Aug. 2, 1938. C. A. BIELING 2,125,279

ELECTRON DISCHARGE DEVICE

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FIG. 1

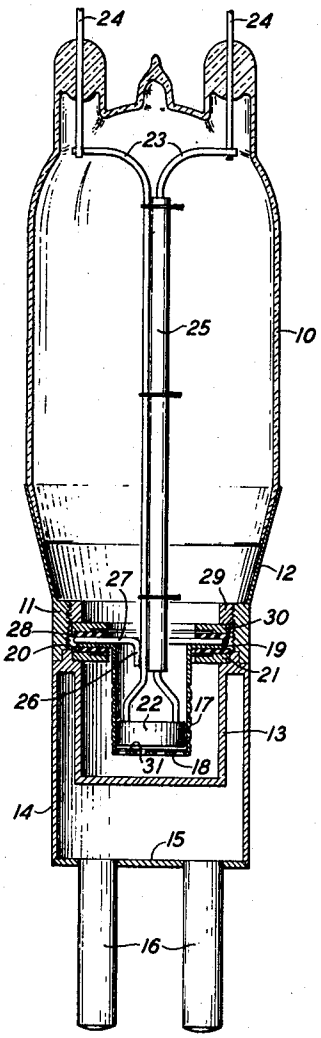

FIG. 2

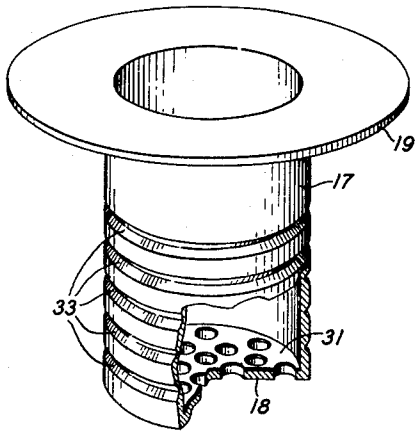

FIG. 3

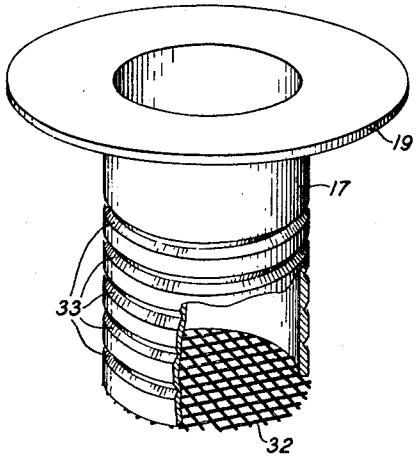

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FIG. 4

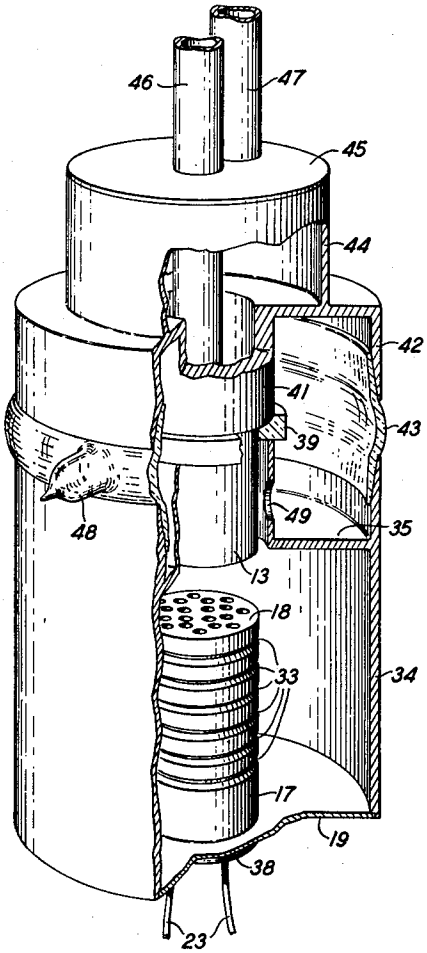
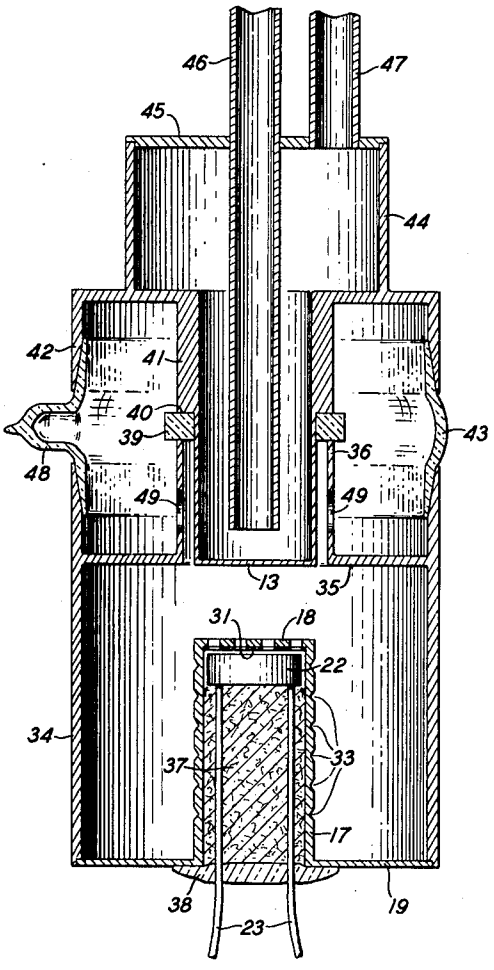


