

April 13, 1937.

V. L. RONCI

2,077,156

ELECTRON DISCHARGE DEVICE

Filed April 27, 1935

2 Sheets-Sheet 1

FIG. 1

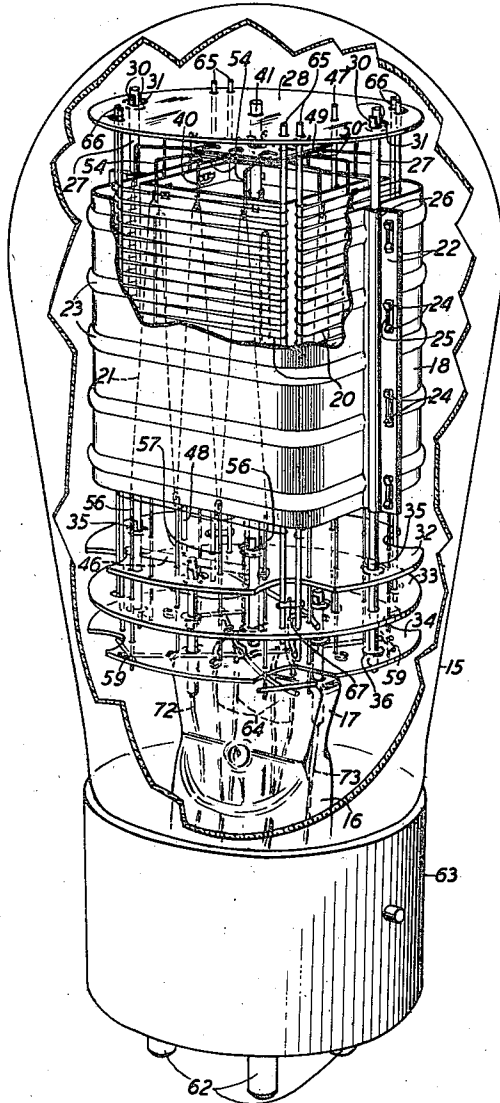


FIG. 3

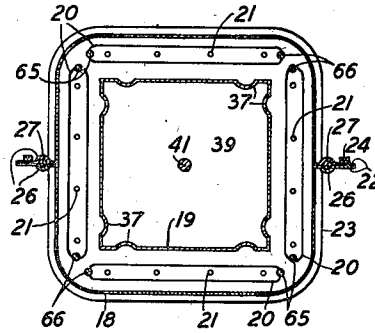


FIG. 9

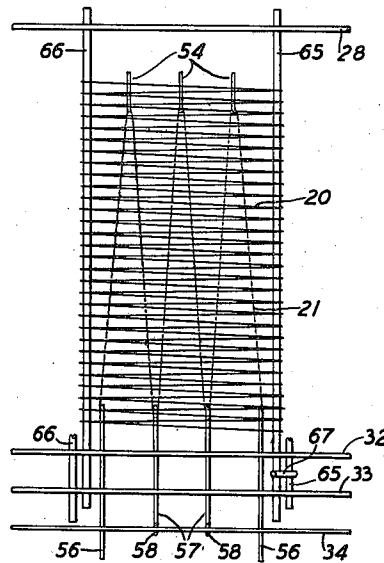
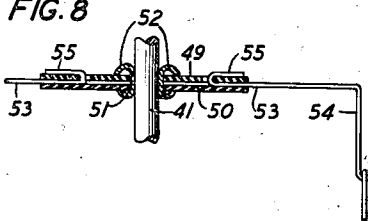


