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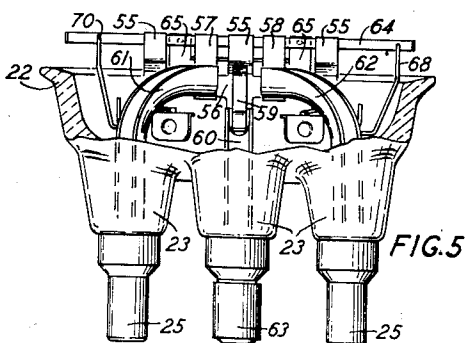
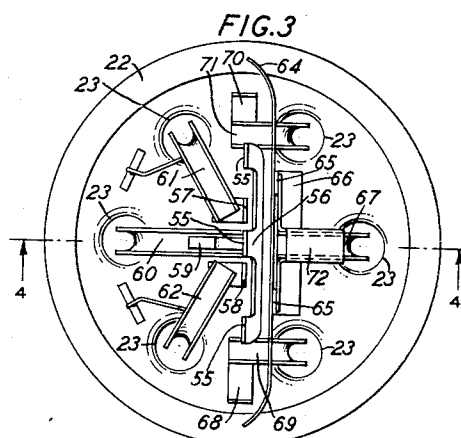
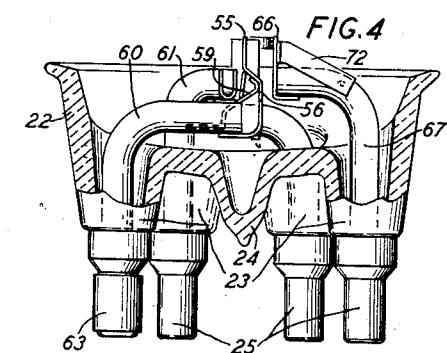
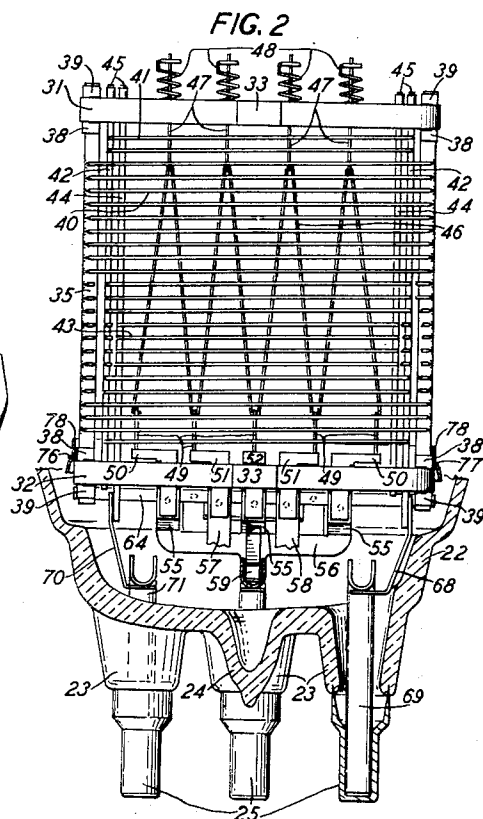
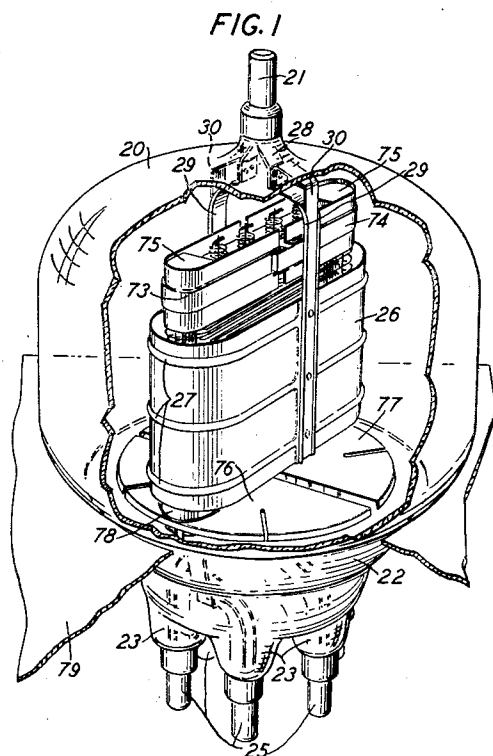
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2,267,450

