Dec. 1, 1936. A. L. SAMUEL 2,062,334

ELECTRON DISCHARGE DEVICE

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FIG. 1

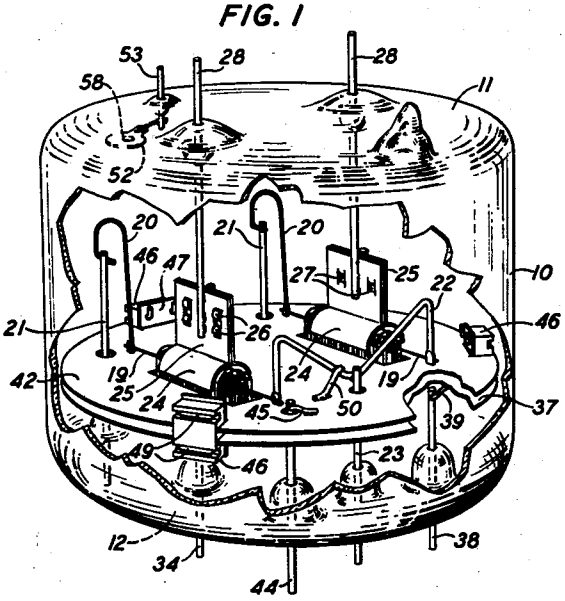


FIG. 3

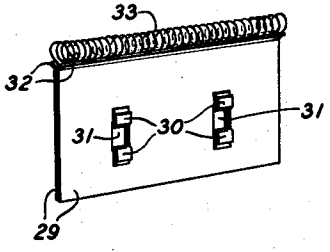
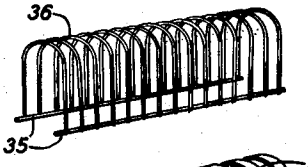


