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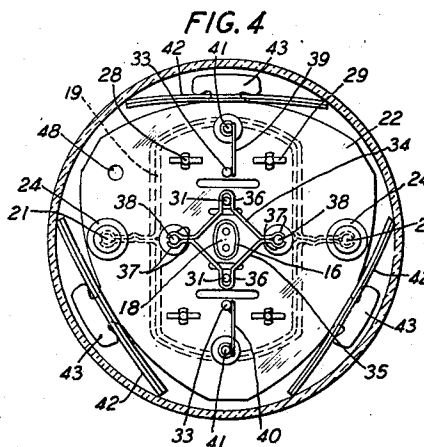
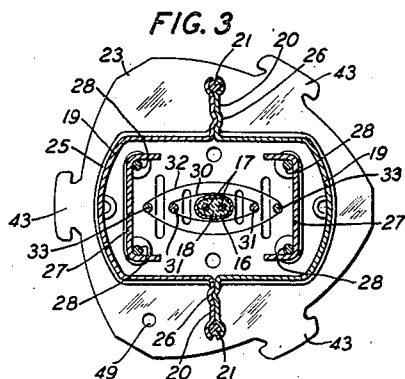
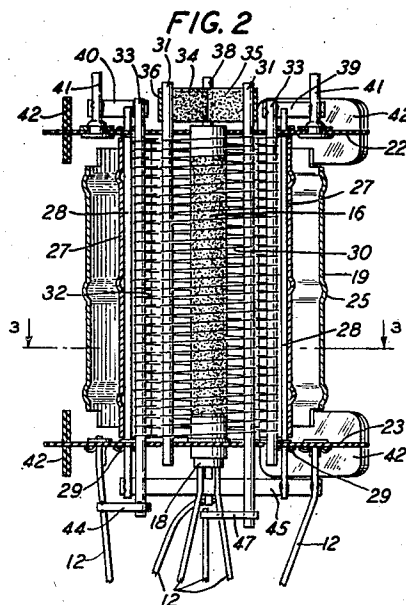
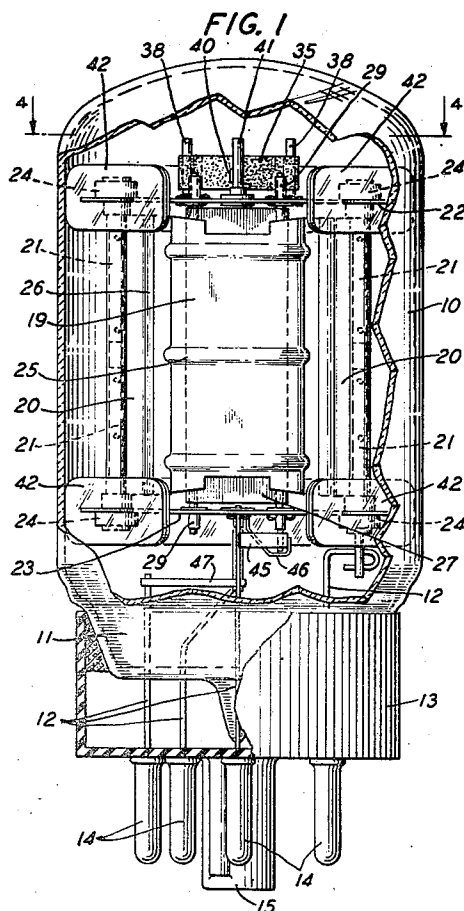
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2,442,378