FIG. 8



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2 Sheets-Sheet 2

FIG. 7

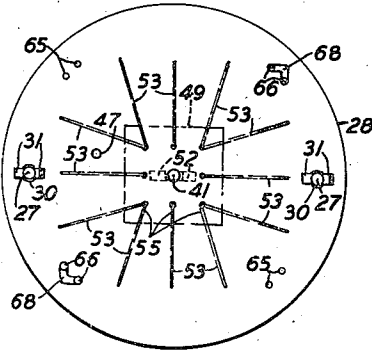


FIG. 4

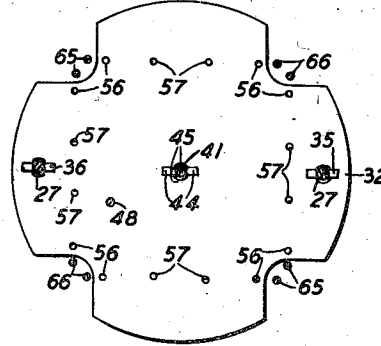


FIG. 2

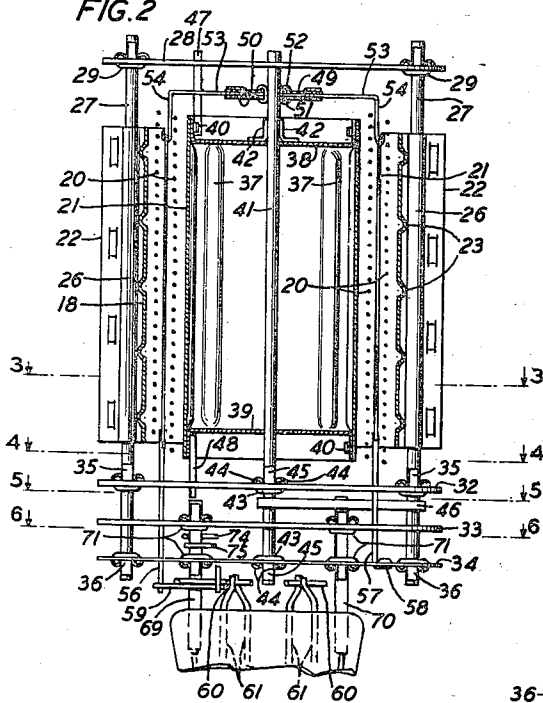


FIG. 5

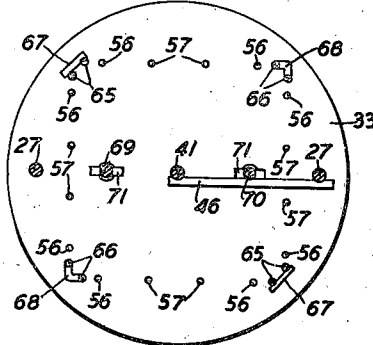


FIG. 6

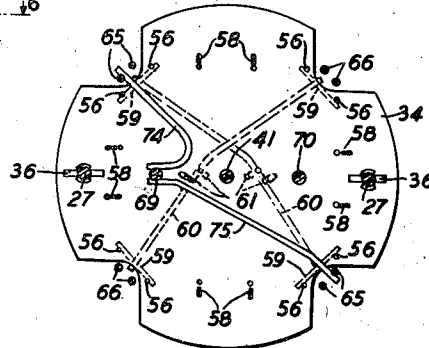
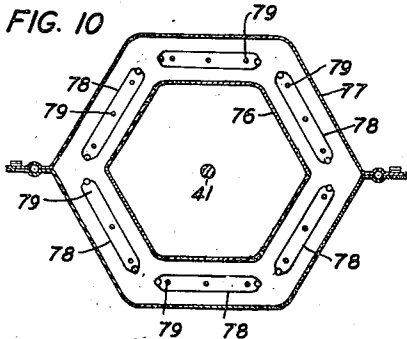


FIG. 10



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2,077,156

ELECTRON DISCHARGE DEVICE

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Application April 27, 1935, Serial No. 18,518

8 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices and more particularly to such devices especially suitable for audio frequency amplification.

One object of this invention is to increase the mutual conductance and power capacity of electron discharge devices.

Another object of this invention is to maintain the space relation of the electrodes in electron discharge devices having a large number of electrode elements.

In one illustrative embodiment of this invention, an electron discharge device comprises a plurality of flattened helical grids arranged laterally adjacent each other and forming an enclosure, and a plurality of cathode sections disposed one within each of the grids. Each cathode section may include a plurality of V-shaped filaments arranged in the medial plane of the corresponding grid parallel to the longer sides of the grid. The several grids are surrounded by an anode member and another anode member is disposed within the closure formed by the grids, the two anode members being electrically connected together.

In accordance with one feature of this invention, the anode members are polygonal, for example, square or hexagonal, in lateral section so that they present parallel electron receiving surfaces in juxtaposition to each of the grids and cathode sections. The electrode spacings, therefore, may be made relatively small and substantially equal paths are insured for substantially all electrons emanating from the cathode sections to the anode members so that a high mutual conductance and a relatively large power capacity are obtained.

In accordance with another feature of this invention, the inner anode member and the cathode sections are supported from a central standard or rod secured to end closure discs on the anode. An insulating member is carried by the standard or rod and has extending therefrom a plurality of resilient hook members which engage the apices or bights of the filaments.

