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A. L. SAMUEL

2,086,578

ELECTRON DISCHARGE DEVICE

Filed April 27, 1934

FIG. 1

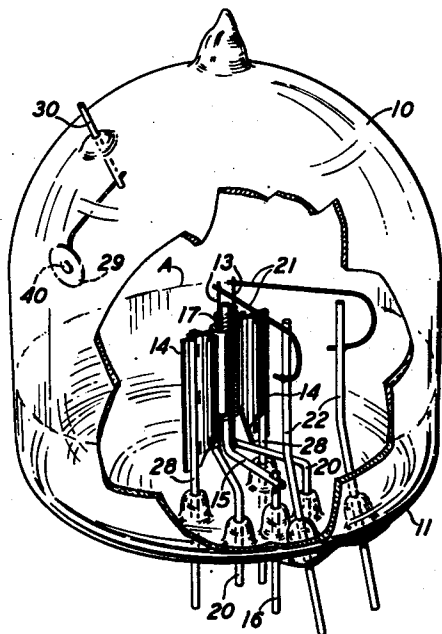


FIG. 4

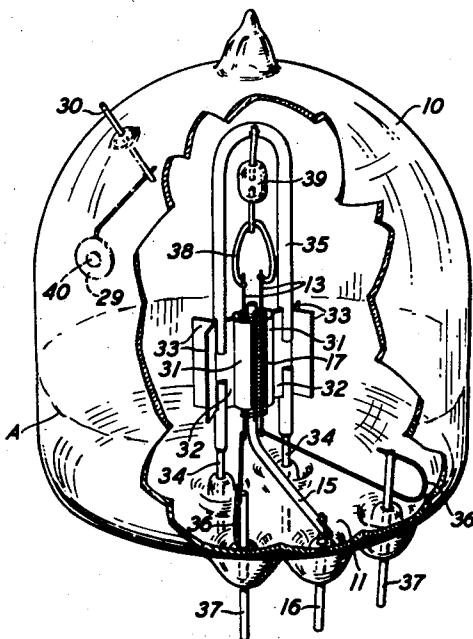


FIG. 3

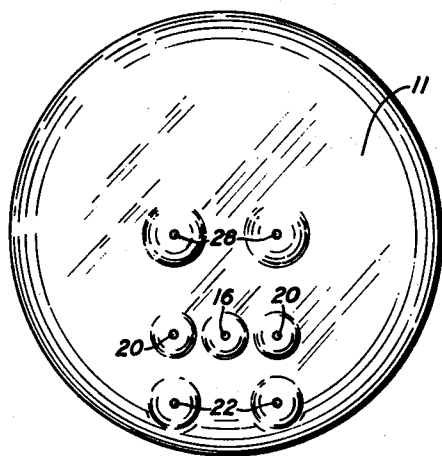


FIG. 5

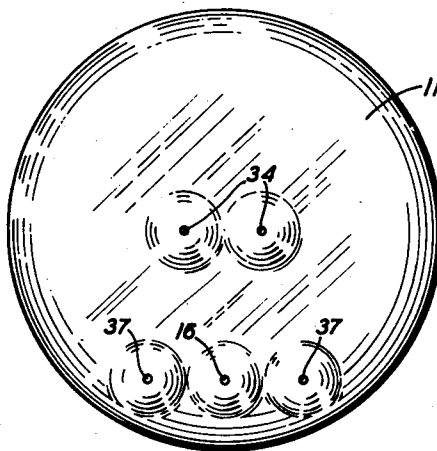


FIG. 2

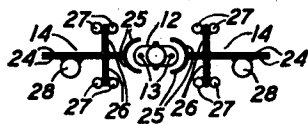


FIG. 6

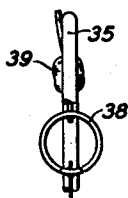
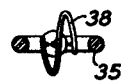


FIG. 7



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ELECTRON DISCHARGE DEVICE

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15 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices and more particularly to such devices operable as amplifiers and oscillators at ultra-high frequencies.

One object of this invention is to effectively dissipate the heat from the output and control electrodes of electron discharge devices.

Another object of this invention is to increase the effective surge impedance of the electrode structure and to decrease the surge impedance of the leading-in conductors for the electrodes in electron discharge devices.