ELECTRON DISCHARGE DEVICE

Filed Sept. 24, 1945

2 Sheets-Sheet 1



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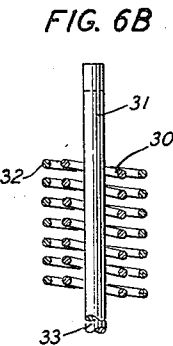
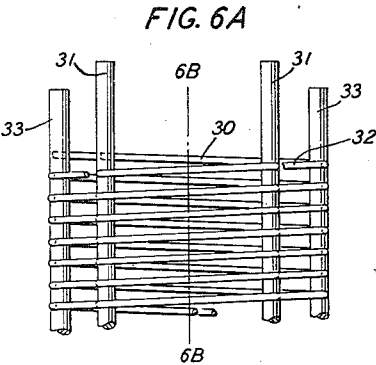
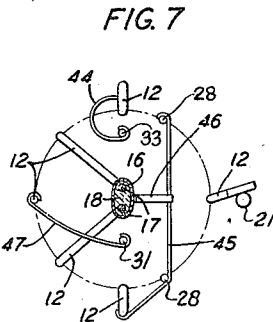
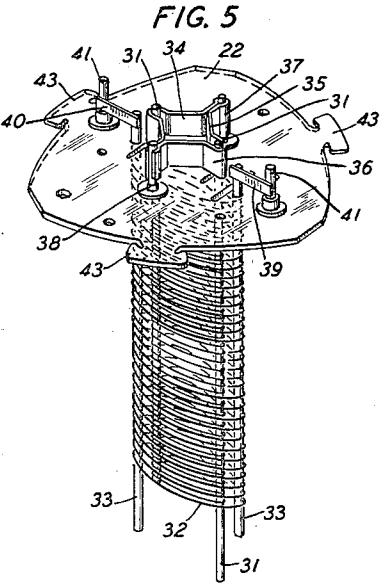
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2 Sheets-Sheet 2



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## UNITED STATES PATENT OFFICE

2,442,378

## ELECTRON DISCHARGE DEVICE

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6 Claims. (Cl. 250—27.5)

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This invention relates to electron discharge devices and more particularly to such devices of the multigrid type and especially suitable for use as power amplifiers.

In certain multigrid tubes, the control and screen grid electrodes have been positioned in the discharge path between the cathode and anode with their laterals or grid turns in alignment so that the control grid acts as a shield for the screen grid to reduce the screen grid current. Other advantages of the aligned grid electrodes are to increase the operating range, to overcome burn-out of the screen grid, to prolong life and to provide more efficient performance of the device as a modulator.

However, in such devices considerable difficulty has been experienced in maintaining stable and reproducible static and dynamic characteristics in the device over an extended period of life due to the disturbance of the alignment of the grid electrodes either because of temperature changes or mechanical instability of the supporting structure.

Heretofore, it has been usual to mount the grid electrodes in aligned relation and maintain them in such position by attachment to conductors in the stem below the electrode unit. This construction has proved unsatisfactory because of frailty of the supports and also because of expansion of the conductors under varying temperature conditions which resulted in misalignment and in destructive burn-out of the screen grid by electron impact. The strengthening of the supports at the lower end of the unit in order to avoid the above difficulties caused other deleterious effects, such as reduced leakage resistance, higher capacitance between the electrodes and short-circuiting of the electrodes, which render the device unfit for service.

An object of this invention is to overcome these defects in multigrid electrode device.

Another object of the invention is to attain positive collateral relationship of the turns of the two grids over an extended period and under varying operating conditions.

A further object of the invention is to relieve torsional stresses in the grid electrodes so that temperature changes do not affect the transverse linearity of the electrodes.

Another object of the invention is to facilitate the assembly of the electrode unit in multigrid devices and to enable production at low cost.

These objects are attained in accordance with features of this invention in a beam power type device having a cathode and anode mounted be-

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tween and spacer members and a pair of laterally mounted deflector plates interposed between the cathode and anode and affixed to the end spacers. A pair of helically wound grids surround the cathode and are disposed in such relation to the anode and deflector plates that beams of electrons are projected toward the surfaces of the anode between the plates. The unitary assembly of the electrodes is mounted on a pair of rigid conductors anchored to the lower spacer and the unit is partially supported from the side walls of the device by cushion spacers extending from both end spacer members.