FIG. 4



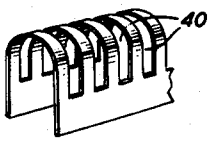


FIG. 5

FIG. 2

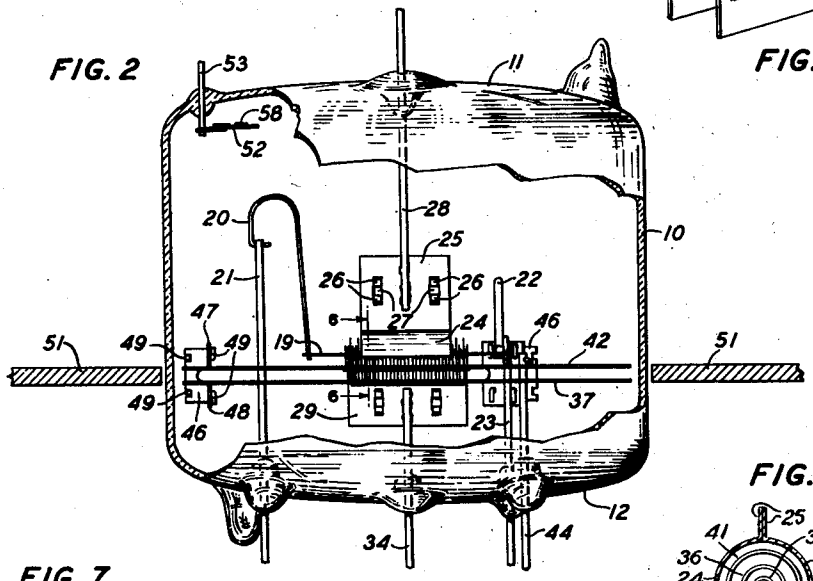


FIG. 6

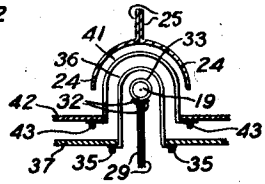


FIG. 7

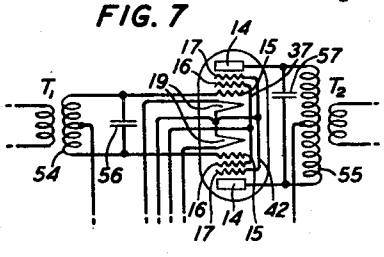


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FIG. 8

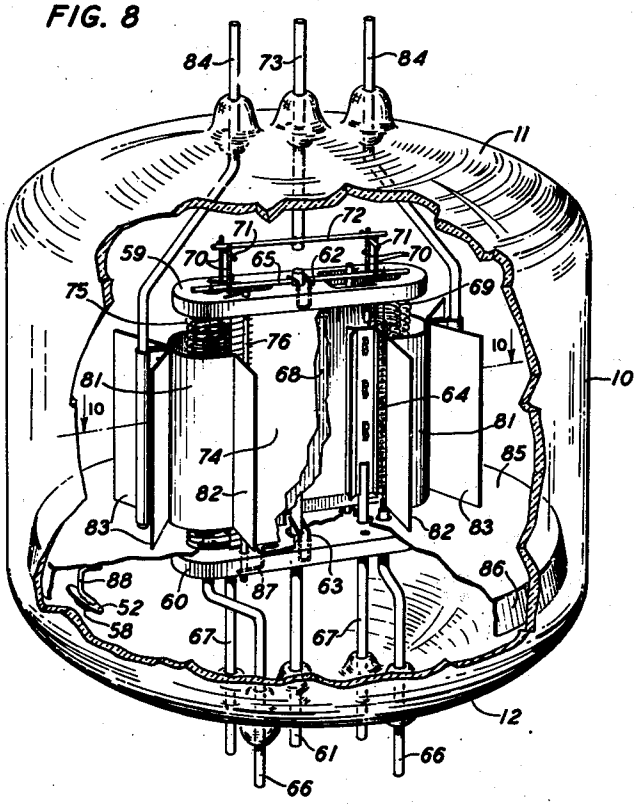


FIG. 9

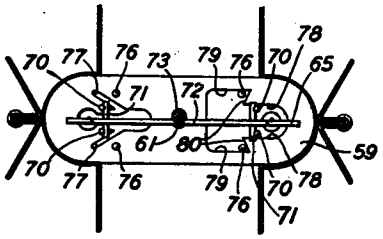
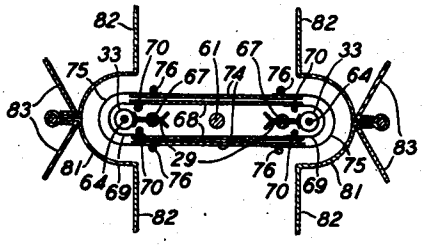


FIG. 10



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UNITED STATES PATENT OFFICE

2,062,334

ELECTRON DISCHARGE DEVICE

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Application October 27, 1934, Serial No. 750,287

17 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices and more particularly to such devices of the pentode type adapted for the amplification of ultra-high frequency impulses.

One object of this invention is to amplify efficiently ultra-high frequency currents and voltages.

Another object of this invention is to shield effectively the input and output electrodes and leading-in conductors in an electron discharge device from each other.

A further object of this invention is to simplify the structure of electron discharge devices having a plurality of individual electrode units within a single enclosing vessel.

In one embodiment of this invention, an electron discharge device comprises an enclosing vessel having a plurality of pentode units. Each of the pentode units comprises a cathode, an anode, a control electrode between the anode and the cathode, a shield electrode, and a suppressor electrode. Each of the shield and suppressor electrodes includes a wire or perforate or grid portion disposed between the control electrode and the anode of the respective pentode units and has secured thereto a metallic disc or plate extending between the several electrode units and to immediately adjacent the side walls of the enclosing vessel. The plates or discs electrically connect the shield and suppressor electrodes of the several electrode units and are disposed closely adjacent to form a condenser coupling the screen and suppressor electrode. The discs or plates also serve as screens to effectively shield the anodes and the leading-in conductors therefor from the control electrodes and the leading-in conductors therefor.

The discharge device preferably is mounted in a metallic partition disposed substantially coplanar with the discs or plates and capacitively coupled thereto, the partition preferably being grounded.