The invention and the several features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawings in which:

Fig. 1 is a perspective view of an electron discharge device illustrative of one embodiment of this invention, a portion of the enclosing vessel and of the outer anode member being broken away to show details of the electrode structure more clearly;

Fig. 2 is an elevational view of the electrode assembly embodied in the device shown in Fig. 1 and shown partly in cross-section;

Fig. 3 is a view in cross-section along the line 3—3 of Fig. 2, showing the configuration and relative disposition of the electrodes;

Figs. 4, 5 and 6 are detail plan views along lines 4—4, 5—5, and 6—6, respectively, of Fig. 2, showing the several insulating members adjacent the lower end of the electrode assembly and the supporting and tie members associated therewith;

Fig. 7 is a top view of the insulating member at the upper end of the electrode assembly and the supporting system for the upper end of the cathode sections;

Fig. 8 is an enlarged detail view in elevation and partly in cross-section of the supporting system for the upper end of the cathode sections;

Fig. 9 is an enlarged detail view in elevation of one of the cathode and control grid units; and

Fig. 10 is a view in cross-section of the electrodes in a modification of the device shown in Fig. 1.

Referring now to the drawings, the electron discharge device shown in Fig. 1 comprises an enclosing vessel 15 having a stem 16 which terminates in a substantially rectangular press 17 from which the electrode assembly is supported.

The electrode assembly, as shown more clearly in Figs. 2 and 3, includes an outer box-like or square anode member 18, an inner anode member 19 of similar configuration, electrically connected to the outer anode member, a plurality of electrically connected flattened helical grids 20 disposed edge-to-edge and each having its longer sides parallel to corresponding juxtaposed sides of the inner and outer anode members, and a plurality of electrically connected filamentary cathode sections 21 disposed one within each of the helical grids 20 and preferably in a medial plane thereof. This arrangement enables close spacing of the electrodes and assures substantially uniform paths of the same impedance between the cathode sections and the anode members for substantially all electrons emanating from the cathode so that a high mutual conductance may be obtained in the device. It also enables the use of a cathode of large aggregate area and anode surfaces in juxtaposition to opposite surfaces of the cathode sections so that a high power output and high operating efficiency are obtained.

The outer anode member 18 may be formed of two similar opposed U-shaped portions having flanges 22 and provided with parallel stiffening corrugations or flutes 23. The corresponding

flanges 22 are secured together in face-to-face relation as, for example, by integral tabs 24 on one flange extending through apertures 25 in the corresponding flange and crimped against the latter flange. The joined flanges may be provided with longitudinal flutes 26 forming grooves in which rigid metallic supports or rods 27 are held.

An insulating spacer member 28, which may be a sheet or disc of mica, extends across the end of the electrodes remote from the stem 16, and is supported by the rods 27, which extend through apertures in the member. The spacer member 28 may be fastened to the supports or rods 27 by eyelets, each of which has a head or flange 29 abutting against the lower surface of the spacer member, fingers 30 suitably affixed, as by welding, to the supports or rods 27, and other fingers 31 bent against the upper surface of the spacer member.

Disposed adjacent the other end of the electrodes are a plurality of parallel insulating spacer members 32, 33, and 34, which also may be sheets or discs of mica, and which are maintained in angular relation to the electrodes by the supports or rods 27. The spacer member 32, shown more clearly in Fig. 4, is cross-shaped and may be affixed to the supports or rods 27 by eyelets 35 which may be of the same construction as the eyelets securing the spacer member 28 to the supports or rods. The spacer member 34, shown more clearly in Fig. 6, is of the same form as the spacer member 32 and is secured to the supports or rods 27 by eyelets 36. The spacer member 33, shown more clearly in Fig. 5, is disposed substantially midway between the spacer members 32 and 34 and is provided with apertures in which the supports or rods 27 are slidably fitted.

