Jan. 9, 1940. A. L. SAMUEL 2,186,127

ELECTRON DISCHARGE DEVICE

Filed July 22, 1937

FIG. 1

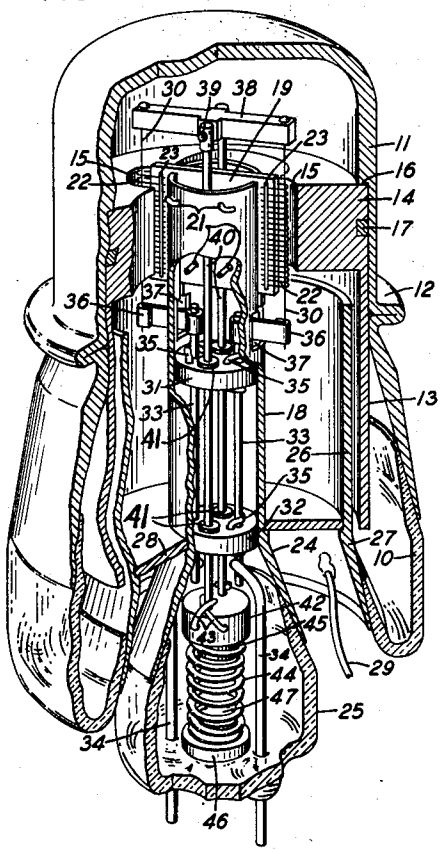


FIG. 2

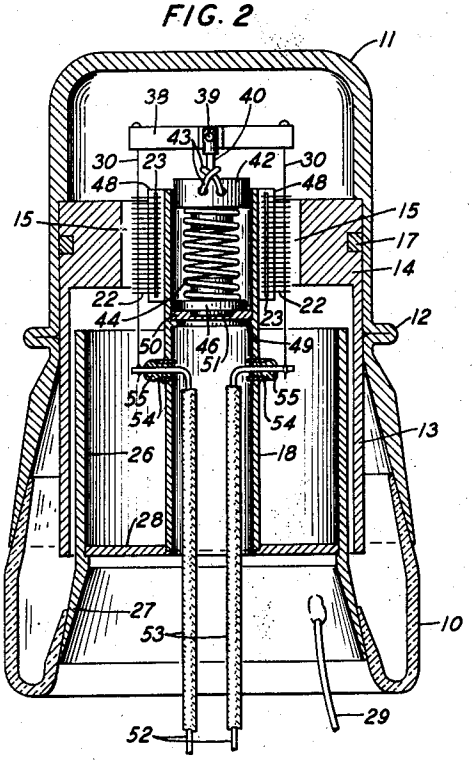


FIG. 3

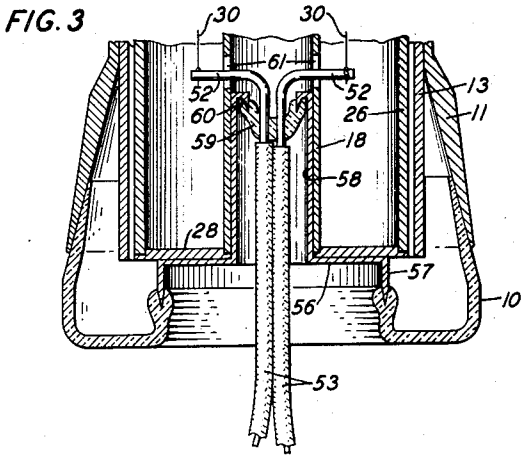
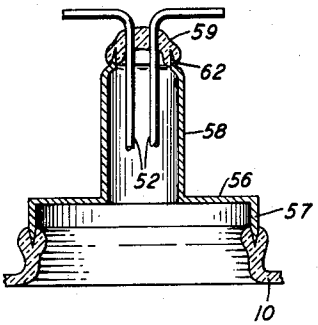


FIG. 4



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ELECTRON DISCHARGE DEVICE

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10 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices and more particularly to such devices, for example of the general construction disclosed in my Patent 2,063,341 granted December 8, 1936, especially suitable for the generation and amplification of ultra-high frequency impulses.

