the bus wire studs 41 and a similar supporting stud 44 is positioned in aligned relation with a stud 42 supporting bus wire 40, as shown in Fig. 5.

The increased number of electrodes in the mount and the expanse of the mount across one diameter of the vessel necessarily increases the mass thereof and renders the mount susceptible to shocks and vibrations which endanger the uniform space relation between the various electrodes in the mount and also the space relation between the mount electrodes and a cooperating output electrode or anode 45 which surrounds the mount assembly and is supported individually from a tubular conductor 46 extending into a cup terminal 47 sealed to the top of the vessel, the anode being connected to the tubular conductor by a plurality of bent arms 48 coupled to heat radiating fins 49 on the anode and to the tubular conductor 46 by nickel sleeves 50 surrounding the arms, the arms being welded to the conductor through the fluxing characteristic of the sleeves.

The unitary mount of electrodes is rigidly supported in coaxial relation to the anode surface across one diameter of the vessel in alignment with conductors 14 and 15 by extensions of the control grid 26 and screen grid 33. As shown more clearly in Fig. 7, the control grid assembly has an upright rod 25 which is provided with an extension below the insulating block 21 substantially in line with tubular conductor 14, the extension projecting within the tubular conductor and being welded thereto and the extension being reinforced by side rods 51 rigidly fixed to insulating block 21 and welded to the exterior surface of tubular conductor 14, the side rods and the grid extension being joined by a strap 52. The other end of the mount brings an extension of screen grid 33 in line with conductor 15 which is welded to the exterior of the conductor through a nickel fluxing sleeve 53. This mounting forms a direct coupling to the respective grids of the mount to the conductors in line therewith and materially increases the resistance of the mount to shocks or vibrations in a longitudinal direction or at an angle parallel to the horizontal dimension of the mount.

The above-mentioned mounting strengthens the support of the mass of the mount from impacts or shocks incident to one direction but offers very little resistance to shocks imparted in a direction at a 90 degree angle with respect to the unit. The latter forces are resisted by providing transverse brace members 54 and 55 which are coupled to the mount and conductors 16 and 17, to reinforce the assembly and to withstand severe gravity forces in planes at right angles or perpendicular to the sides of the mount. The 75

connecting braces 54 and 55 are channel shaped in cross-section to provide a rigid coupling and are diagonally mounted with respect to the conductors by welding one end to the periphery of the conductor and connecting the other end to aligned studs on the lower insulating block, studs 41 and 43 being attached to channel brace 54 and studs 42 and 44 being connected to channel brace 55. The channel braces in addition to supporting the unit in a transverse plane also serve as conductors for the heaters and cathodes coupled to the bus wires 39 and 40. Furthermore, the channel braces contribute to the resistance of the unit to shocks in a plane parallel to the long dimension of the mount and thereby relieve the copper extensions of the grids of some of the burden placed upon them. A strap connector 56 may be provided from the electrostatic shield assembly 37 to the brace 54 to maintain the shields at cathode potential and thereby reduce the potential gradient along the insulating blocks. A grooved ring getter support 57 may be mounted within the dish stem 11 and supported from the conductor 17 so that the flash of the getter is deposited on the stem wall during the final evacuation treatment of the device to keep the getter film as far as possible from the terminal connection of the high potential anode at the top of the vessel.

While the invention has been disclosed in a particular embodiment of a detail assembly of the mounting, it is, of course, understood that various modifications may be made in the construction and assembly of the mount without departing from 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 rigid conductors disposed longitudinally in pairs in a stem, a unitary mount within said vessel including a plurality of electrodes and end insulating members supporting said electrodes in a plane coincident with two of said conductors, means including certain of said electrodes connecting said mount directly to one of said pairs of said conductors, and reinforcing brace members extending transversely from said mount to the conductors of another of said pairs of conductors and coupling other electrodes thereto.

2. An electron discharge device comprising an enclosing vessel having rigid conductors disposed longitudinally in pairs in a stem, a unitary mount within said vessel including a plurality of electrodes and end insulating members supporting said electrodes in a plane coincident with two of said conductors, means including certain of said electrodes connecting said mount directly to one of said pairs of conductors, and rigid channel-shaped bars extending in opposite directions from said mount to conductors of another of said pairs.

3. An electron discharge device comprising an enclosing vessel having rigid conductors disposed longitudinally in pairs in a stem, a unitary mount within said vessel including a plurality of electrodes and end insulating members supporting said electrodes in a plane coincident with two of said conductors, means connecting said mount to one pair of said conductors to resist shock in planes parallel to said mount, and means connecting said mount to another pair of said conductors to offset shock in a like plane, said latter means also exhibiting shock resistance in the first-mentioned plane.

4. An electron discharge device comprising an enclosing vessel having rigid conductors disposed longitudinally in a stem thereof, a unitary mount within said vessel including a plurality of electrodes and end insulating members supporting said electrodes in a plane coincident with two of said conductors, means including certain of said electrodes connecting said mount directly to certain of said conductors, and diagonally mounted brace members interconnecting said mount to other of said conductors, said members being offset to the periphery of said conductors.