The inner anode member 19, as shown more clearly in Fig. 2, may be provided with longitudinal stiffening corrugations or flutes 37 and with flanged metallic end closure discs 38 and 39, which may be secured to the anode member 19 by tabs 40 integral with the member 19 and extending through apertures in and crimped against the flanges of the closure members. The inner anode member 19 is carried by a support or rod 41 which extends through central apertures in the closure members 38 and 39 and is rigidly affixed to the closure member 38 by metallic brackets 42 suitably secured to the support or rod 41 and to the closure member 38, as by welding. The support or rod 41 is rigidly affixed to the spacer members 32 and 34 by eyelets, each of which has a head 43 bearing against one surface of a spacer member, fingers 44 bent against the opposite surface of the corresponding spacer member, and other fingers 45 secured to the support or rod 41, as by welding. As shown clearly in Figs. 1 and 2, the support or rod 41 extends slidably through a central aperture in the upper spacer member 28, and, as shown clearly in Figs. 2 and 6, is coupled to one of the supports 27 by a tie wire or rod 46 so that the inner and outer anode members 19 and 18 respectively are electrically connected and may be maintained at the same operating potential. Relative angular displacement of the inner anode member 19 is prevented by studs 47 and 48 which are secured to the inner anode member 19 and extend slidably through the spacer members 28 and 32, respectively.

Each of the cathode sections 21 comprises a plurality of V-shaped portions, as shown more

clearly in Fig. 9, each section being disposed in a plane midway between corresponding surfaces of the anode members 18 and 19 and parallel thereto. The several cathode sections 21 are supported in common at the upper end by a suspension system carried by the central support or rod 41. The suspension system, as shown more clearly in Figs. 7 and 8, comprises a pair of insulating plates 49 and 50, for example sheets of mica, which are secured to the support or rod 41 by an eyelet having a head 51 upon which the plate 50 rests, fingers 52 bent against the plate 49, and other fingers, not shown, affixed, as by welding to the rod or support 41. The plates 49 and 50 carry a plurality of resilient metallic members each of which includes a lateral arm 53 extending between the plates 49 and 50, and a downwardly extending hook portion 54 which engages the apex of one of the V-shaped filament portions. The inner end 55 of each arm 53 passes through a close-fitting aperture in the plate 49 and is bent over against the plate 49. The metallic members may be affixed securely in position by cementing the ends 55 to the plate 49.

The ends of the several cathode sections 21 are secured individually to straight wires 56 which extend through the insulating spacer members 32, 33, and 34. The lower bights of each of the cathode sections are secured to similar wires 57 which also extend through the spacer members 32, 33, and 34 and are bent at their lower end, as indicated at 58, to anchor the wires 57 to the lowermost spacer member 34. As shown in Fig. 6, adjacent wires 56 are coupled by tie wires or stubs 59 and diametrically opposite pairs of the wires 56 are coupled by wires 60 secured, as by welding, to the tie wires or stubs 59. Each of the wires 60 is secured to two metallic stubs 61 embedded in the press 16 and connected to terminal prongs 62 on a base 63 by conductors 64. From this system of connections, it will be apparent that one end of each of the cathode sections 21 is electrically connected to one of the terminal prongs 62 and the other end of each of the sections 21 is connected to another of the terminal prongs 62 so that the four cathode sections 21 are electrically in parallel and a relatively low voltage source may be used for heating the cathode.

Each of the flattened helical grids 20 is supported by a pair of metallic uprights or rods 65 and 66 to which each turn or a suitable number of turns of the grids are secured as by welding. The uprights or rods 65 are connected in pairs by stubs or wires 67, as shown in Fig. 5, and extend through apertures in the spacer members 28 and 33. The other uprights or rods 66 are positioned at the ends of an L-shaped slot 68 in the spacer members 28 and 33 and are free to move laterally so that the grids 20 may expand and contract without substantial restraint during the outgassing treatment and also during the operating life of the device. As shown clearly in Figs. 4 and 6, the uprights or rods 65 and 66 do not pass through the insulating disc 28 but are positioned in cut-out portions of this disc so that relatively high insulation is provided between the grid supports and the cathode wires 56 thereadjacent.

The electrode assembly, it will be apparent, may be fabricated as a unit including the stem exteriorly of the enclosing vessel. The electrodes may be supported within the vessel as a unit by two relatively heavy rigid metallic rods or wires

69 and 70 embedded in the press 17 in accordance with the disclosure of my copending application, Serial No. 740,735, filed August 21, 1934. These wires 69 and 70 are rigidly secured to the spacer members 33 and 34 by eyelets 71 and may be connected to two of the terminal prongs 62 by conductors 72 and 73, respectively. The wire 70 is secured to the tie wire 46 and forms a part of the lead-in system for the anode members 18 and 19. The wire 69 is connected to two tie wires 74 and 75, shown more clearly in Fig. 6, which are secured to a pair of grid support rods 65, and thus the wire 69 forms a part of the lead-in system for the control electrode, which is composed of the grids 20.