In electron discharge devices adapted for the generation and translation of ultra-high frequency currents, for example currents of frequencies corresponding to wave lengths of one meter or less, the various electrodes, such as the cathode, control grid and anode, usually are spaced very closely in order that very short transit times may be obtained, and the control grid, therefore, is of small dimensions. Consequently, during the outgassing treatment of the electrodes and the operation of the device, the control grid may become heated to unduly high temperatures. As a result, undesirable secondary emission from the grid may occur or the grid may be destroyed.

One object of this invention, therefore, is to prevent deleterious heating of electrodes in electron discharge devices so that the devices will be capable of handling safely relatively high power.

Another object of this invention is to expedite the fabrication and assembly of electron discharge devices.

In one illustrative embodiment of this invention, an electron discharge device comprises an enclosing vessel including a vitreous portion and a metallic portion constituting the anode of the device, a cathode, and a control electrode assembly. The control electrode assembly may include a grid between the cathode and the anode and a metallic tuning member forming an inductance and a capacitance of predetermined magnitude with the anode.

In accordance with one feature of this invention, the control electrode structure is provided with a relatively large surface metallic portion exposed or thermally coupled to the atmosphere whereby the heat dissipation from the control electrode assembly is increased and the grid thereby maintained at a safe temperature during the outgassing treatment of the electrodes and the operation of the device.

In accordance with another feature of this invention, the cathode and the control electrode structure are fabricated as a unitary assembly which may be inserted as a unit into the enclosing vessel and mounted therein.

The invention and the foregoing and other features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawing, in which:

Fig. 1 is an elevational view in perspective of an electron discharge device illustrative of one embodiment of this invention, portions of the device being broken away to show details of construction more clearly;

Fig. 2 is an elevational view mainly in cross-section of an electron discharge device illustrative of another embodiment of this invention;

Fig. 3 is a fragmentary view in cross-section showing a modification of the embodiment of the invention illustrated in Fig. 2; and

Fig. 4 is a fragmentary view in cross-section of a modification of the structure illustrated in Fig. 3.

Referring now to the drawing, the electron discharge device shown in Fig. 1 comprises an evacuated enclosing vessel having a vitreous portion 10 and a cup-shaped metallic portion 11 hermetically sealed to the vitreous portion 10 and provided with an external annular flange 12 by means of which the device may be supported. Mounted upon and secured to the metallic portion 11 is an anode element having an extended cylindrical portion 13 and a generally annular portion 14 provided with diametrically opposite, parallel U-shaped recesses 15. The annular portion 14 of the anode element abuts a shoulder 16 in the inner wall of the metallic portion 11 and may be affixed to this portion as by solder 17 contained initially in an annular groove in the outer wall of the annular portion 14.

A control electrode structure is cooperatively associated with the anode and includes a metallic cylinder or sleeve 18 coaxial with the annular portion 14 and provided at its inner end with diametrically opposite slots in which a metallic plate 19 is fitted. The metallic plate may be locked in position by a plurality of cross members or wires 21 extending therethrough and through the cylinder 18, and carries a pair of grids 22, each disposed in one of the channels or grooves 15 and preferably coaxial therewith. Each of the grids may be composed of a plurality of parallel U-shaped wires having their ends affixed, as by welding, to opposite faces of the plate 19 and further held in position by backing wires 23 also affixed, as by welding, to the plate 19. The metallic cylinder 18 is provided at its outer end with a flared portion 24 hermetically sealed to a vitreous dished member 25, and is encompassed by a cylindrical metallic member 26 coaxial with and adjacent the cylindrical portion 13 of the anode

member. The cylindrical member 26 is provided with a flaring end 27 sealed hermetically to the vitreous portion 10 and is joined to the cylinder 18 by a metallic disc 28, rigidly affixed to both the cylinders 18 and 26, as by welding.

As described in my Patent 2,063,341 aforementioned, the members 18, 26 and 27 may be so dimensioned and disposed that they constitute an inductance with the anode, the inductance being of such magnitude, for example, as to form with the interelectrode capacitances a circuit resonant to the frequency at which the device is intended to operate. The cylindrical members 18 and 26 may be spaced to define a blocking condenser of desired magnitude. A suitable potential may be impressed upon the control grids through a leading-in conductor 29.

