Jan. 16, 1951 P. P. DERBY 2,538,087

ELECTRON DISCHARGE DEVICE OF THE MAGNETRON TYPE

Filed Dec. 26, 1944

FIG. 1.

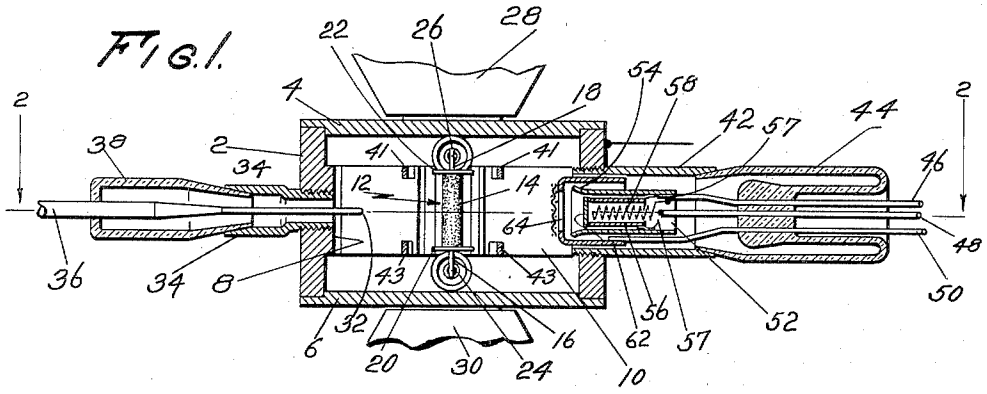


FIG. 2.

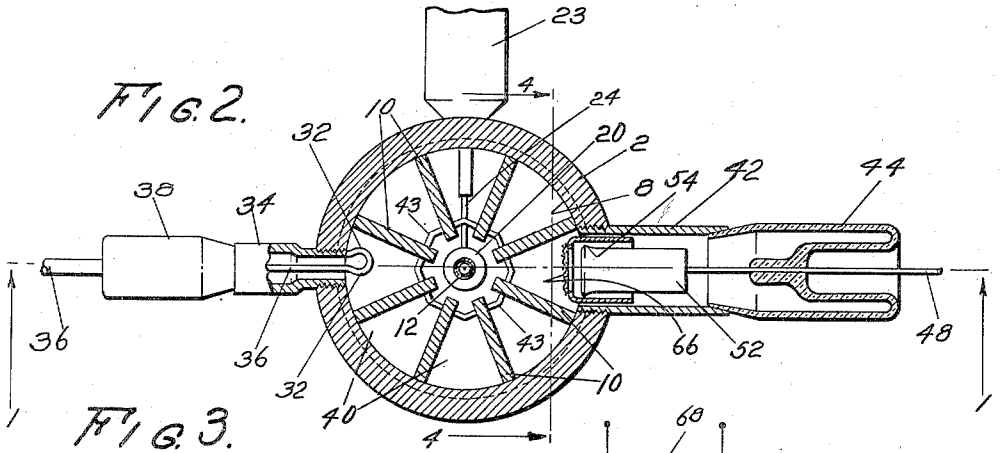


FIG. 3.

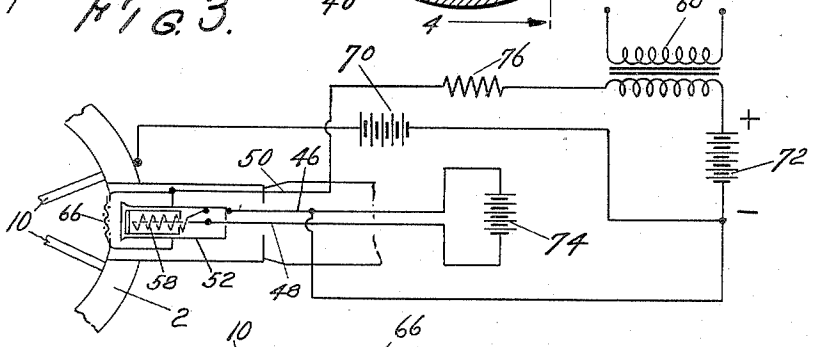
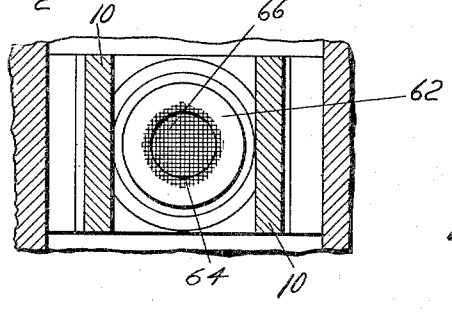


FIG. 4.