FIG. 5



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UNITED STATES PATENT OFFICE

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ELECTRON DISCHARGE DEVICE

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5 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices and more particularly to such devices capable of generating ultra-high frequency oscillations, for example oscillations of frequencies corresponding to wave-lengths of 10 centimeters or less.

One object of this invention is to reduce the internal losses in electron discharge devices operable at ultra-high frequencies and thereby to improve the operating efficiency of such devices.

Another object of this invention is to improve the thermal efficiency of indirectly heated electron emitters for electron discharge devices.

The invention may be embodied, for example, in a diode oscillator comprising an anode having a substantially plane electron receiving surface and a cathode including a tubular portion and an electron emitting portion in juxtaposition and substantially parallel to the plane electron receiving surface of the anode. A heater element is mounted within the cathode and preferably in immediate proximity to the electron emitting portion thereof.

In accordance with one feature of this invention, the anode is provided with a cylindrical portion and the cathode is provided with a similar portion encompassing the anode and preferably disposed coaxially therewith, whereby a uniform field distribution obtains between the anode and the cathode.

In accordance with another feature of this invention, the electron emitting portion of the cathode is composed of a reticulated or screen member coated with a thermionic material on only the surface thereof remote from the anode, whereby the high resistance coating material is removed from the anode-cathode circuit and a low resistance path for the high frequency currents is obtained.

The invention and the various 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 an elevational view partly in longitudinal section of an electron discharge device illustrative of one embodiment of this invention;

Fig. 2 is an enlarged detail view in perspective, partly broken away, of the cathode of the discharge device shown in Fig. 1;

Fig. 3 is another enlarged detail view in perspective and partly broken away, illustrating a modification of the cathode shown in Fig. 2;

Fig. 4 is an elevational view in perspective of an electron discharge device illustrative of another embodiment of this invention, portions of the enclosing vessel being broken away to show the internal structure more clearly; and

Fig. 5 is an elevational view partly in longitudinal section of the electron discharge device shown in Fig. 4.

Referring now to the drawings, the electron discharge device shown in Fig. 1 is of the type designated as diode oscillators and comprises an enclosing vessel including a vitreous portion 10 and a metallic portion 11 having a flaring sleeve 12 hermetically sealed to the vitreous portion 10. Suitably affixed to the metallic portion 11, as by welding or soldering, is a metallic member including a cup-shaped portion 13, which serves as the anode of the device. The cup-shaped portion 13 has integrally formed therewith a surrounding cylinder 14 sealed at one end by a closure disc 15 and carrying terminal prongs 16, through which electrical connection to the anode may be established.

Disposed in cooperative relation with the anode 13 is a cathode, which preferably is of a low-resistance material, such as copper, and includes a cylindrical portion 17 coaxial with the anode 13, a reticulated disc 18 parallel to the base of the anode, and a flange 19. The flange 19 is seated upon an annular insulating spacer or shim 20 lying upon a metallic ring 21 seated upon the edge of the cup-shaped anode 13. The cathode encloses a heater element disposed in immediate proximity to the disc 18 and including, for example, a filament, not shown, encased in a ceramic body 22. Energizing current for the heater filament may be supplied through conductors 23 secured to wires 24 sealed in the vitreous portion 10 of the enclosing vessel, one of the conductors being encased in insulating material, such as a glass sleeve 25. The cathode may be connected electrically to the heater element by a tie wire secured at one end 26 to one of the conductors 23 and having an arcuate portion 27 resting upon the flange 19 and held thereagainst by an insulating spacer or shim 28. The cathode, the tie wire 26, 27 and the various annular members 19, 20 and 28 are clamped to one another and held in position by a locking ring 29 threaded in the metallic portion 11 and bearing against a metallic seating ring 30 in turn bearing against the spacer or shim 28.