As will be seen, the disc 28 and the members 24 and 27 are exposed to the atmosphere and provide relatively large area heat radiating surfaces. Consequently, heat generated in the control electrode structure during operation of the device, and which might be retained because of the mass of this structure and particularly of the tuning member 26, 28, will be dissipated rapidly so that this structure will be maintained at a relatively low and safe temperature and secondary emission from the grids 22 will not occur. The rate of heat dissipation may be further increased, if desired, by circulating a cooling medium, such as a stream of air, over the outer surfaces of the disc 28 and the end portions 24 and 27 so that the power capacity of the device may be increased accordingly.

Disposed within each of the grids 22 is a cathode 30, which may be a linear thoriated tungsten filament coaxial with the corresponding grid. The cathodes are supported and maintained in proper position to the anode and the grids by a structure which includes a pair of insulating blocks or discs 31 and 32 fitted within the metallic cylinder 18. The blocks or discs 31 and 32 are mounted on and spaced by a pair of metallic rods 33 supported by rigid leading-in conductors 34 sealed in the vitreous member 25, the blocks or discs being locked to the rods 33 as by metallic stubs 35 embedded in the blocks or discs and affixed to the rods. Mounted upon the rods 33 at the inner ends thereof are metallic strips or bands 36 which extend through oversized apertures 37 in the cylindrical member 18 and are affixed to the cathodes 30 at one end thereof.

The cathodes 30 are supported at the other end by a rigid cross-arm or rocker member 38 which is pivotally mounted upon a pin 39 extending through and between a pair of rigid supports or uprights 40. The supports or uprights 40 extend slidably through metallic bushings or bearings 41 in the blocks or discs 31 and 32 and are embedded at the lower end thereof in an insulating carrier or platform 42 to which they may be locked by metallic stubs or wires 43. The carrier or platform 42 is supported by a helical spring 44 which is fitted at one end about a reduced hub 45 on the carrier or platform and is seated at the other end upon an insulating block 46 having a reduced portion 47 fitted within the spring 44. In the fabrication of the device, the spring 44 is placed under compression so that it exerts an upward force upon the carrier or platform 42, the force being transmitted to the cathodes 30 through the rods or uprights 40 and rocker member 38 so that the cathodes are maintained under tension during operation of the device.

As will be apparent, the control grid and cathode structures constitute a unitary assembly which may be inserted into the anode as a unit and likewise removed as a unit to allow repair or replacement thereof.

In the embodiment of this invention illustrated in Fig. 2, the cathodes 30 are supported upon the metallic cylinder 18 of the control grid structure. As shown in this figure, the grids 22 are mounted upon individual fins or plates 48 suitably affixed, as by welding, to the outer surface of the cylinder 18. The cylinder 18 is provided with an internal annular flange 49 having sealed thereto a metallic disc 50 upon which the insulating block 46 is seated, the disc 50 being provided with a central recess for receiving a reduced portion 51 of the block. The platform 42 carried by the spring 44 is slidably fitted in the cylinder 18 and mounts the rods or uprights 40 supporting the rocker member 38.

The leading-in conductors 52 for the cathodes 30, provided with insulating sleeves 53, extend through metallic eyelets 54 projecting from the cylinder 18, and are sealed thereto hermetically by vitreous beads 55.

The flared portion 27 of the tuning cylinder, the discs 28 and 50 and the cylinder 18 constitute walls of the enclosing vessel and provide relatively large heat radiating surfaces so that the heat developed in the control electrode structure during operation of the device will be dissipated rapidly and the grids 22 thereby maintained at a relatively low temperature. If desired, a cooling medium, such as a stream of air, may be circulated through the chamber formed by the members 27, 28, 50 and 18.