ELECTRON DISCHARGE DEVICE

Filed Aug. 24, 1940

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

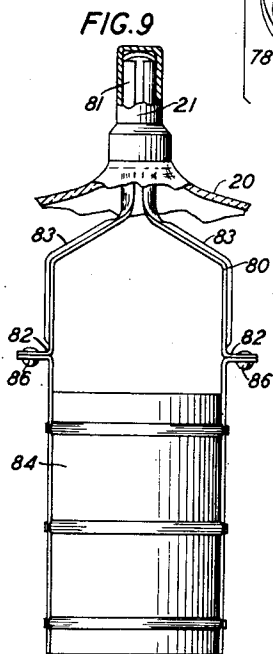
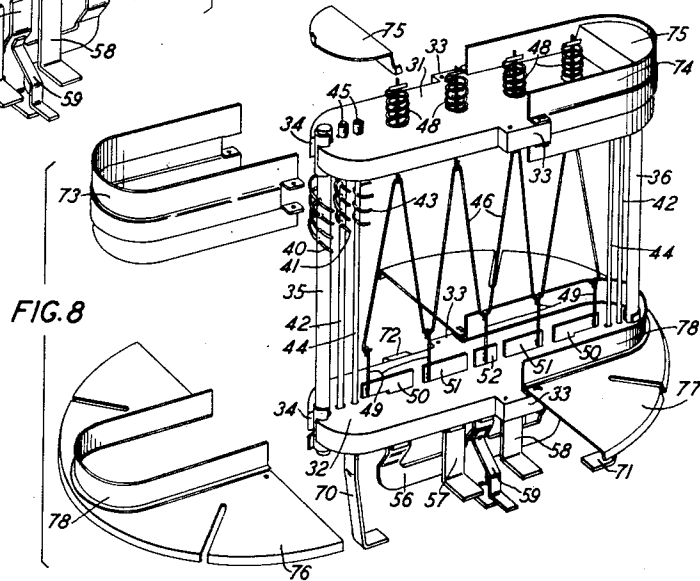
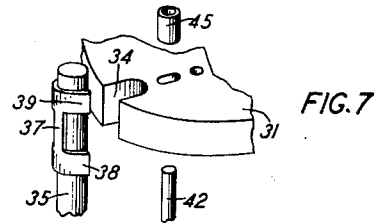
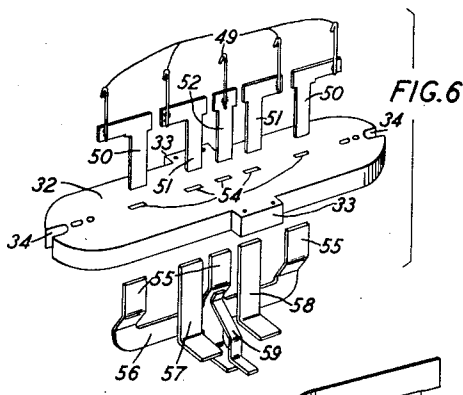
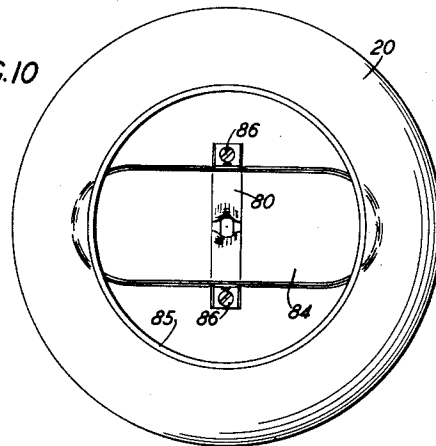


FIG. 10



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ELECTRON DISCHARGE DEVICE

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18 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices and more particularly to such devices for high frequency operation, for instance, in short wave radio and frequency modulation translating systems.

The physical requirements of high power discharge devices in such systems are quite conflicting yet must be reconciled to achieve the ultimate degree of efficiency as to power output and other electrical characteristics for the device. For instance, the power dissipation must be large, yet the capacitance and lead inductance should be small. The heat radiation per unit area should be large yet the size of the device must be held to a minimum. The electron transit paths must be short yet the amplification constant should be large. The power output should be large yet the effective reactance must be small. The conductors of the electrodes should be of large surface area to utilize the skin conducting paths thereof and of sufficient strength to support the electrodes yet they should not cause the leakage paths to be shortened.