The control grid nearest the cathode is maintained in positive relation to the cathode by a suspension mounting including a metallic frame member having loop portions secured to the extending uprights of the grid and other loop portions which engage pins projecting from the top of the upper spacer member. A specific assembly of the frame mounting involves a pair of bent angular metallic bands mounted edgewise on the pins and grid uprights and so related to form a closed rectangular or diamond-shaped frame symmetrical with respect to the axis of the cathode. The other or screen grid is supported similarly by a suspension mounting. The uprights therefor, after alignment of the laterals of the two grids, are attached to offset pins in the upper insulating spacer by edge mounted metallic bands to rigidly affix the grid to the upper insulator. The suspension mounting of the two grids insures positive alignment of the laterals of the grids and rigid fixation thereof at the top of the assembly where the rigid supporting frames or bands do not interfere electrically with the internal capacitance properties of the assembly. The grid electrodes are free to expand and contract uniformly under temperature changes since the grids are coupled to conductors in the stem by light, flexible straps so that necessary elongation of the grids occurs at the lower end of the unit.

The suspension mounting of the grid electrodes provides firm anchorage of the individual grids in such manner that the device can withstand rough handling without the possibility of the grids being misaligned. The edge mounting of the suspension supports counteracts thrust stresses affecting the alignment of the grid electrodes and the bracing frame mounting offsets torsional strains set up in the grid which is closest to the cathode and, therefore, is subjected to heating by the intense cathode stream.

A feature of the invention relates to the dual role of the rectangular or diamond-shaped sus-

pension support. The projecting vane construction of the edge mounted suspension support is an efficient heat radiation member for the grid and by coating this member with a black body substance, such as carbon, the dissipation of heat from the grid is accelerated so that the grid is rendered relatively cool and emission therefrom is suppressed.

Another feature of the invention relates to the main support of the electrode unit in the enclosing vessel so that excessive expansion of the conductors in the stem does not cause deleterious distortion of the frail grid electrodes in the assembly, which are the structurally weakest elements. This construction involves the mounting of the unitary assembly in such a manner that the wall of the enclosing vessel laterally supports the electrode mount through the side spacers at opposite ends of the assembly, and the unit is longitudinally supported by a pair of supports in the stem which are anchored to the lower insulating spacer. The frail grid electrodes are connected to separate rigid conductors in the stem by light flexible straps and, therefore, are linked to the rigid conductors through yieldable connectors which do not transmit the stress forces applied to the rigid conductors during temperature changes.

These and other features of the invention are set forth in more detail in the following description which together with the accompanying drawings depict one embodiment of the invention:

Fig. 1 is an elevation view of a device made in accordance with this invention with the enclosing vessel and base partly broken away to show the internal structure;

Fig. 2 illustrates in elevation the assembly of the electrode unit or mount incorporated in the device of Fig. 1, with several of the electrode elements shown in longitudinal section to show the relationship of the elements and the supporting structure thereof;

Fig. 3 is a plan view partly in cross-section taken on the line 3—3 of Fig. 2 in the direction of the arrows;

Fig. 4 is an end view of the device illustrating the top end position of the unit in the vessel, taken along the lines 4—4 of Fig. 1;

Fig. 5 is a perspective view of a partial assembly of the unit involving the supports of the grid electrodes in accordance with this invention;

Fig. 6a is an enlarged view in elevation showing the alignment of the grid laterals as accomplished by the mounting assembly of Fig. 5;

Fig. 6b illustrates in cross-section the relationship of the grid electrodes as viewed on line 6b—6b of Fig. 6a; and

Fig. 7 is a plan layout of the connections between the conductors in the stem of the device and the electrodes in the unitary assembly.

The invention is embodied in a multigrid high power tube of rigid construction to withstand severe usage and operating conditions. This construction, as shown in Figs. 1 and 2, forms a compact assembly. The tube is equivalent in power output and operating characteristics to a similar tube, not embodying this invention, three times its size, both having the same potential, for example 1250 volts, applied to the anode or output electrode. The compact assembly is capable of withstanding high gravitational shock, both laterally and longitudinally, so that severe shock encountered in operation will not cause distortion

of the electrodes and thereby alter the characteristics of the electrode assembly.