In a modification of the structure shown in Fig. 2, the vitreous portion 10 of the enclosing vessel may have sealed thereto a metallic member which, as illustrated in Fig. 3, includes a base portion 56 having a flange 57 sealed to the vitreous portion 10, and an inwardly extending cylindrical portion 58. The cylinder 18 of the control grid structure is frictionally fitted about the cylindrical portion 58 and the disc 28 engages and rests upon the base 56. The inner end of the cylindrical portion 58 may be sealed by a vitreous member 59 fused to an inwardly extending annular flange 60 integral with the cylindrical portion 58. Embedded in and extending through the vitreous member 59 are the cathode leading-in conductors 52 which extend through apertures 61 in the cylinder 18 and are secured to the lower ends of the cathodes 30.

As shown in Fig. 4, the cylindrical portion 58 may have, alternatively, an upstanding, knife-edged annular projection 62 to which the vitreous member 59 is hermetically sealed.

Although specific embodiments of the invention have been shown and described, it will be understood of course, that various 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 an enclosing vessel, a cathode, an anode, a control electrode, a metallic member connected to said control electrode and mounted in juxtaposition to said anode to form a condenser therewith, and heat radiating means thermally connected to said metallic member and constituting a portion of said enclosing vessel.

2. An electron discharge device comprising a cathode, an anode, a control electrode structure

including a grid in cooperative relation with said cathode and said anode, a hollow member supporting said grid and a cylindrical member integral with said hollow member, having a portion in juxtaposition to said anode and forming a condenser therewith, and an enclosing vessel portions of which are constituted by said hollow member and another portion of said cylindrical member.

3. An electron discharge device comprising an enclosing vessel having a dished portion and a cylindrical metallic wall at one end of said dished portion, a metallic disc within the confines of said wall and joined thereto, a cylindrical metallic member extending into said disc and sealed thereto, said member having an exposed heat radiating portion, and an electrode mounted on said cylindrical member.

4. An electron discharge device comprising an enclosing vessel having a vitreous portion, a metallic cylinder within and sealed to said vitreous portion, an annular disc member intermediate the ends of said cylinder and sealed thereto, a hollow member extending through said disc member, and an electrode mounted on said hollow member, said hollow and disc members and portions of said cylindrical member constituting walls of said enclosing vessel.

5. An electron discharge device comprising an enclosing vessel including a cylindrical metallic member at one end thereof one surface of which constitutes an external wall of said vessel, and an electrode structure mounted on said metallic member comprising a metallic sleeve fitted to the other surface of said metallic member and an electrode carried by said sleeve.

6. An electron discharge device comprising an enclosing vessel having a metallic wall adjacent one end thereof, a metallic annulus carried by said metallic wall, a metallic cylinder mounted on said annulus and having an open end in communication with the aperture therein, a grid electrode supported by said cylinder, a disc within said cylinder and sealed thereto intermediate the ends thereof, a cathode in cooperative relation with said grid electrode, and means mounted on said disc supporting said cathode.

7. An electron discharge device comprising an enclosing vessel having a dished metallic portion and a vitreous portion, an anode element mounted on said metallic portion and having a cylindrical portion, a metallic cylinder within said cylindrical portion and sealed to said vitreous portion, said cylinder having a part constituting a wall of said enclosing vessel, a metallic disc within and sealed to said cylinder, a metallic sleeve affixed to said disc, a grid carried by said sleeve, a cathode, and means supporting said cathode supported by said sleeve.

8. An electron discharge device in accordance with claim 7 wherein said sleeve has a heat radiating portion extending outwardly from said disc.

9. An electron discharge device comprising an enclosing vessel including a cup-shaped metallic portion and a vitreous portion, an inwardly extending metallic cylinder sealed to said vitreous portion, an anode element having a cylindrical portion encompassing said cylinder and having also an annular portion, a hollow member supported by said cylinder, a pair of grids mounted on said hollow member, a pair of cathodes each in cooperative relation to one of said grids, leading-in conductors extending through said hollow member and connected to said cathodes at one end thereof, and supporting means mounted on said hollow member and engaging said cathodes at the other end thereof.

10. An electron discharge device in accordance with claim 9 wherein said supporting means comprises a platform slidably mounted within said hollow member, a rocker member carried by said platform and having its ends affixed to said other end of said cathodes, and a helical spring supported by said hollow member and supporting said platform.

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