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ELECTRON DISCHARGE DEVICE OF THE MAGNETRON TYPE

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3 Claims. (Cl. 315—40)

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The present invention relates to electron discharge devices, such as magnetrons for example, and more particularly to tuning means for such devices.

One of the objects of the present invention is to provide an electron discharge device of the aforesaid general type having electronic tuning means.

Another object of the present invention is to provide an electron discharge device of the general type referred to having means for modulating the frequency more especially for transmission purposes.

These objects and such other objects and aims of the present invention as may hereinafter appear will be best understood from the following description, taken in connection with the accompanying drawing of one embodiment of the invention herein presented for illustrative purposes.

In the drawing:

Fig. 1 is a vertical section on line 1—1 of Fig. 2 showing a magnetron embodying one illustrative embodiment of the present invention;

Fig. 2 is a horizontal section on line 2—2 of Fig. 1 of the illustrative embodiment of the invention shown in Fig. 1;

Fig. 3 shows the various circuits of the device; and

Fig. 4 is a top plan view of a sectional detail on line 4—4 of Fig. 2.

Referring to the drawing the invention is herein illustratively shown in its application to an electron discharge device of the magnetron type, herein comprising a cylindrical member 2 closed at both ends by caps 4 and 6, respectively, soldered to the edges of said member 2 to form an hermetically sealed envelope or enclosure. Said cylindrical member 2 and said caps 4 and 6 may be made of copper or other suitable electrically conductive material. Said cylindrical member 2 has formed upon its inner surface a central, annular projection 8 to which are soldered a plurality of suitably spaced, radially disposed plates or arms 10. Said arms 10, cylindrical member 2 and caps 4 and 6 constitute the anode structure, and the inner ends of said arms 10 form anode faces for receiving electrons from a cathode 12 supported substantially centrally of said anode faces. Said plates or arms 10 are preferably made of highly conductive copper, and may conveniently be stamped from a plate of such copper.

The cathode 12 is preferably of the indirectly heated, oxide-coated, thermionic type, provided with an outer electrically conductive sleeve 14, and an internal heater wire of which the end conductors 16 and 18 project centrally from the opposite ends of the cathode 12. One of said conductors, the conductor 16, for example, may be connected to said outer conductive cathode sleeve 14, while the other conductor 18 is insulated from said sleeve. Light, conductive shields 20, 22, herein conveniently integral with said cathode sleeve 14 at opposite ends of the latter,

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prevent electrons beams from being projected outwardly toward said end caps 4 and 6. The cathode 12 is preferably supported by a cathode and heater wire lead-in conductor 24 welded to the end of conductor 16 which, as previously stated, is electrically connected to said conductive cathode sleeve 14 and to one end of said cathode heater wire. A second lead-in conductor 26 has its inner end welded to the free end of said heater wire conductor 18. Said two lead-in conductors are connected to a suitable source of voltage, such as a battery, for example, not shown, and are sealed in well-known, conventional manner through glass seals mounted at the outer ends of conducting pipes, one of which is shown at 23 in Fig. 2, which extend through the wall of the cylindrical member 2 and are hermetically secured therein adjacent the two ends, respectively, of said cylindrical member 2. Said glass seals and conducting pipes are all of well-known, identical, conventional construction and arrangement and therefore only one is shown, as above stated, so as not needlessly to increase the number of the figures.

If such an electron discharge device be placed between suitable magnet pole pieces 28 and 30 to produce a longitudinal magnetic field within the device and the device be energized, oscillations will be generated which may be led out of said device by a coupling loop 32, see Figs. 1 and 2, extending into the space between two of said anode arms 10. One end of said coupling loop 32 is connected to the inner end of a conducting pipe 34, hermetically sealed through the wall of said cylindrical member 2, substantially midway between the ends of the latter, and its other end is connected to a conductor 36 which extends through said pipe 34 and is sealed through a glass seal 38 mounted at the outer end of said pipe 34. An additional conducting pipe, not shown, may be electrically connected to said pipe 34 and form with said conductor 36 a concentric line through which the high frequency oscillations generated by said device may be conducted to any suitable utilization circuit.

Each pair of anode arms 10 forms with the portion of the projection 8 between them an oscillating cavity or cavity resonator 40. A capacitance exists between the cathode 12 and the end faces of said anode arms 10 and also between the side walls of each resonator cavity. The conductive path around each cavity afforded by the side walls thereof and the portion of said projection 8 between them constitutes an inductance. The anode, therefore, is so designed and spaced relatively to the cathode that said inductances and capacitances constitute tuned circuits. It is desired that the circuits shall be resonant at definite, predetermined frequencies at which the device is to be operated.

Electrically conductive straps 41 and 43 may be provided at opposite ends respectively of said anode to prevent spurious oscillations, the strap

41 connecting alternate anode arms at one end of the anode, and the strap 43 at the other end of the anode connecting the intervening anode arms.