The objects of this invention are to overcome these difficulties by providing a device of high efficiency, large power output, and compact assembly so that it may be fabricated at low cost commensurate with the type of service for which it is to be employed.

In accordance with this invention the high frequency power discharge device comprises a pentode electrode assembly including a multisection filament, and a plurality of grid electrodes mounted as a unit and coupled to large surface conductors sealed in spaced relation in a molded dished stem, the electrode unit being provided with adequate electrostatic shielding to confine the electron paths to the electrode areas. An anode surrounds the unit and is supported from the top of the enclosing vessel of the device to eliminate the presence of dielectric material in the power circuit and to provide a dielectric connection of high leakage resistance between the anode and the unit assembly.

A feature of this invention relates to the coupling of the unit electrodes to rigid conductors in the dished stem by flat metallic coupling members or strap connectors, which are shaped to cooperate with the electrodes and the conductors to support the unitary assembly solely from the conductors.

Another feature of this construction is the provision of diagonal bracing members arranged in a plane transverse to the flat coupling mem-

bers to strengthen the assembly, eliminate vibration and add stability to the unit.

A further feature of the invention relates to the incorporation of angular-shaped metallic flat strips or punchings fitted into slots in the lower insulating spacer which, together with the coupling members, securely lock the filament supporting assembly in position. This arrangement also facilitates the fabrication of the unit and materially reduces the cost and time of assembly.

Another feature of the invention attributable to the above-mentioned assembly is the cooperative alignment of the electrode supports with the radially positioned conductors in the molded stem to avoid mechanical strain and distortion in the coupling members of the assembly. Furthermore, the staggering of the projections of the coupling members facilitates the welding of the members to the electrode extensions projecting through the lower insulating spacer and provides an assembly which promotes efficient mass production with a minimum of skilled labor.

Another feature relates to the fabrication of the grid electrodes in accurate alignment without strain or stress on the connections, electrodes or supporting structure. In this arrangement, the suppressor grid or outer grid is provided with bifurcated clips having arcuate terminations which frictionally engage the surfaces of the spacing insulators to prevent longitudinal movement in the insulators and together with the insulators form a frame to support the remaining electrodes. The inner grids are horizontally aligned with the outer grid and secured by metallic strap connectors connected to conductors in the stem and the upper ends are surrounded by collars to suspend the grids in the frame. The outer grid is secured in the frame assembly by surrounding electrostatic shield members which are attached to the insulators.

Another feature of the invention relates to the assembly and support of the anode from the top of the vessel. This comprises a reinforced fork member which is held in and suspended from an external terminal sealed to the dome of the vessel. In one form, the anode assembly is provided with longitudinal braces to eliminate vibration of the assembly. In a modification of the anode structure which involves a two-part assembly, the forked member is secured to the terminal at the top of the vessel and provided with extensions and longitudinal corrugations to strengthen the support. The anode proper which is of greater diameter than the opening of the vessel is inserted sidewise through the opening of the vessel

and then turned within the larger space of the vessel and placed in cooperating relation with the forked member and secured thereto in order to produce a rigid assembly. The two parts of the vessel, namely, the stem with the electrode unit and the vessel with the anode inserted therein are placed in cooperating relation with the anode coaxial with the unit and hermetically sealed to form a compact device having high efficiency in the high frequency range of communicating systems.

These and other features 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 the complete device made in accordance with this invention with a portion of the enclosing vessel broken away to show the internal structure, and a cooperating shielding shelf associated with the lower end of the vessel in the same plane as the shielding within the vessel;

Fig. 2 is a view in elevation, partly in section, of the unit assembly employed in the device of Fig. 1 with the anode and shielding eliminated to clarify the presentation and with the details of the supporting structure disclosed which are associated with the conductors of the stem;

Fig. 3 is a plan view of the stem of the vessel of Fig. 1 showing the disposition of the conductors and the supporting connections;

Fig. 4 is a view in elevation, partly in section, of the stem showing the position of the conductors and the supporting elements of the electrode unit of Fig. 2 taken on the line 4-4 of Fig. 3;

Fig. 5 is a different view of the stem of Fig. 4, partly in section, showing the staggered relation of one of the ends of the supporting elements connected to the conductors;

Fig. 6 is a perspective view, in exploded fashion, of the lower insulator assembly of the unit of Fig. 2 showing the position of the various elements and their relation with respect to the insulator prior to coupling;

Fig. 7 is an enlarged perspective view of a section of the upper insulator and associated elements for coupling thereto illustrating the detailed assembly of one of the grid electrodes;

Fig. 8 is a perspective view of the electrode unit of Fig. 2 with parts of the shielding removed and the grids broken away to show the various details of the assembly;

Fig. 9 is a view in elevation of a modified construction of the anode assembly suitable for use in the device of Fig. 1; and

Fig. 10 is a plan view of the bulb of the vessel showing the relation of the anode structure of Fig. 9 in the vessel after assembly.

