

April 26, 1949.

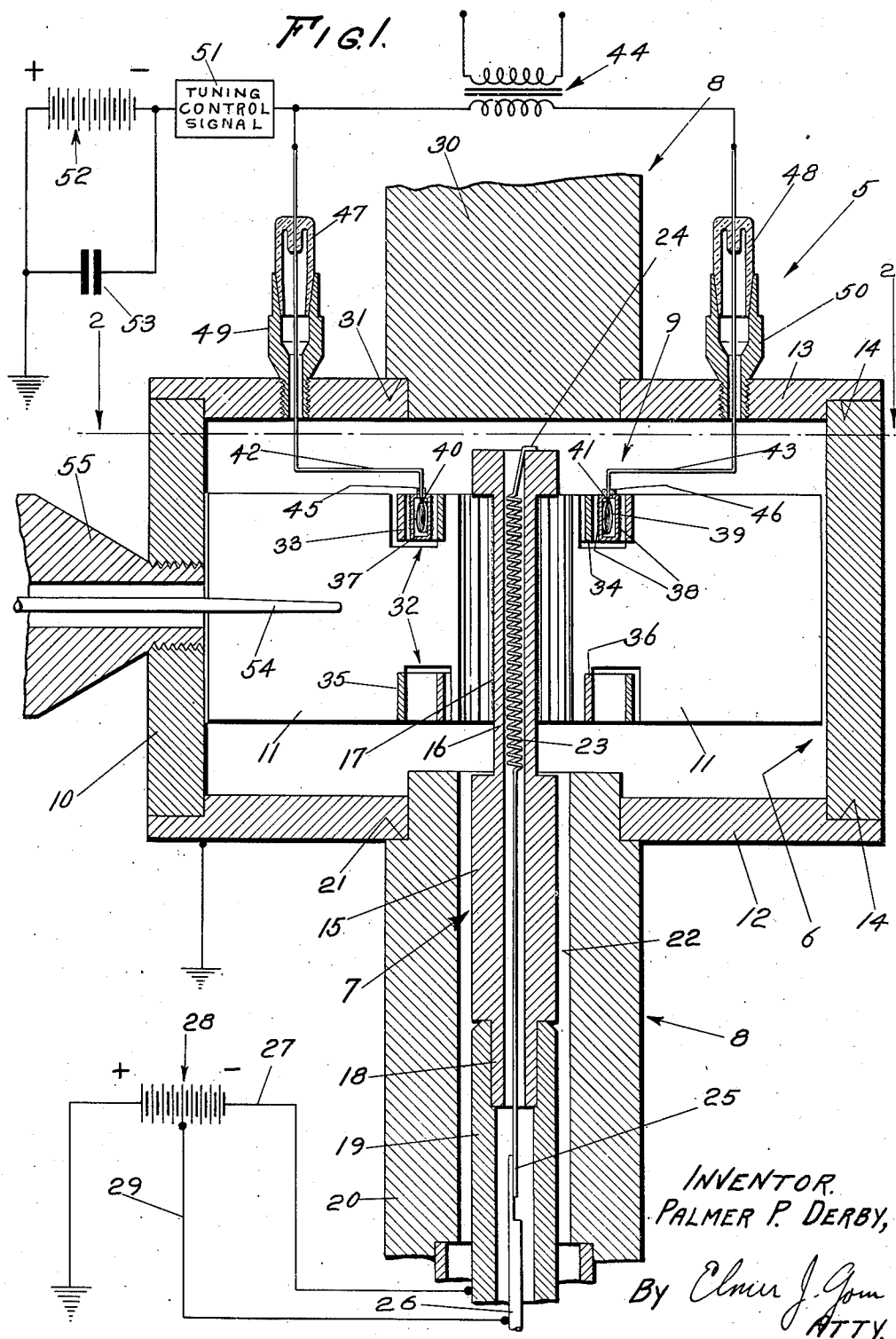
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ELECTRON DISCHARGE DEVICE