Referring to Figs. 1 and 2, the device includes a cylindrical vitreous vessel or receptacle 10 having a molded dish stem 11 joined to the lower end and in which the leading-in wires or conductors 12 are sealed for conduction of electrical energy to the various electrodes contained in the unit within the vessel. The stem is cemented in a molded supporting insulating base 13 having a series of terminal pins 14 secured in the bottom thereof in a circular boundary to which the conductors 12 are attached for external connection of the device in the appropriate circuit. The base is provided also with a central integral projection 15 for indexing the device in its associated socket so that the terminal pins are connected to the appropriate circuit connections for the device.

The unitary electrode assembly mounted within the vessel includes a central tubular cathode 16 formed to an oval configuration and provided with an appropriate emissive coating for the production of a copious supply of electrons. The cathode is provided with an internal heater 17, as shown in Fig. 3, embedded in an insulating sleeve 18 extending through the length of the cathode. The cathode is surrounded by a rectangular-shaped anode formed of two half sections 19 having outwardly extending fins 20 which terminate in formed sockets to receive support pins 21 extending through end insulating spacer discs or members 22 and 23, for example of mica. The spacer members rigidly fix the cathode and anode in coaxial relation in the assembly, the pins 21 extending through insulating bushings 24 in the end insulating spacers and being welded in the sockets of the fins of the anode. In order to strengthen the anode to withstand the high temperatures encountered due to the high voltage operation, the body sections of the bipart anode are provided with deep spaced corrugations 25 running transversely to the length of the sections and the fins are provided with longitudinal corrugations 26 to offset buckling in the metal surfaces. The whole anode assembly may be coated with a black body substance, such as carbon or zirconium, to serve as an efficient heat radiator to dissipate the heat generated in the anode due to the high voltage operation.

A pair of beam-forming or deflector plates 27 of angular cross-section, as shown in Fig. 3, are mounted longitudinally between the inner anode surfaces and the cathode to shield the short sides of the anode and thereby increase the projection of electrons from the cathode in a definite path toward the broad sides of the anode, whereby the production of beams of electrons is facilitated. The deflector plates 27 are mounted in opposed relation on opposite sides of the cathode with their open ends facing toward the cathode and are rigidly held in position by pairs of rods 28 welded to the inside corners of the plates. The rods 28 have extensions projecting through metallic eyelets 29 secured in the end spacer members 22 and 23 and welded to the rods.

The location of the electrodes in the assembly is completed by the mounting of the grids coaxially surrounding the cathode with the laterals of the two grids aligned in accurate transverse relation in the direction of electron flow from the cathode to the anode. In order to maintain accurate alignment and to secure stable operating characteristics regardless of temperature changes or rough usage of the device, the grids are supported in accordance with one of the main fea-

tures of this invention so that true alignment of the laterals of the two grids is maintained constant throughout the operating life of the device. The control grid or the grid nearest the cathode is in the form of an oval helix 30, of small diameter wire but of great strength, such as molybdenum wire, supported by a pair of upright rods 31 positioned at the extremities of the oval. The second or screen grid 32 is formed of similar wire and supported by upright rods 33. Both grids are wound with the same pitch but of different diameters, as shown in Figs. 6a and 6b and are supported coaxially around the cathode and between the end spacer discs 22 and 23 so that all the laterals are aligned in a transverse direction between the emitting surfaces of the cathode and the receptive surfaces of the anode. Since the grid electrodes are placed close to the cathode it is preferable to provide the grids with a non-emissive coating, such as a metallic plating of gold, to maintain the grids conductive yet render the grids non-emitting. Furthermore, heat from the grids is accelerated by forming the upright rods of good heat conducting material, such as copper or a copper alloy having greater strength.