Referring to the drawings and particularly to Figs. 1 and 2, the high frequency pentode discharge device of this invention comprises an enclosing vessel 20 of bulbous form having a hollow terminal 21 sealed to the top thereof in a central position and a molded or pressed vitreous stem 22 of dished form sealed to the lower extremity of the vessel and provided with a plurality of tubular extensions 23 arranged on a circular boundary, as shown in Fig. 3, and surrounding a central nipple 24 which forms the sealing tubulation of the vessel. Each of the extensions 23 is provided with a hollow cup-shaped metallic terminal 25 having the edge thereof hermetically sealed to the rim of the extension 23, as shown in Fig. 2. The vessel and stem form a hermetically sealed receptacle or container which is highly evacuated

for an electrode assembly involving two separately insulated components in order to achieve the highest degree of leakage resistance between the low voltage component and the high voltage or power circuit component in the device. One of the components is the anode 26, of sheet molybdenum, formed of two U-shaped sections in opposed relation to form a flat cylinder and provided with a plurality of spaced corrugations 27, to strengthen the material of the anode. It is supported from the terminal 21 at the top of the vessel by a yoke or forked suspension member 28 having a tubular formed arm projecting within the terminal 21 and secured therein and a pair of downwardly extending channel arms 29 which are secured to the exterior of the anode 26 over the lap joint of the U-shaped sections. In order to strengthen the support of the anode a pair of angle braces 30 are secured to the top of the arms 29 and extend downwardly within the channel of the arms.

The other component is the electrode unit, as shown in Fig. 2, which is supported from the dished stem 22 of the vessel so that a high insulation path is provided between the terminal connections of the electrode unit and the high power terminal connection of the anode. Since the mass of the electrode unit is considerable in comparison to the ordinary discharge device employed in radio receivers, it is evident that the supporting structure of the unit should be of sufficient strength to maintain the unit in proper spacial relation with respect to the anode and also to avoid vibration or shock causing displacement of the unit with respect to the anode. In order to achieve these ends the low voltage electrodes, such as the filament and a plurality of grids, as used in the conventional pentode device, are combined in a unitary structure in which they are maintained in proper spacial relation with respect to each other to obtain the proper operating characteristics for the device. This unitary assembly comprises a pair of end insulating blocks 31 and 32, of ceramic or other vitreous composition material, having integral projections 33 extending outwardly in the same plane from the long sides of the blocks and the curved ends being provided with recesses 34, as shown in Fig. 7, to receive a pair of parallel stout rods 35 and 36 which are secured to the blocks by metallic clips 37 having bifurcated arcuate extensions 38 and 39 which frictionally engage opposite surfaces of the blocks 31 and 32 adjacent the slot 34 in which the rods 35 and 36 are disposed. This construction forms a rigid frame for the assembly of the low potential electrodes of the device. The rods 35 and 36 are provided with a continuously wound spaced grid winding 40 and serve as the suppressor grid of the device. Two additional grids are mounted within the suppressor grid, the one next adjacent being a helical winding 41 supported on a pair of upright rods 42 which extend through apertures in the blocks 31 and 32 while the inner grid winding 43 is supported on rods 44 which extend through adjacent apertures in the blocks immediately within the grid 41. The three grids have their lateral windings aligned in longitudinal planes and the inner grids 41 and 43 are suspended from the top block 31 by metallic collars 45 which embrace the ends of the rods projecting through the block 31.