The invention and the 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 this invention, portions of the enclosing vessel being broken away to show the electrode assemblies more clearly;

Fig. 2 is an elevational view of the electron discharge device shown in Fig. 1 together with an external shield in alignment with the internal metallic discs or plates;

Fig. 3 is a detail view of the control electrode assembly included in each of the electrode units;

Fig. 4 is another detail view showing the construction of the screen or shield electrodes;

Fig. 5 is a fragmentary view showing an alternative form for a screen or shield electrode;

Fig. 6 is a cross-sectional view of an electrode unit along line 6—6 of Fig. 2 showing the configuration and relative disposition of the electrodes;

Fig. 7 is a schematic view illustrating one general circuit including an electron discharge device constructed in accordance with this invention;

Fig. 8 is a perspective view of an electron discharge device illustrative of another embodiment of this invention in which a separate shield is provided for segregating the leading-in conductors for the anodes from the leading-in conductors for the control electrodes and the cathodes;

Fig. 9 is a top view of the electrode assembly in the device shown in Fig. 8; and

Fig. 10 is a cross-sectional view of the electrodes showing the configuration and relative disposition thereof along the line 10—10 of Fig. 8.

Referring now to the drawings, the electron discharge device shown in perspective in Fig. 1 and schematically in Fig. 7, comprises an enclosing vessel having a cylindrical portion 10 and substantially plane end walls 11 and 12. Enclosed within the vessel are two electrode units each of which includes a cathode 19, an anode 14, a control electrode 15 between the cathode and the anode, and a shield electrode 16 and a suppressor electrode 17 disposed between the control electrode and the anode. The electrodes in each unit are coaxially arranged and the two units may be disposed parallel to each other. Preferably, the electrodes in each unit are disposed as closely adjacent as is mechanically and electrically feasible.

Each cathode comprises a linear filament 19, which may be of thoriated tungsten, supported at one end by a flexible inverted J-shaped member or wire 20 extending from a rigid metallic support or rod 21 sealed in the end wall 12 of the enclosing vessel. The filaments 19 are secured at their other end to a rigid M-shaped metallic member or wire 22 carried by a metallic support or rod 23 also sealed in the end wall 12 of the enclosing vessel. The anode 14 of each electrode unit includes two sections, each having an arcuate portion 24 and a large surface flange 25. The flanges 25 are secured together in face-to-face

relation by integral bent-over tabs 26 on one flange extending through apertures 27 in the other flange, so that the arcuate portions 24 form a semi-cylinder which is coaxially disposed about the corresponding filament 19. Each anode is supported by a rigid metallic rod or wire 28 secured to the flanges 25 and sealed in the end wall 11 of the enclosing vessel. Each of the control electrodes 15, as clearly shown in Fig. 3, comprises two large area plates 29 secured together in face-to-face relation by integral bent tabs 30 on one plate extending through apertures 31 in the other plate. The plates 29 are provided at one end with outwardly bent flanges 32 to which each turn of a helical grid 33 is secured, for example, by welding. As clearly shown in Fig. 6, each grid 33 encompasses a corresponding filament 19 and is coaxial therewith. The control electrodes 15 are individually supported by metallic rods or wires 34 sealed in the end wall 12 of the enclosing vessel.

The control electrodes are each encompassed by a shield electrode which, as shown in Fig. 4, comprises a pair of parallel supporting wires 35 carrying a plurality of U-shaped wires 36 which are disposed parallel to one another and are secured to the wires 35 in any suitable manner, for example by welding. As shown in Fig. 6, the U-shaped wires 36 extend through an aperture in a metallic plate or disc 37 and are bent over at their ends, the wires 35 being secured to the plate or disc 37 as by welding. The plate or disc 37 extends to immediately adjacent the inner wall of the cylindrical portion 10 of the enclosing vessel and is supported by a single rigid rod or wire 38, which abuts against the disc and carries a wire stub 39 secured to the plate or disc, sealed in the end wall of the enclosing vessel. The disc or plate 37 together with the wire grids 36 form an assembly which serves as a shield between the control electrodes 15 and the anodes 14 and hence segregate these electrodes and the leading-in conductors 34 and 28, respectively, therefor so that the device may be operated efficiently at ultra-high frequencies.