In order to maintain the grids in lateral aligned relation, the end portions of the upright rods of the control grid extending through the top insulator spacer 22 are secured to a symmetrical frame member which is anchored to the top insulator to provide a rigid suspension support. One embodiment of this suspension support is a rectangular shaped frame member or vane, preferably formed of two sections to facilitate attachment to the grid uprights and the supporting assembly on the top of the unit. These sections, as shown more clearly in Fig. 4, are a pair of angularly bent relatively wide strap members 34 and 35 having mid-point loop portions 36 which substantially embrace and are secured to the projecting ends of the upright rods 31 of the control grid. The opposite ends of both frame members are bent outwardly and formed into half socket portions 37 and when brought together, as shown in Fig. 4, the end portions 37 form sockets to embrace stationary pins 38 projecting from and riveted to the top insulating spacer 22. The pins are laterally in line with and project from the spacer parallel to the axis of the cathode 16. In addition to the rigid suspension support of the grid afforded by the frame, the symmetrical frame member extending above the unit serves as an efficient heat radiator for dissipating the heat absorbed by the grid. By applying a black coating to the frame member, such as a coating of carbon or zirconium similar to the coating on the anode, the dissipation of heat from the grid by radiation is increased. The screen grid 32 is suspended from the top insulator assembly by a pair of edgewise mounted straps 39 and 40 which extend transversely above the spacer disc 22 from the ends of the grid rods 33 and are secured to rivet pins 41 secured to the spacer 22 after proper alignment of the two grids, as shown in Fig. 6a, the pins 41 being mounted at oppositely disposed points in line with the cathode and grid supports across one axis of the spacer disc 22.

The rigid suspension support of the multigrid assemblies of this invention insures a shock-proof mounting whereby the two cooperative grid electrodes are positively held in constant lateral relation to each other so that the turns of the grid are in accurate alignment and maintained in such position regardless of temperature varia-

tions or other changes affecting the electrodes. It will be noted that the grid supports extend through the lower insulating spacer 23 and are free to expand and contract uniformly without altering the aligned relation of the laterals of the grids. The symmetrical anchor mounting of the grids from the top insulating spacer also avoids introducing deleterious capacity effects which would be liable to occur if the mounting support of the grids were located at the bottom of the assembly where the structure might interfere with the conductors to the various electrodes.

In addition to the rugged assembly provided by the unitary mounting of the electrodes in accordance with this invention, the unit withstands severe shock both laterally and longitudinally, so that service conditions are not apt to endanger the structure by distortion or stresses due to severe shock. Lateral distortion is overcome by mounting the unit from the side walls of the cylindrical vessel 10 by side mica spacers 42 locked on ears 43 extending at three equally spaced positions on both mica spacers 22 and 23, to resiliently cushion the entire unit within the enclosing vessel and protect the unit from lateral shock imparted to the vessel. In addition, the unit is mounted from the stem to withstand longitudinal shock by a pair of rigid conductors 12 extending through and attached in eyelets secured in the lower spacer member 23, as shown in Fig. 2. The supporting conductors 12 extending to the lower spacer 23 also serve as current conductors for certain electrodes, i. e., the longer support rod 33 of the screen grid is connected to the left-hand support conductor, as shown in Fig. 2, by a light flexible conductor 44 while the right-hand conductor is connected by a bent strap 45 to a pair of the support rods 28 for the deflector plates. The cathode is coupled to the strap 45 by a flexible connector 46 so that the cathode and the deflector plates are at the same potential, which is nominally zero. The heater of the cathode is connected to a pair of leading-in conductors 12 by extending the conductors up to the end of the tubular insulator 18 and attaching these conductors to the ends of the heater. The control grid 30 is connected to the remaining conductor in the stem by a light flexible strap 47. The straps from the conductors to the multigrids in the unit are made relatively flexible so that the grids can expand and contract without danger of the transmission of expansion stresses being imparted by the conductors in the stem.