A multisection tungsten filament 46 is folded in zigzag form and mounted in a single plane in the center of the grids of the unit. These sections are supported at the top by hooks 47 which

are held under tension by coiled springs seated in the top insulator block 31. The ends of the tungsten filament and the intermediate blights adjacent the lower insulator 32 are secured to hooks 49 which are welded to flat metallic punchings 50, 51 and 52 which project through narrow slots 54 in the lower insulator block 32. The central punching has a long longitudinal tongue projecting through the slot and a short horizontal projection to which the hook 49 is welded to limit the progress of the punching through the slot and form a stop for the punchings. The longitudinal tongues of punchings 50 and 51 are similarly formed to extend through the remaining slots and the horizontal portions are longer than the central punching and extend in opposite directions from the center so that these punchings form an inverted L-shaped element to provide uniform spacing of the hooks 49 to engage the filament 46. The relation of the flat punchings and narrow slots of the spacing block 32 insures rigid position of the hooks and prevents twisting or movement of the filament assembly out of its normal plane in the center of the grid structures. These punchings are securely locked to the insulating block 32 by coupling members below the block, the center punching 52 and the punchings 50 at opposite ends being secured to upright arms 55 of a yoke or trifurcated member 56 and the punchings 51 being secured to separate flat strap connectors 57 and 58. The yoke 56 is bent in gooseneck fashion as shown in Figs. 4 and 6 to provide alignment of the arms thereof with the coupling members or strap connectors 57 and 58 as shown in Fig. 3. Furthermore, the staggering of portions of the coupling members permits the free access of welding electrodes to opposite sides of the coupling members beneath the insulating block 32 to insure a rigid and tight connection against the lower surface of the block. The yoke member 56 is also provided with an angular shaped brace 59 to offset lateral strain in the yoke member and thereby increase the rigidity of the electrode unit connected to the yoke member.

The yoke member 56 is secured to a channel conductor 60 to which the brace 59 is also attached, the channel conductor being in the form of an elbow securely fastened in one of the terminals 25 which the elbow extending toward the center of the stem 22 in a radial direction. The coupling members 57 and 58 are secured to elbow channel conductors 61 and 62, respectively, which extend radially toward the center and are seated in other terminals of the stem. This provides three terminals for the filament to equalize the heating of the filament by connection of the terminals associated with conductors 61 and 62 to the ends of the secondary winding of a heating transformer while the other terminal, connected to the conductor 60, is joined to the mid-point connection of the transformer winding, this terminal being slightly enlarged in diameter by a copper sleeve 63 to easily identify the connection of the device in an appropriate circuit. The stout rods of the suppressor grid 40 are secured at their lower ends by a horizontal metallic strip 64 which extends across the unit below the insulating block 32 and is secured to the upright tongues 65 of a yoke member 66 which extends parallel to the yoke 56 and is attached to a channel conductor 67 rigidly secured in another terminal 25 and extending in alignment with the conductor 60 toward the center of the stem. One of the upright rods of the grid 41 is secured below the insulator 32 to a strap 68

welded to a channel conductor 69 while the inner grid 43 is connected to a strap 70 welded to a channel conductor 71. A channel brace 72 is welded to conductor 67 and extends diagonally upwards and is fastened to a projection 33 of the lower insulator 32 to increase the rigidity of the assembly in a direction opposite to the brace 59.

The flat coupling members between the electrodes and the channel conductors in the stem provides a rigid mounting for the unit assembly and insures adequate insulation resistance between the numerous connections involved in the assembly. Furthermore, the radial disposition of the channel conductors facilitates the coupling to the electrodes with the shortest metallic connections to reduce capacitance effects between the electrodes. In order to decrease the interelectrode coupling between the low potential electrodes of the unitary component and the high potential electrode, namely, the anode, suitable electrostatic shielding is provided at the top and bottom of the unit to eliminate stray paths of charges which would alter the characteristics of the device. As shown in Fig. 8 the top of the unit assembly is shielded by U-shaped metallic shields 73 and 74 which are provided with central grooves to closely embrace the top insulator 31 so that the curved ends of the shields may be welded to the clips 37 and the rods 35 and 36 of the frame assembly. The shields are also provided with bent ears which engage the projections 33 on the insulator 31 and are securely held thereto by bent wires extending through the ears and the projections. The shields are provided with cap inserts 75 which enclose the projecting ends of the grids seated in the insulating block 31. A pair of semicircular shields 76 and 77 are mounted on the lower insulator 32 and provided with an upstanding flange 78 which extends above the insulator and the curved ends thereof are welded to the stout rods of the grid frame, the parallel edges of the shields adjacent the center being secured to the projections 33 of the lower insulator block by locking wires which hold the shields in proper relation to each other and the unit. An advantage of this shielding arrangement at the lower end of the device may be realized in the disclosures of Figs. 1 and 2, which show the circular shield forming a substantial cover or barrier for the various connections below it so that the anode field cannot extend to the low potential terminal connections of the electrodes of the unit. Furthermore, the close relation of the disc shield to the glass facilitates the coupling of the shield with a shielding shelf or platform 79 exterior to the vessel so that the low potential terminals may be segregated from the power circuit or anode terminal 21.