In an alternative construction the shield electrodes may be made by punching holes 40 in a sheet and then bending it into a U shape as shown in Fig. 5. If desired, the grid shown in Fig. 5 may be formed integrally with the plate.

Disposed between each shield electrode and anode is a suppressor electrode which may be of the same general construction as the shield electrodes shown in Figs. 4 and 5. Each suppressor electrode comprises a U-shaped perforate or wire portion 41 extending through an aperture in a plate or disc 42 and secured to parallel wires 43 which are suitably secured, as by welding, to the plate or disc 42. The plate or disc 42 is disposed parallel to the plate or disc 37 and coextensive therewith, and is supported by a single wire or rod 44 sealed in the end wall 12 of the enclosing vessel and carrying a stub 45 secured, as by welding, to the disc or plate 42. The plates or discs 37 and 42 are maintained in parallel spaced relationship by a plurality of insulators 46 to which tabs 47 and 48 integral with the plates or discs 37 and 42, respectively, are secured by wires 49, and form a condenser coupling the shield and suppressor electrodes. The disc or plate 42 is electrically connected to one end, preferably the negative or grounded end, of the filaments 19 by a wire 50 secured to the M-shaped member 22, and hence serves to increase the shielding between the control electrodes 15 and anodes 14 and the leading-in conductors 34 and 28, respectively, therefor.

In order to further increase the shielding between these elements, an apertured external metallic member or shield 51 may be provided, the member or shield 51 extending from immediately adjacent the wall 10 of the enclosing vessel and being disposed substantially coplanar with the plates or discs 37 and 42.

A metallic disc 52 carrying a getter material 53, such as magnesium, is supported by a short wire or rod 53 sealed in the end wall 11 of the enclosing vessel at a point remote from the electrodes. After the electrodes of the device have been out-gassed and the enclosing vessel sealed, the getter may be flashed, as by high frequency induction heating, to fix residual gases within the enclosing vessel.

In one typical circuit, illustrated in Fig. 7, in which the two pentode units of devices of the construction described hereinabove are connected in push-pull, the control electrodes 15 may be connected to opposite ends of the secondary winding 54 of an input transformer T_1, the center of the secondary being connected to the negative terminal of a suitable potential source. The anodes 14 may be connected similarly to opposite ends of the primary winding 55 of an output transformer T_2, the center of the primary 55 being connected to the positive terminal of a suitable potential source. A suitable positive potential, less than the anode potential, is applied to the shield electrodes 16.

The secondary winding 54 and the primary winding 55 may be shunted by fixed or variable condensers 56 and 57, respectively. Alternatively, one or both of these condensers may be omitted, depending upon the frequency at which the device is intended to operate and the characteristics of the input and output circuits.

In another embodiment of this invention shown in Fig. 8, the two pentode units are disposed with their longitudinal axes substantially parallel to the longitudinal axis of the enclosing vessel 10, the cathodes and grid electrodes being maintained in proper position relative to each other by spaced insulating members 59 and 60. The insulating members 59 and 60 are supported by a metallic upright or rod 61 sealed in the end wall 12 of the enclosing vessel and are maintained in the proper relation by bent wires 62 and 63 secured to the upright or rod 61 and extending through the insulating members 59 and 60, respectively.

Each of the pentode units includes a helical filamentary cathode 64 which is secured at one end to a tie wire 65 upon the insulating member 59 and secured to the upright or rod 61, and which is secured at the other end to a corresponding rod or wire 66 sealed in the end wall 12 of the enclosing vessel. Two control electrodes, which may be of the same general construction shown in Fig. 3 are associated individually with the corresponding cathodes 64 and are supported individually by rods or wires 67 extending through the lower insulating member 60 and sealed in the end wall 12 of the enclosing vessel.