In one embodiment of this invention, an electron discharge device comprises a grid electrode including a support member and an oval or flattened helix encompassing the member, each of the longer sides of each turn of the helix being secured at substantially its midpoint to the support member. Two electrically separate cathodes are disposed within the helix and on opposite sides of the support member. A pair of anodes are disposed one adjacent each of the filamentary cathodes, each of the anodes including a semi-cylindrical portion disposed about an end of the grid helix, a large surface fin extending from the convex side of the semi-cylindrical portion, and a plurality of flanges extending from the fin from adjacent the semi-cylindrical portion.

The grid and anode supports, which serve as leading-in conductors, are sealed in one end of the enclosing vessel and are positioned relatively close together so that the surge impedance thereof may be comparable with the effective surge impedance of the electrodes. The portions of the supports between the end of the enclosing vessel and the ends of the electrodes are made as short as feasible in order to reduce the total impedance of the leading-in system to the grid and anode.

The arrangement of the electrodes provides a relatively high surge impedance of the electrode structure which may be of the order of one-half the surge impedance of the leading-in systems to the control electrode or grid and the anode.

If desired the cathodes may be inductively coupled within the enclosing vessel and the anodes may also be inductively coupled, to provide two circuits including the inter-electrode capacities, tuned to the same frequency, preferably substantially to the frequency at which the device is intended to be operated.

The invention and the 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 a perspective view of an electron discharge device illustrative of one embodiment of this invention, portions of the enclosing vessel being broken away to show the electrode assembly more clearly;

Fig. 2 is an enlarged end view of the electrodes showing the configuration and relative position thereof;

Fig. 3 is a diagrammatic view showing the relative disposition of the electrode leading-in conductors in the base of the enclosing vessel of the device shown in Fig. 1;

Fig. 4 is a perspective view of another embodiment of the invention, portions of the enclosing vessel being broken away to show the electrodes more clearly;

Fig. 5 is a diagrammatic view of the base of the enclosing vessel of the device shown in Fig. 4, showing the disposition of the leading-in conductors for the electrodes;

Figs. 6 and 7 are fragmentary views showing the arrangement of the conductive members connecting the anodes and cathodes, with respect to each other.

Referring now to the drawing, the electron discharge device shown in Fig. 1 comprises an evacuated enclosing vessel 10 having a base wall 11. Supported within the vessel are a control electrode or grid 12, two cathodes 13, and two anodes 14, the several electrodes being positioned as closely together as is mechanically and electrically feasible, so that the device may be operated at ultra-high frequencies, for example frequencies corresponding to wave lengths of the order of 30 centimeters or less.

The control electrode or grid comprises an L-shaped metallic central support or rod 15 which is mounted from a short rigid wire or stub 16 sealed in the base wall 11 of the enclosing vessel. The vertical arm of the support or rod 15 is encompassed by an oval or flattened helical grid 17, each of the longer sides of each turn of the grid being secured to the vertical arm, as by welding. In the fabrication of the control or grid electrode, the helical grid may be wound about three rods, for example, a rod 15 and two spacer rods disposed on opposite sides of the rod 15, the turns of the grid welded to the rod 15, and the spacer rods then withdrawn. The support or rod 15 being of relatively large area serves to radiate heat from the grid 17, whereby all portions of the grid are maintained at a relatively low and substantially uniform temperature during the operation of the device, and as a result the device has a high power capacity.

Two electrically separate filamentary cathodes 13, which may be of thoriated tungsten, are disposed within the helical grid 17 and on opposite sides of the central support or rod 15. Each of the filamentary cathodes 13 is fixedly supported at its lower end by a bent wire or rod 20 sealed in the end wall 11 of the enclosing vessel, and is connected at its other end to a flexible J-shaped member or spring 21 extending from a support or rod 22 also sealed in the end wall 11 of the enclosing vessel.

An anode, generally designated as 14, is disposed in juxtaposition to each of the filamentary cathodes 13, each anode including two L-shaped flanged sections 24 and two arcuate sections 25 having flanges 26. The several sections are secured together, together with reinforcing rods 27, in any suitable manner, for example by welding, and form a substantially semi-cylindrical portion disposed about an end of the helical grid 17 and substantially coaxial with a corresponding one of the filamentary cathodes 13. Each of the anodes 14 is mounted on a metallic support or rod 28 sealed in the end wall 11 of the enclosing vessel. The flanged section 24 and flanges 25 provide a relatively large heat radiating surface so that the anodes are effectively cooled during the operation of the device and a high power capacity for the device is obtained.