The construction of the anode assembly in the device of Fig. 1 utilizes a spacing between the outer grid and the anode whereby the device has a high current amplification characteristic. In order to obtain a high voltage amplification characteristic a greater spacing is desired between the grid structure and the anode and in accordance with this invention this is secured by an anode assembly as shown in Figs. 9 and 10. In this arrangement the anode supporting fork embodies a formed member 80 having the head within the terminal 21 shaped in semi-cylindrical form as shown at 81 in Fig. 9 and the ends of the downwardly projecting arms bent at an angle to form securing tabs 82 for the anode. The arms are provided with a central longitudinal corrugation 83 to strengthen the anode yoke. The anode 84 being of larger diameter along one

dimension than the opening in the vessel 20 may be assembled in the vessel with the suspension yoke 80 by inserting the anode edgewise into the opening 85 until the anode is wholly within the vessel, then turning the anode which is provided with ears 86 in alignment with the tabs 82 of the yoke and securing them thereto by screws which may be arc welded to prevent loosening of the screws. This construction facilitates the adaptability of the device of this invention to the requirements of different characteristics for the operation of the device and materially increases the flexibility of fabrication of the complete device.

While the invention has been disclosed with respect to a specific embodiment of the device, it is, of course, understood that various modifications may be made in the detailed assembly of the coupling and support of the unitary assembly of electrodes in various types of devices and therefore the invention is to be construed in accordance with the scope of the appended claims.

What is claimed is:

1. An electron discharge device comprising a vessel having a bulbous portion and a molded dished stem portion, a high potential electrode supported by said bulbous portion, a unitary mount including a plurality of low potential electrodes supported by said stem portion and extending within said high potential electrode, terminals for said low potential electrodes in said stem, and an electrostatic shield of large transverse area supported by said mount and forming a barrier between said high potential electrode and said terminals.
2. An electron discharge device comprising an enclosing vessel having a molded dish stem, a plurality of hollow terminals sealed to said stem, a plurality of conductors extending into said dish stem from said terminals, a mount within said vessel including a plurality of electrodes, and a plurality of metallic coupling members arranged in parallel vertical planes connecting said electrodes to said conductors.
3. An electron discharge device comprising an enclosing vessel having a molded dish stem, a plurality of hollow terminals sealed to said stem, a plurality of conductors extending into said dish stem from said terminals, a mount within said vessel including a plurality of electrodes, and means including a pair of multiarm coupling members arranged in parallel vertical planes interconnecting said electrodes and said conductors.
4. An electron discharge device comprising an enclosing vessel having a molded dish stem, a plurality of hollow terminals sealed to said stem, a plurality of conductors extending into said dish stem from said terminals and having elbow terminations of U-shaped cross-section extending radially towards the center thereof, a mount within said vessel including a plurality of electrodes, and a plurality of metallic coupling members having portions arranged in parallel vertical planes interconnecting said electrodes and said conductors.
5. An electron discharge device comprising an enclosing vessel having a molded dish stem, a plurality of hollow terminals sealed to said stem, a plurality of channel-shaped conductors extending into said dish stem from said terminals and extending radially toward the center thereof, a mount within said vessel including a plurality of electrodes, and a plurality of metallic coupling members connecting said electrodes to said conductors.
6. An electron discharge device comprising an enclosing vessel having a molded dish stem, a plurality of current supplying conductors in said stem, a frame mount supported from said conductors, a multisection electron emitter within said frame, a plurality of angle-shaped flat strips extending through a portion of said frame and connected to said emitter, and cooperating strap connectors between said frame and a plurality of said conductors for connection to said flat strips to securely lock them in said frame.
7. An electron discharge device comprising an enclosing vessel having a molded dish stem, a plurality of current supplying conductors in said stem, a frame mount supported from said conductors, a multisection electron emitter within said frame, a plurality of angle-shaped flat strips extending through a portion of said frame and connected to said emitter, and means including multiarm coupling members between said frame and a plurality of said conductors for connection to said flat strips to securely lock them in said frame.
8. An electron discharge device comprising an enclosing vessel having a molded dish stem, a plurality of current supplying conductors in said stem, a frame mount supported from said conductors, a multisection electron emitter within said frame, a plurality of angle-shaped flat strips extending through a portion of said frame and connected to said emitter, cooperating coupling members between said frame and a plurality of said conductors for connecting said flat strips thereto, a plurality of wire wound electrodes surrounding said emitter and supported by said frame, and additional flat strap connectors connecting said electrodes to other conductors in said stem.
9. An electron discharge device comprising an enclosing vessel having a stem, an electrode mount within said vessel and supported from said stem, said mount including rod members and transverse end insulating members having openings to receive said rod members, and metallic clips attached to the ends of said rod members, said clips having arcuate terminations frictionally engaging the surfaces of said insulating members.
10. An electron discharge device comprising an enclosing vessel having a stem, an electrode mount within said vessel and supported from said stem, said mount including rod members and transverse end insulating members having openings to receive said rod members, metallic clips having arcuate terminations frictionally engaging said insulating members and attached to said rod members, a pair of wire wound grid elements having parallel support rods extending through said insulating members, and metallic collars secured to said support rods above the top insulating member to prevent downward movement of said elements in said mount.
11. An electron discharge device comprising an enclosing vessel having a molded dish stem, a plurality of current supplying conductors in said stem, a frame mount supported from said conductors, a multisection electron emitter within said frame, other cooperating electrodes supported by said frame, means for coupling said emitter and said electrodes to said conductors in said stem, an anode surrounding said mount and being supported from the top of said vessel,