Filed May 21, 1945

2 Sheets-Sheet 1



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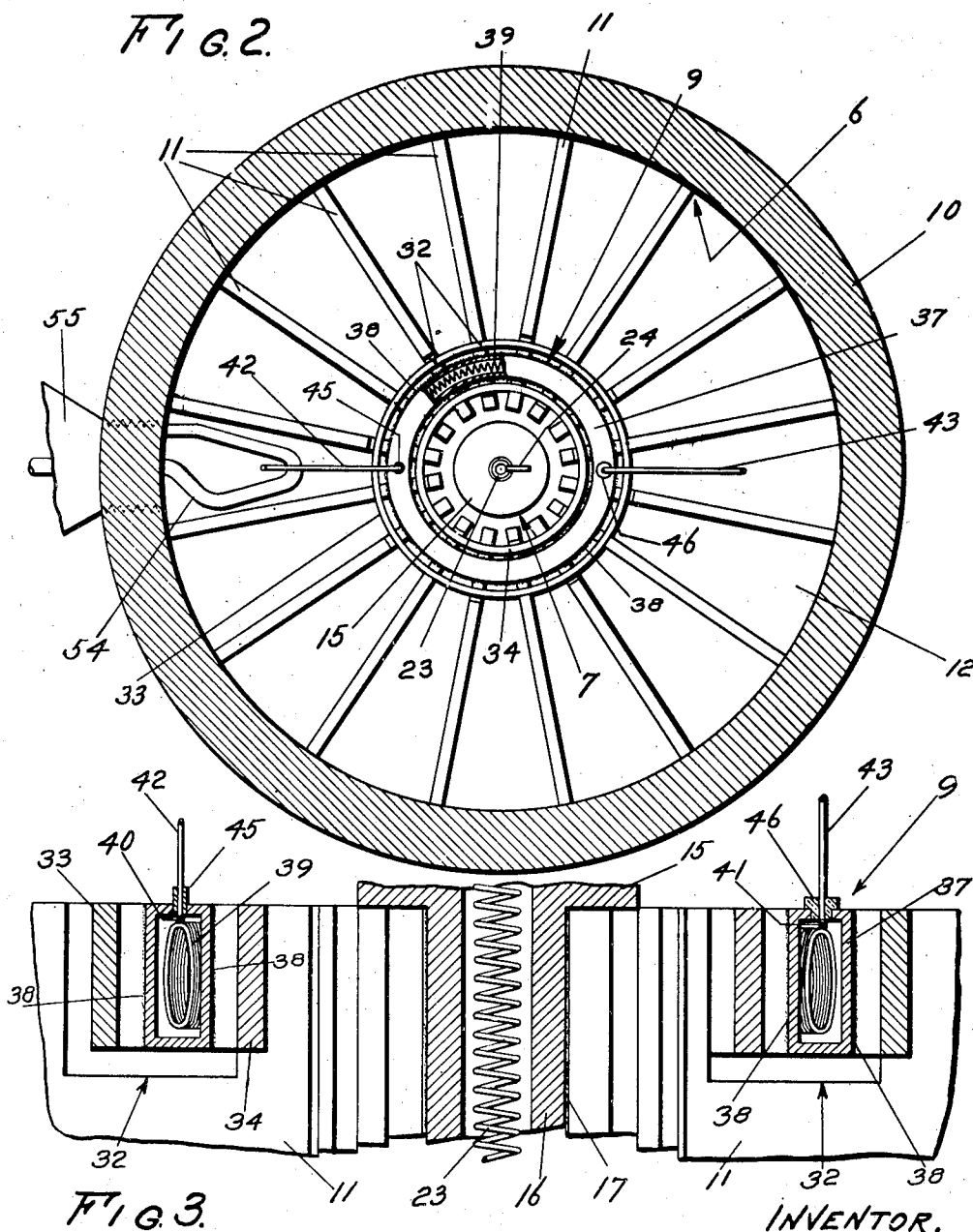
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ELECTRON DISCHARGE DEVICE

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8 Claims. (Cl. 250—27.5)

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My present invention relates to electron-discharge devices, and more particularly to tuning means therefor.

My present invention is especially suitable for tuning or frequency modulating electron-discharge devices adapted to generate electrical oscillations having a wave length of the order of a few centimeters or less, for example, devices of the so-called magnetron type.

One of the objects of my present invention is to provide tuning means for an electron-discharge device of the general character indicated which enables the attainment of increased frequency deviation.

Another object of my present invention is to accomplish the foregoing in a simple and inexpensive manner.

These, and other objects of my present invention, which will become more apparent as the detailed description thereof progresses, are attained, briefly, in the following manner:

I prefer that my present invention be applied to an electron-discharge device comprising, in general, a centrally disposed cathode structure, an anode structure spaced from and surrounding said cathode structure, and incorporating a plurality of radial cavity resonators, means for establishing a magnetic field in a direction perpendicular to the electron-path between said cathode and anode structure, and a pair of conducting straps electrically connected to points of opposite polarity on each of said cavity resonators.

When a proper voltage is applied between the cathode and anode structures of such a device, and the magnetic field thereof is properly adjusted with respect to the electric field created by said voltage, such a device generates electrical oscillations of a wave length determined by the inductance and capacitance incorporated therein as a function, primarily, of the geometry of the physical elements making up the aforementioned cavity resonators.

Now, I have found that by introducing a stream of electrons into one or more of the cavity resonators of such a device, and altering the space charge created by said electrons, the resonant frequency of the device can be changed. Hence, appropriate alteration of said space charge results in frequency modulation of the device.

Previous methods of accomplishing this, for example, those disclosed in my copending applications entitled "Electron discharge device," Ser. No. 591,029, filed April 30, 1945, and "Electron discharge device," Ser. No. 594,841, filed

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May 21, 1945, and now U. S. Patent No. 2,446,531, granted August 10, 1948, are, for some purposes, too limited in the frequency deviation obtainable.