As can be seen from Fig. 3 in particular, the anode supports or rods 28 are sealed in the end wall 11 of the enclosing vessel at closely adjacent points but remote from the points at which the cathode leading-in conductors or supports 20 and 22 are sealed in this wall. The close positioning of the anode supports with respect to each other provides a low surge impedance for the leading-in system for the electrodes.

A metallic disc 29 having a getter 40, such as magnesium, thereon for fixing residual gases in the enclosing vessel is supported from a wire stub 30 sealed in the upper portion of the enclosing vessel 10. Inasmuch as the disc 29 is supported remote from the electrodes, the getter will not be affected by the heat to which the electrodes are subjected during the out-gassing treatment thereof. The disc 29 may be disposed substantially parallel to the longitudinal axis of the electrodes or at an angle thereto and may be heated at a desired time in the fabrication of the device, for example by high frequency induction, to vaporize the getter.

In the fabrication of the device, the enclosing vessel may be made in two portions. The electrodes may then be mounted on one portion and the two portions then fused together as indicated at the line A.

Preferably the flanged sections 24 and the helical grid 17 extend to immediately adjacent the base wall 11 of the enclosing vessel so that the supports 28 and stub 16, which serve as leading-in conductors for the anodes and control electrode respectively, are of very small length. As a result a relatively low impedance of the electrode leading-in conductors is obtained. The supports or leading-in conductors 28 for the anode, as previously noted, are placed close together so that the inductance thereof is small. Although the capacity between these conductors is increased as the spacing therebetween is decreased, at ultra-high frequencies, the surge impedance is the controlling factor and this impedance is decreased by close spacing of the conductors.

The device described hereinabove, it will be

seen, comprises basically two triode units which may be operated in push-pull. An important feature of the device is that the two control elements of the triode units are at the same potential, whereas in usual push-pull circuits the two cathodes are at the same potential. Hence, the effective surge impedance of the two triode units, referred to the anode leading-in conductors, which are included in the main tuned circuit of the device, is just twice that of each triode unit. This invention, therefore, provides an electron discharge device in which the surge impedance of the electrodes is relatively high, for example of the order of one-half the surge impedance of the leading-in conductors, so that a relatively high operating efficiency is obtained.

In another embodiment of this invention shown in Fig. 4, an electron discharge device comprises a control electrode or grid 15, 17 which may be of the same construction as in the device shown in Fig. 1. Two filamentary cathodes 13 are disposed one on each side of the central support rod 15 of the control electrode, and two anodes are disposed one in juxtaposition to each of the filamentary cathodes. Each of the anodes comprises two metallic plates having an arcuate portion 31, an intermediate portion 32, and a fin portion 33 disposed at an angle to the intermediate portion 32. The anodes are supported by metallic rods 34 sealed in the end wall 11 of the enclosing vessel and having slots in their inner end for receiving the intermediate portions 32 of the anodes.

An elongated U-shaped metallic member 35 is supported upon the anodes, the arms of the member 35 being provided with slots for receiving the intermediate portions 32 of the anodes. The member is designed so that the inductance thereof together with the inter-anode capacities provides a circuit tuned to the frequency at which the device is intended to operate most efficiently.

The cathodes 13 may comprise linear thoriated tungsten filaments, each of which is connected at its lower end to a flexible J-shaped member or spring 36 supported from a rigid wire or stub 37 sealed in the end wall 11 of the enclosing vessel and adjacent the periphery thereof. The two filaments are connected at the other end by a looped or ring shaped conductor 38 which is supported from an insulating bead 39 suspended from the U-shaped member 35. The looped or ring shaped conductor 38 serves as an inductance and is designed so that, together with the inter-electrode capacities, it provides a circuit tuned to the same frequency of the circuit including the U-shaped member 35. Preferably as shown in Figs. 6 and 7, the ring shaped conductor 38 is disposed at substantially right angles to the U-shaped member 35 so that the coupling therebetween is small.

As is clearly shown in Fig. 5, the cathode leading-in conductors 37 are widely spaced from the anode support rods and leading-in conductors 34 so that the capacitive and inductive coupling therebetween is very small.

Although two specific embodiments of the invention 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 single unitary cylindrical grid, said grid constituting the sole control electrode of the device, a

plurality of electrically separate cathodes mounted side by side within said grid, and a plurality of anodes outside of said grid and each disposed in operative relation with a corresponding one of said cathodes.