and a transverse shield positioned between one end of said anode and said dish stem.

12. An electron discharge device comprising an enclosing vessel having a dish stem, a plurality of hollow terminals sealed to said stem, an electrode unit within said vessel, rigid conductors within said terminals and extending towards said unit, and flat metallic strap connectors secured to said conductors, said connectors having arms secured to the individual electrodes of said unit.

13. In an electron discharge device a hollow metallic anode having ear extensions bent at an angle, a forked suspension support, and coupling means connecting said ear extensions to said forked support.

14. In an electron discharge device a hollow metallic anode, a forked support secured to the sides of said anode, and reinforcing braces on the forked support to eliminate vibrational strains on said support.

15. An electron discharge device comprising an enclosing vessel having a molded dish stem, a plurality of current supplying conductors in said stem, a frame mount supported from said conductors, a multisection electron emitter within said frame, a plurality of angle-shaped flat strips extending through a portion of said frame and connected to said emitter, a plurality of coupling members between said frame and a plurality of said conductors, and diagonal braces on opposite sides of said frame coupling said mount to said conductors in the vicinity of said members.

16. An electron discharge device comprising a bulbous vessel, a stem joined to said vessel and having tubular projections, hollow terminals sealed to said projections, channel-shaped conductors rigidly secured in said terminals, said conductors having elbow extensions directed toward the center of said stem, a mount beyond

said stem including a plurality of electrodes, an anode supported from the top of said vessel and surrounding said mount, and metallic flat strap connectors securing the electrodes of said mount to said conductors.

17. An electron discharge device comprising a bulbous vessel, a stem joined to said vessel and having tubular projections, hollow terminals sealed to said projections, channel-shaped conductors rigidly secured to said terminals, said conductors having elbow extensions directed toward the center of said stem, a mount beyond said stem including a plurality of electrodes, an anode supported from the top of said vessel and surrounding said mount, a pair of parallel multi-arm coupling members securing the inner and outer electrodes of said mount to opposed conductors in said stem, and strap connectors coupling the intermediate electrodes to the other conductors.

18. An electron discharge device comprising a bulbous vessel, a stem joined to said vessel and having tubular projections, hollow terminals sealed to said projections, channel-shaped conductors rigidly secured in said terminals, said conductors having elbow extensions directed toward the center of said stem, a mount beyond said stem including a plurality of electrodes, an anode supported from the top of said vessel and surrounding said mount, a pair of parallel multi-arm coupling members securing the inner and outer electrodes of said mount to opposed conductors in said stem, strap connectors coupling the intermediate electrodes to other conductors, and diagonal braces secured to said opposed conductors and extending towards said mount to provide additional support therefor in a direction transverse to the plane of said members.

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