When the anode and cathode are suitably energized and connected in circuit, as known in the art, oscillations of very high frequencies, for example of frequencies corresponding to wavelengths of the order of 10 centimeters, will be generated. It has been found that in the cathode

the high frequency currents are concentrated and flow in a thin layer at the surface of the cathode directed toward the anode. For example, calculations indicate that at oscillations of a wave-length of 10 centimeters the current in a copper conductor is concentrated at the surface in a layer approximately 4 mils in thickness. In order to reduce the resistance losses in the cathode and hence to improve the operating efficiency of the device, it is desirable that the current path in the cathode be of low resistance. To this end, in accordance with one feature of this invention, the thermionic material, which is of relatively high resistance, is removed from the current path in the cathode. Specifically, in one embodiment shown clearly in Fig. 2, the thermionic coating 31 is applied only to the surface of the disc portion 18 remote from the surface of the anode opposite this disc portion. The high frequency currents in the cathode, then, will flow substantially entirely in a thin layer at the surface of the cathode directed toward the anode and hence will be confined to a low resistance path.

In another embodiment, illustrated in Fig. 3, the portion of the cathode opposite and parallel to the base of the cup-shaped anode 13 is in the form of a disc screen 32 suitably affixed to the tubular portion 17 of the cathode and coated with thermionic material only on the surface thereof remote from the base of the anode.

In order to improve the thermal efficiency of the cathode, the tubular portion 17 may be provided with a plurality of annular grooves or recesses 33 which decrease the heat conductivity of this portion and thereby assure a sharp temperature gradient away and heat attenuation from the portion of the cathode coated with the thermionic material. Consequently, concentration of heat at this coated portion obtains and thermal losses in the cathode are reduced.

In the embodiment of this invention shown in Figs. 4 and 5, the cathode is of substantially the same construction as that in the device shown in Figs. 1 and 2 and is disposed within a metallic shell having a cylindrical wall 34 to which the flange 19 is sealed, an inwardly extending annular flange 35 and a cylindrical portion or sleeve 36 coaxial with the tubular portion 17 of the cathode. The tubular portion 17 may have therein thermal lagging 37 and has its outer end closed as by a glass disc 38 sealed to the flange 19 and having the heater leading-in conductors 23 sealed therein.

The anode 13 is disposed coaxially within the cylindrical sleeve 36 and is spaced therefrom by an annular insulating member 39 bearing against the sleeve 36 and a shoulder 40 on a cylindrical extension 41 integral with the anode. Formed integrally with the anode 13 is a casing member having a cylindrical wall 42 hermetically sealed to the wall 34 by a vitreous annulus 43, and an upstanding wall 44 closed at one end by a disc 45. The closure disc 45 carries inlet and outlet pipes 46 and 47, respectively, through which a cooling medium may be circulated within the anode and the casing member. The annulus 43 may be provided with an exhaust tubulature 48 through which the device may be evacuated, the sleeve 36 having apertures 49 therein to allow exhaust of the cathode chamber.

The disc 18 and the base of the cup-shaped anode 13 constitute the principal electrode surfaces of the device, between which the electron discharge occurs. The cylindrical sleeve 36, which is electrically integral with the cathode and hence at the same potential as the cathode, insures uniform distribution of the high frequency fields extant in the device and a relatively concentrated and uniform electron stream between the cathode member 18 and the base of the anode 13 whereby internal losses in the device are reduced.

Although specific embodiments of the invention have been shown and described, it will be understood that these embodiments are merely illustrative and 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 anode, a cathode having a tubular portion and a reticulated portion in juxtaposition to said anode, a coating of thermionic material only upon the surface of said reticulated portion facing away from said anode, and a heater element within said cathode and in immediate proximity to said coated surface.

2. An oscillation generator comprising an anode, a cathode having a tubular portion and a low resistance reticulated disc portion at one end of said tubular portion and in juxtaposition to said anode, a coating of thermionic material only upon the surface of said disc portion facing away from said anode, a heater element within said cathode and in proximity to said coated surface, and means for producing sharp heat attenuation in said tubular portion away from said one end.

3. A diode oscillator comprising a cup-shaped anode having a plane base, a thermionic cathode having a plane emitting portion in juxtaposition and parallel to said base, and a cylindrical metallic member electrically integral with said emitting portion, encompassing and coaxial with said anode and in proximity to the periphery of the base thereof.

4. An electron discharge device comprising a metallic casing having a cylindrical sleeve extending from one end thereof, an electron emitting disc member within said casing and electrically connected thereto, and an anode insulatingly joined to said casing, including an extended portion in juxtaposition to said disc member and commensurate in area therewith and a cylindrical portion within said cylindrical sleeve and in proximity thereto.

5. An ultra-high frequency oscillation generator comprising a tubular metallic casing having a cylindrical sleeve extending from one end thereof, a cathode within said casing and having a tubular portion joined to the other end of said casing and coaxial with said sleeve, said cathode having also a reticulated disc portion at the inner end of said tubular portion, a heater element within said cathode and adjacent said inner end thereof, a coating of thermionic material only upon the surface of said reticulated portion toward said heater element, and a unitary metallic member having a wall portion sealed to said casing and insulated therefrom, a cylindrical portion within said sleeve and coaxial therewith, and a disc electrode portion in juxtaposition and parallel to said reticulated portion of said cathode.

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