2. An electron discharge device comprising an oval helical electrode, a pair of electrically separate cathodes within said electrode and adjacent opposite sides thereof, and a semi-cylindrical anode disposed about each of said sides of said electrode.

3. An electron discharge device comprising a control electrode including a central supporting member and a helical wire encompassing said member and secured thereto, a pair of electrically separate cathodes disposed within said helical wire and on opposite sides of said supporting member, and a pair of anodes disposed each in juxtaposition to a corresponding one of said cathodes.

4. An electron discharge device comprising an enclosing vessel, a single unitary control electrode, a plurality of electrically separate cathodes adjacent said control electrode, a plurality of anodes disposed one in juxtaposition to each of said cathodes, leading-in conductors for said anodes sealed in one wall of said vessel and adjacent one another, and leading-in conductors for said cathodes sealed in said wall adjacent one another and remote from said first mentioned leading-in conductors.

5. An electron discharge device comprising an enclosing vessel, a single control electrode, a plurality of separate cathodes mounted side by side within the confines of said control electrode, a plurality of anodes disposed one adjacent each of said cathodes, and leading-in conductors for said anodes sealed in one wall of said enclosing vessel at closely adjacent points, each of said anodes including a portion secured to said conductors and extending to adjacent said wall.

6. An electron discharge device comprising an enclosing vessel, a plurality of electrode units within said vessel, each including a cathode, a control member, and an anode, each anode being in cooperative relation to only the cathode corresponding thereto, said control members being electrically connected within said vessel, and an inductance means within said vessel connecting said anodes.

7. An electron discharge device comprising an enclosing vessel, a single control electrode, a pair of cathodes adjacent said control electrode, a pair of anodes disposed one adjacent each of said cathodes and remote from the other of said cathodes, and a conductor connecting said anodes, said conductor having such inductance that together with the inter-electrode capacities it forms a circuit substantially tuned to the frequency at which the device is intended to operate.

8. An electron discharge device comprising an enclosing vessel, a plurality of electrode units within said vessel, each unit including a cathode, an anode, and a control member, the anode of each unit being in cooperative relation to only

the cathode corresponding thereto, and an inductance within said vessel connecting said cathodes.

9. An electron discharge device comprising an enclosing vessel, a pair of electrode units within said vessel, each unit including a cathode, an anode, and a control member, and a looped conductor connecting said cathodes, said conductor having an inductance value which combined with the interelectrode capacities forms a circuit tuned to the operating frequency of the device.

10. An electron discharge device comprising an enclosing vessel, a plurality of electrode units within said vessel, each unit including a cathode, an anode, and a control member, the anode of each unit being in cooperative relation to only the cathode corresponding thereto, inductive means connecting said anodes and forming a tuned circuit including the inter-electrode capacities, and another inductive means connecting said cathodes and forming another tuned circuit including the inter-electrode capacities.

11. An electron discharge device in accordance with claim 10, in which the value of the inductances tunes said circuits to the same frequency.

12. An electron discharge device comprising a control electrode, a pair of cathodes adjacent said control electrode, a pair of anodes disposed one adjacent each of said cathodes and remote from the other of said cathodes, a conductive member forming an inductance connecting said anodes, and another conductive member forming an inductance connecting said cathodes, said conductive members being disposed at substantially right angles to each other.

13. An electron discharge device comprising a hollow perforate control electrode, a pair of cathodes within said control electrode, a ring shaped inductive member connecting said cathodes, a pair of anodes each disposed in proximity to one of said cathodes and relatively remote from the other of said cathodes, and a U-shaped inductive member connecting said anodes.

14. An electron discharge device comprising an enclosing vessel, a hollow perforate control electrode, a pair of cathodes within said control electrode, a pair of anodes disposed one adjacent each of said cathodes, supporting members sealed in one wall of said enclosing vessel and connected to said anodes at one end, a U-shaped inductive member secured to said anodes at the other end and carried thereby, supporting means sealed in said wall and connected to one end of said cathodes, a ring shaped inductive member connected to the other end of said cathodes, said ring shaped member being disposed at substantially right angles to said U-shaped member, and means including an insulating member supporting said ring shaped member from said U-shaped member.

15. An electron discharge device in accordance with claim 14 in which the U-shaped and ring shaped members have an inductance as to form with the inter-electrode capacities two circuits tuned to substantially the same frequency.

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