The control electrodes are encompassed in common by a shield or screen grid assembly including parallel metallic plates 68 and U-shaped end portions which may comprise a plurality of U-shaped wires 69 secured, as by welding, to rigid uprights or wires 70. The uprights or wires 70 are secured to the plates 68 and extend through the insulating members 59 and 60, thereby maintaining the end portions 69 in proper position,

preferably coaxial, with respect to the cathodes 64 and control grids 33. As shown clearly in Fig. 9, corresponding of the uprights or rods 70 may be electrically connected by short wires or stubs 71 which are connected in turn to a tie wire 72 secured to a leading-in conductor 73 sealed in the end wall 11 of the enclosing vessel.

The shield or screen electrode assembly is encompassed by a similarly shaped suppressor electrode assembly including metallic plates 74 disposed parallel to each other and to the plates 68, and U-shaped end portions, comprising spaced U-shaped wires 75, coaxial with the corresponding cathode 64 and control grid 33. The wires 75 are secured, as by welding, to uprights or rods 76 secured to the plates 74 and extending through the insulating members 59 and 60. The suppressor electrode assembly may be connected electrically to the cathodes 64 by the wire 62 which may be suitably secured, as by welding, to one of the plates 74.

As shown clearly in Fig. 9, the insulating member 59 may be provided with slots 77 extending between corresponding of the uprights or rods 70 and 76, thereby increasing the insulating path therebetween. In order to allow lateral expansion and contraction of the shield and suppressor electrode assemblies, the insulating member 59 is provided with a cut-out portion forming bearing or guiding surfaces 78 for the uprights or rods 70 adjacent one end of the shield electrode assembly, and forming other bearing or guiding surfaces 79 for the uprights or rods 76 adjacent the same end of the suppressor electrode assembly. The cut-out portion is formed also to provide shoulders 80 limiting outward movement of the uprights or rods 76 thereadjacent.

Each of the pentode units includes an anode comprising a substantially semi-cylindrical portion 81 coaxial with the corresponding cathode 64, and outwardly extending flanges 82 and 83 which increase the rate of heat radiation from the anodes and thereby maintain them at a safe temperature during operation of the device. The anodes are supported individually by metallic rods or wires 84 which serve as leading-in conductors and are sealed in the end wall 11 of the enclosing vessel.

In order to segregate the anode and control electrode leading-in conductors more completely, a shielding disc 85 is provided, the disc having a flange 86 immediately adjacent the side wall of the enclosing vessel. The disc 85 rests upon the insulating member 60 and may be electrically connected to the suppressor electrode by a bent wire 87 which may be secured, as by welding, to one of the plates 74 and one of the rods 76.

Suitable apertures are provided in the disc 85 for allowing free passage of the cathodes 64, grid supporting rods 67, and the uprights 70.

The device may be mounted in a metallic partition 51 similarly to the device shown in Fig. 3, the partition being disposed substantially coplanar with the disc 85.

A metallic disc 52 is supported below the disc 85 by a short wire 88 and carries a quantity of getter material, such as a strip of magnesium 58, for fixing residual gases in the enclosing vessel.

Although specific embodiments have been shown and described, it will be understood, of course, that modifications may be made therein 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 cathode, a control electrode surrounding said cathode, an anode, and a plurality of grid electrode assemblies having electrode portions between said cathode and said anode and having other portions removed from the space between said cathode and said anode forming a condenser coupling said electrode portions.

2. An electron discharge device comprising a cathode, a control electrode surrounding said cathode, an anode, a plurality of grid electrode elements disposed between said cathode and said anode, and a plurality of plate members individually secured to said electrode elements and spaced to form a condenser coupling said electrode elements, one of said plates also extending across the device and serving also as shield.

3. An electron discharge device comprising a cathode, an anode, a control grid between said cathode and anode, a plurality of arcuate grids disposed between said anode and control grid, and parallel metallic plate members extending from said arcuate grids and each individually associated electrically with a corresponding one of said arcuate grids, said plate members forming a condenser coupling said grids.

4. An electron discharge device comprising a plurality of metallic members spaced to form a condenser, shield and suppressor grids individually secured to said metallic members, and a cathode, a control electrode, and an anode in cooperative relation to said grids.