5. An electron discharge device comprising an enclosing vessel having rigid conductors disposed longitudinally in a stem thereof, a unitary mount within said vessel including a plurality of electrodes and end insulating members supporting said electrodes in a plane coincident with two of said conductors, means including certain of said electrodes connecting said mount directly to certain of said conductors, and reinforced brace members extending from said mount to other of said conductors and coupling certain electrodes thereto, said members being offset with respect to the axis of said mount and extending in opposed direction therefrom.

6. An electron discharge device comprising a vessel having a stem, a plurality of pairs of rigid conductors disposed longitudinally in said stem and projecting into said vessel, a unitary assembly of electrodes including multiple cathodes and multiple grids disposed in line across one diameter of said vessel, an insulating block on each end of said electrodes to space said electrodes in cooperating relation, one of said blocks being adjacent said conductors, an anode surrounding said unitary assembly, pairs of parallel support studs extending from said block adjacent said rigid conductors, bus wires for said cathodes carried by said studs, said grids being individually connected to one pair of said conductors, and a pair of oppositely disposed rigid connectors individually joined to pairs of said studs and another of said pairs of said conductors in line with each pair of said studs.

7. An electron discharge device comprising an enclosing vessel having a dished stem, pairs of conductors in spaced relation extending longitudinally in said stem, an electrode mount in said vessel including a plurality of auxiliary electrodes surrounding parallel cathode sleeves, said sleeves having heater elements therein, an insulating spacer block supporting said auxiliary electrodes and cathode sleeves, spaced pairs of studs extending from said block, parallel bus wires connected to said studs across said block, said sleeves and heater element terminations being connected to said bus wires, said auxiliary electrodes being connected to one pair of said conductors in one plane, and rigid channel-shaped straps connected to another pair of said conductors and bridging pairs of said studs in line with said latter conductors.

8. In an electron discharge device, a plurality of groups of sleeve cathodes disposed in line, a pair of wire wound grid electrodes surrounding each group of cathodes, the uprights of said grid electrodes being aligned with said cathodes, and a frame support combining said cathodes and grids into a unitary mount including rectangular insulating spacer members engaging said cathodes and grid electrodes at opposite ends, and connecting posts joining said members together at the corners thereof.

9. In an electron discharge device, a plurality of groups of sleeve cathodes disposed in line, a pair of wire wound grid electrodes surrounding each group of cathodes, the uprights of said grid electrodes being aligned with said cathodes, a frame support combining said cathodes and grids into a unitary mount including rectangular insulating spacer members engaging said cathodes and grid electrodes at opposite ends and connecting posts joining said members together at the corners thereof, and bi-part angular metallic shields extending around the edges of said members and being secured to said posts.

10. In an electron discharge device, a plurality of groups of sleeve cathodes disposed in line, a pair of wire wound grid electrodes surrounding each group of cathodes, a frame support combining said cathodes and grids into a unitary mount including rectangular insulating spacer members engaging said cathodes and grid electrodes at opposite ends, and central connectors attached to pairs of said grid electrodes to separately couple like grids in series relation.

11. In an electron discharge device, a plurality of groups of sleeve cathodes disposed in line, a pair of wire wound grid electrodes surrounding each group of cathodes, the uprights of said grid electrodes being aligned with said cathodes, and a frame support combining said cathodes and grids into a unitary mount including rectangular insulating spacer members engaging said cathodes and grids at opposite ends, said spacer members having apertures to locate said cathodes and grid electrodes in spaced relation across the length thereof and having slots formed between said apertures on opposite sides thereof, the slots on one side extending in opposite direction to the slots on the other side.

12. An electron discharge device comprising an enclosing vessel having a dish stem with depending tubular portions, hollow metallic cap terminals sealed to said portions, straight tubular conductors seated in said terminals and extending within said vessel, an electrode mount within said vessel comprising dual pairs of sleeve cathodes mounted in a row and having heater elements therein, a control grid having upright rods surrounding each pair of cathodes and aligned therewith, a screen grid having upright rods surrounding each control grid, coupling connections joining the control grids and screen grids respectively at the center, insulating spacer blocks supporting opposite ends of said cathodes and grids across one diameter of said vessel, one of said control grids having an end upright rod extending within and attached to one of said tubular conductors, a pair of posts extending from the lower block and engaging said conductor adjacent said grid rod extending therein, one of said screen grids having an upright rod extending to another tubular conductor in the same plane and attached to the exterior thereof, parallel bus wires supported on said lower spacer block, said cathodes and heater terminations being connected thereto in multiple, pairs of studs attached to the lower block adjacent said wires, and channel-shaped elongated connectors extending from said pairs of studs and connected to the remaining conductors, said connectors projecting in opposite parallel planes transverse to the plane of said mount.

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