Since the top and bottom mica spacers 22 and 23 are substantially similar except for the pins projecting from the top mica and the eyelets in the bottom mica for the supporting conductors, it is difficult to select the proper pair of spacing micas from a supply tray in assembly and, accordingly, it is one of the features of this invention to facilitate the selection of the proper pair of spacing insulators by the provision of indexing holes 48, as shown in Fig. 4, for the upper spacer and 49, as shown in Fig. 3, for the lower spacer. When these holes are aligned, it is an indication that the proper pair of spacers are being applied to the assembly. If the holes do not register when an indexing rod is passed through the micas at the beginning of the assembly, the operator will immediately be aware of the selection of the wrong pair of spacers and the mistake can be rectified before further assembly is attempted.

While the invention has been disclosed with respect to a specific beam power device, it is, of course, understood that the invention may be

applied to other types of devices of the multi-grid type without departing from the scope and spirit of the invention as defined in the appended claims.

What is claimed is:

1. An electron discharge device comprising an enclosing vessel, an electrode mount within said vessel including a cathode, anode and a pair of grid electrodes in coaxial relation, insulating spacer members at opposite ends of the electrodes, and suspension means supporting said grid electrodes from the upper spacer member with the laterals of said grid electrodes in transverse alignment.

2. An electron discharge device comprising an enclosing vessel, an electrode mount assembly within said vessel including a cathode, anode and a pair of grid electrodes in coaxial relation, said grid electrodes having the laterals thereof aligned with each other in a transverse direction, insulating spacer members at opposite ends of the electrodes, and edge-mounted metallic members exterior to said mount assembly rigidly anchoring said grid electrodes to the upper spacer member.

3. An electron discharge device comprising an enclosing vessel, an electrode unit supported within said vessel including a cathode, anode and a plurality of grids in coaxial relation with insulating spacer members at opposite ends thereof, said grids having their laterals in accurate alignment in the direction of electron flow between said cathode and anode, and means rigidly maintaining said grids in aligned relation including edge-mounted strap members coupled to said grids and attached to supports projecting from the top spacer member.

4. An electron discharge device comprising an enclosing vessel, an electrode mount assembly supported within said vessel including a cathode, anode and a pair of grid electrodes, upper and lower disc insulating spacers supporting said cathode and anode in coaxial relation, said grids each having a pair of support rods extending through said spacers, a pair of pins projecting outwardly from said upper spacer in line with said support rods, a second pair of pins extending from said spacer laterally in line with the axis of said cathode and in transverse relation to said first pins, a symmetrical strap member embracing the second pair of pins and a pair of support rods for one of said grid electrodes, and a pair of bridging strip members attached to said other pair of support rods and said first pair of pins.

5. An electron discharge device comprising an enclosing vessel, an electrode mount assembly supported within said vessel including a cathode, anode and a pair of wire wound grid electrodes,

said grid electrodes having their laterals in alignment in the direction of electron flow between said cathode and anode, upper and lower insulating spacer members supporting said cathode and anode in coaxial relation, said grid electrodes having upright rods extending through said spacer members, and means rigidly suspending said grid electrodes from said upper spacer member whereby both grid electrodes can expand in unison through said lower spacer member, said means comprising support pins extending from said upper spacer member and symmetrical strap connectors in edgewise relation extending between said support pins and said upright rods.

6. An electron discharge device comprising an enclosing vessel, an electrode mount assembly supported within said vessel including a cathode, a pair of deflector plates, an anode, and a pair of grid electrodes, said grid electrodes having their laterals in alignment in the direction of electron flow between said cathode and anode, upper and lower insulating spacer members supporting the electrodes in coaxial relation, means rigidly suspending said grid electrodes from said upper spacer member whereby both grid electrodes can expand in unison through said lower spacer member, a pair of rigid support conductors in said vessel extending toward said mount assembly, means to anchor said conductors in said lower spacer, a flexible conductive connector extending between one of said grid electrodes and one of said conductors, and a bridging strap member connected to said deflector plates and cathode and attached to said other conductor.

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