Referring to Figs. 1 and 2, a conducting pipe 42 extends through the wall of said cylindrical member 2 and is hermetically sealed in said wall, its inner end opening into one of the resonant cavities 40. At its outer end said pipe 42 is connected to a glass seal 44 through which are sealed three lead-in conductors 46, 48 and 50. The conductor 46 is welded to and supports an electrically conductive tubular member 52 having an outwardly flaring inner end 54 and surrounding a cathode 56 closed at its inner end 57, the outer surface of said end being preferably coated with an electron-emissive surface, such as barium or strontium oxide, or a mixture of the two. Said cathode 56 contains a heater wire 58 connected at one end to the second conductor 48 and at the other end to the inner wall of said tubular member 52. At its other end said cathode is connected by wires 57 to the inner wall of said tubular member 52 by which it is supported, said tubular member being suitably spaced from said cathode and acting as a shield for said cathode 56 to prevent undue cooling of the latter. The third lead-in conductor 50 is welded to and supports an electrically conductive circular cap 62 which surrounds the inner end 54 of said tubular member 52 and is spaced from the latter and from said pipe 42. The end wall of said cap 62 is provided with a circular, central aperture 64 facing the inner end 57 of said cathode 56 and fitted with a fine mesh accelerator grid 66, see Fig. 4. The anode voltage, the grid voltage and voltage for the cathode 54 and its heater wire 58 may be supplied from suitable sources, such as 70, 72 and 74, respectively, as diagrammatically represented in Fig. 3. A resistance 76 may be inserted in the grid circuit to limit the voltage thereof.

If the cathode 56 be energized, it will emit an electron beam of which the electrons will be attracted by the accelerator grid 66, and, guided by the flaring end walls of the inner end 54 of said tubular member 52, will pass through said grid 66 and into the resonant cavity between the two anode arms 10 at each side of the latter.

In accordance with my present understanding of the operations of the present invention, the injection of the electron beam or cathode ray into the space between two anode arms changes the effective dielectric constant between said two arms and thus varies the capacitances of the anode structure, without affecting the inductance thereof to the same degree. Therefore, injection of an electron beam into a space between two of said anode arms will vary the tuning of the magnetron. The frequency will be varied in accordance with the intensity of the cathode ray. By controlling the voltage of the accelerator grid 66, the frequency of the magnetron can thus be controlled, an increase of the grid voltage increasing the frequency of the magnetron and vice versa. The electrons projected into said resonant cavity between said two anode arms will be dispersed within said cavity and captured before penetrating the region of the main discharge of the magnetron. Varying the grid voltage may be effected in any suitable manner, manually or automatically. For example, in the illustrative embodiment of the invention shown, the grid, responsive to any modulated signal received through said transformer 68, will vary the intensity of the electron beam emitted by the cathode 56, and thus will modulate the frequency of the magnetron in accordance with the modulated signal received.

The present invention is a distinct advance in the art. It provides a device for electronic tuning. The great rapidity of operation of the device makes it particularly valuable for tuning where ultra-high frequencies are involved, for which mechanical means are wholly inadequate.

Wherever the expression "a plurality" occurs it is to be construed as meaning two or more.

I am aware that the present invention can be embodied in other specific forms without departing from the spirit or essential attributes thereof, and I therefore desire the present description to be considered in all respects as illustrative and not restrictive, reference being had to the appended claims rather than to the aforesaid description to indicate the scope of the invention.

What is claimed is:

1. A tunable electron-discharge device comprising: a cathode; an anode structure spaced from said cathode, and incorporating a cavity resonator in which radio-frequency oscillations are adapted to be generated; means adjacent said cavity resonator for establishing a magnetic field therethrough; means, cooperable with the electric-field component of said radio-frequency oscillations, and with said magnetic field, for setting up a space charge in said cavity resonator; and means, coupled between said cavity resonator and said last-named means, for varying the density of said space charge.

2. A tunable electron discharge device comprising: a first cathode; an envelope spaced from said first cathode; a pair of anode arms extending inward from said envelope and, together with that portion of said envelope lying therebetween, defining a cavity resonator; means adjacent said cavity resonator for establishing a magnetic field therethrough; and a second cathode, communicating with said cavity resonator through said portion of said envelope lying between said anode arms, for setting up a space charge in said cavity resonator.

3. A tunable electron discharge device comprising: a cathode; an envelope spaced from said cathode; a pair of anode arms extending inward from said envelope and, together with that portion of said envelope lying therebetween, defining a cavity resonator; means adjacent said cavity resonator for establishing a magnetic field therethrough, and a metallic sleeve, closed at one end and electron-emissively coated at said end, projecting into said cavity resonator through said portion of said envelope lying between said anode arms, with its longitudinal axis in a direction substantially perpendicular to the direction of said magnetic field, for setting up a space charge in said cavity resonator.

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