The invention may be embodied in devices in which the anode members are of other than square form. For example, in one embodiment illustrated in Fig. 10, the inner and outer anode members 76 and 77 respectively may be hexagonal and six flattened helical grids 78 and six M-shaped filamentary cathodes 79 may be provided. The various electrodes may be supported and electrically connected in a manner similar to the electrodes in the embodiment illustrated in Fig. 1.

The anode members may, of course, be of other form. For example, they may have 12 or 24 sides, and a corresponding number of grids and cathode sections may be utilized. Furthermore, it will be understood that various modifications may be made in the specific embodiments of the invention shown and described without departing from the scope and spirit of this invention as defined in the appended claims.

What is claimed is:

1. An electron discharge device comprising a pair of polygonal anode members disposed one within another and having their corresponding sides parallel, a plurality of helical grids disposed one between each pair of corresponding sides of said anode members, a cathode having a plurality of sections disposed one within each of said grids, a mount for the inner anode member, and means carried by said mount supporting the cathode sections.

2. An electron discharge device comprising a pair of polygonal anode members disposed one within the other and having their corresponding sides parallel, a plurality of flattened helical grids disposed one between each pair of said corresponding sides, the longer sides of each of said grids being parallel and uniformly spaced from the sides of said anode members corresponding thereto, and a cathode having a plurality of sections disposed one within each of said grids, each of said cathode sections including a plurality of filamentary portions disposed in a medial plane of the corresponding grid and parallel to the sides of said anode members corresponding thereto.

3. An electron discharge device comprising a pair of anode members disposed one within the other, means supporting the outer of said anode members, a support for the inner of said anode members extending therethrough, a plurality of helical grids disposed between said anode members and uniformly spaced therefrom, a cathode element within each of said grids, and resilient supporting means extending from said support for the inner anode member and engaging the cathode elements.

4. An electron discharge device comprising a hollow anode, a central standard supporting said anode and extending therethrough, a cathode en-

compassing said anode, and a suspension system for said cathode including an insulating member carried by said standard, flexible means extending from said insulating member and engaging said cathode at one end thereof, a second insulating member secured to said standard remote from said suspension system, and supporting means for the other end of said cathode positioned by said second insulating member.

5. An electron discharge device comprising a pair of anode members disposed one within the other, insulating means maintaining said anode members in spaced relation, a plurality of supports spaced by said insulating means, a plurality of grids carried by said supports and disposed between said anode members, a cathode having a plurality of sections disposed one within each of said grids, a support for the inner of said anode members extending therethrough, and means supporting said cathode sections from the support for said inner anode member.

6. A multi-grid electron discharge device comprising a plurality of grid elements disposed side by side and defining a polygonal boundary, cathode members in cooperative relation with said grid elements, an anode disposed within said boundary, said anode including a shell and closure discs at the ends of said shell, a support for said anode secured to one of said discs, and means carried by said support mounting said cathode members at one end.

7. An electron discharge device comprising a pair of anode members disposed one within the other, the inner anode member including a shell and end closure members, a support for said inner anode member extending through said closure members, a support for the outer anode member, insulating means extending across the ends of said anode members and spacing said supports, a plurality of supports extending between said insulating means and spaced thereby, a plurality of helical grids carried by said last mentioned supports, arranged side by side and disposed between said anode members, a cathode having a plurality of sections disposed one within each of said grids and encompassed thereby, and a suspension system for said cathode including resilient means carried by the support for said inner anode member and engaging said sections.

8. An electron discharge device comprising a pair of polygonal anode members disposed one within the other and having their corresponding sides parallel, the inner anode member including a shell and end closure members, a support for said inner anode member extending through said closure members, supports for the outer anode member, insulating discs extending across opposite ends of said anode members and spacing the supports for said anode members, a plurality of uprights extending through said insulating discs and spaced thereby, a plurality of flattened helical grids carried by said uprights, each of said grids being disposed between corresponding sides of said anode members and having its longer sides parallel thereto, a cathode including a plurality of filament sections disposed one within each of said grids, each of said sections including a plurality of V-shaped filaments, means extending from one of said insulating discs and engaging one end of said filaments, and a supporting system including a plurality of resilient members carried by the support for said inner anode member and engaging said filaments at the other end.

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