5. An electron discharge device comprising a plurality of electrode units each including a cathode, an anode, and a plurality of grid electrodes between said cathode and anode, and metallic members connecting two grid electrodes of one unit with the corresponding grid electrodes of another unit, said metallic members being disposed adjacent one another to form a condenser.

6. An electron discharge device comprising a plurality of electrode units each including a cathode, an anode coaxial with said cathode, and a plurality of grid electrodes between said cathode and anode and coaxial therewith, and a plurality of metallic plate members connecting corresponding grid electrodes of said units, said plate members being disposed substantially parallel to each other.

7. An electron discharge device comprising a plurality of cathodes, a plurality of anodes each disposed adjacent one of said cathodes, and a plurality of hollow metallic members each encompassing said plurality of cathodes, said members having portions in proximity to corresponding anodes and cathodes forming electrode elements and having other portions spaced to form a condenser.

8. An electron discharge device comprising a plurality of cathodes, a plurality of anodes each disposed in cooperative relation to a corresponding one of said cathodes, and a plurality of hollow metallic members encompassing said cathodes in common, each of said members having a grid portion between each cathode and the corresponding anode and having a plate portion connecting said grid portions, the plate portions of said members being disposed adjacent each other to form a condenser.

9. An electron discharge device comprising a plurality of electrode units each including a cathode, an anode, and a control electrode disposed between the anode and cathode, and a metallic shield member extending between said units and

having a grid portion between each control electrode and the anode corresponding thereto.

10. An electron discharge device comprising a plurality of electrode units each including a cathode and an anode, a plurality of spaced metallic shield members extending between said units, and a plurality of grids carried by each of said shield members, each of said grids being disposed between a corresponding cathode and anode.

11. An electron discharge device comprising a plurality of electrode units each including a cathode, a control electrode, a screen electrode, a suppressor electrode, and an anode, means electrically connecting the screen electrodes of said units, and means electrically connecting the suppressor electrodes of said units, said first and second means being cooperatively associated to form a condenser.

12. An electron discharge device comprising a pair of parallel metallic plates forming a condenser, a plurality of grids carried by each of said plates, the grids on the two plates being arranged in cooperative pairs, and an anode, a cathode and a control electrode cooperatively disposed with respect to each of said cooperative pairs of grids.

13. An electron discharge device comprising a plate member having a plurality of apertures therein, a U-shaped perforate electrode adjacent each of said apertures and carried by said plate member, another plate member disposed adjacent said first plate member and having apertures in alignment with said first apertures, a U-shaped grid adjacent each of said second apertures and carried by said second plate, said plate members forming a condenser, a cathode and a grid electrode within each of said grids, and an anode disposed adjacent each of said U-shaped perforate electrodes.

14. In combination, an electron discharge device comprising an enclosing vessel, a cathode, an input electrode, an output electrode, and a metallic member shielding said input electrode from said output electrode and extending adjacent walls of said enclosing vessel, and an external metallic shield surrounding said walls and disposed with its inner edge close to said metallic member.

15. In combination, an electron discharge device comprising an enclosing vessel, a metallic disc within said vessel and extending to immediately adjacent opposite walls thereof, said disc having an aperture therein, a grid carried by said disc and overlying said aperture, a cathode and a control electrode adjacent one surface of said grid, an anode adjacent the opposite surface of said grid, and leading-in conductors for said anode and said control electrode extending from opposite ends of said vessel, and a metallic member encompassing said vessel and disposed with its inner edge in the vicinity of said metallic disc.

16. An electron discharge device comprising a pair of spaced insulating members, a plurality of plate members spaced to form a condenser between said insulating members, and maintained in position thereby, and a plurality of electrodes individually supported by and electrically connected to said plate members.

17. An electron discharge device comprising a pair of spaced insulating members, a plurality of hollow metallic members disposed one within another, between said insulating members and supported thereby, each of said metallic members including perforate end portions and intermediate plate portions, said plate portions being spaced to form a condenser, and a plurality of cathodes extending between said plate members and disposed adjacent said perforate end portions.

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