However, I have further found that by introducing the electrons into the region between the above-mentioned conducting straps, where a high capacitance exists, I am able to considerably increase the percentage of modulation obtainable. For this purpose, I dispose an electron-source between said straps, and establish a unidirectional electric field therebetween. Then, by adjusting a magnetic field, which passes through the space charge region in a direction transversely of the path between said electron-source and said straps, so that the orbital frequency of the electrons differs, slightly, from the natural resonant frequency of the device, I am able to obtain maximum tuning effect, and by suitably modulating the above-mentioned unidirectional field, I obtain corresponding modulation of the frequency of the device.

In the accompanying specification I shall describe, and in the annexed drawings show, an illustrative embodiment of the electron discharge device of my present invention. It is, however, to be clearly understood that I do not wish to be limited to the details herein shown and described for purposes of illustration only, inasmuch as changes therein may be made without the exercise of invention and within the true spirit and scope of the claims hereto appended.

In said drawings:

Fig. 1 is a fragmentary, longitudinal sectional view of an electron-discharge device of the so-called magnetron type incorporating electronic tuning means made in accordance with the principles of my present invention;

Fig. 2 is a transverse sectional view of the same taken along line 2—2 of Fig. 1; and

Fig. 3 is a fragmentary, enlarged, longitudinal sectional view more clearly showing the relationship between the above-referred to electron-source and conducting straps.

Referring now more in detail to the aforesaid illustrative embodiment of my present invention, and with particular reference to the drawings illustrating the same, the numeral 5 generally designates an electron-discharge device of the so-called magnetron type.

As herein shown, said device includes an anode structure 6, a cathode structure 7, magnetic means 8 for establishing a magnetic field in a direction perpendicular to the electron-path be-

tween said cathode and anode structures, and tuning means 9.

The anode structure 6 preferably comprises a cylindrical body 10, made of highly conductive material, such as copper, and provided with a plurality of anode members in the form of the interiorly-extending, radially disposed vanes 11.

The cylindrical body 10 is closed at its ends by plates 12 and 13, the junctions between said body and said plates being hermetically sealed, as at 14.

The cylindrical body 10 is of such diameter, and the number, size, and relative spacing of the vanes 11 are so chosen that each pair of adjacent vanes, together with that portion of said cylindrical body lying therebetween, defines a cavity resonator at the unaltered frequency desired of the output of the device.

The cathode structure 7, which is coaxial with the anode structure 6, preferably comprises an elongated sleeve 15, conventionally made of nickel or the like, and having a reduced portion 16 which is substantially coextensive with the vertical dimension of the vanes 11, in other words, with the length of the cavity resonators, and provided with a highly electron-emissive coating 17, for example, of the well-known alkaline-earth metal oxide type.

In order to support the cathode sleeve 15 with respect to the anode members 11, said sleeve may be reduced at its lower end 18 to fit into a tubular conducting member 19, the latter, in turn, being insulatedly supported, in any desired manner (not shown), by a tubular pole piece 20 hermetically sealed, as at 21, into the end plate 12, said pole piece being provided with a bore 22 through which the cathode structure may enter the device.

The cathode sleeve 15 may be heated by a filament 23 connected at one end 24 to said sleeve, and at the other end 25 to a lead-in conductor 26 suitably entering the device through the tubular conducting member 19. Current may be conveyed to the filament 23 by connecting the member 19, through a conductor 27, to the negative terminal of an appropriate source of voltage 28, and connecting the lead-in conductor 26, through a conductor 29, to a positive tap on said voltage source. The positive terminal of said voltage source may be grounded, as shown, as may be the cylindrical body 10, whereby a potential difference is established between the cathode structure 7 and the anode structure 6.

Another pole piece 30 is hermetically sealed, as at 31, into the end plate 13, said pole piece, and the pole piece 20, being fixed, for example, at the opposite ends of a horseshoe magnet (not shown), the two pole pieces and the horseshoe magnet constituting the above referred to magnetic means 8 for establishing a magnetic field transversely of the electron-path between the cathode and anode structures of the device.

I provide the vanes 11, in both the upper and lower edges thereof, adjacent their inner ends, with slots 32 receptive of two pairs of concentric, conducting straps 33 and 34, and 35 and 36, the straps of each pair thereof alternately contacting successive vanes 11. It has been found that when alternate vanes are electrically interconnected, as by the straps just described, the tendency of the device to generate spurious oscillations, which would reduce its efficiency, is eliminated.

In the device as thus far described, there is no means for controlling the frequency thereof, and

in order to provide such means, I prefer to proceed as follows:

Intermediate the straps 33 and 34, I mount a hollow, annular, cathode member 37 provided, on its outer surfaces, facing said straps, with highly electron-emissive coatings 38. Said cathode member may be heated by means of a filament 39 enclosed within the same and connected, at diametrically opposed points 40 and 41, to lead-in conductors 42 and 43 which, in turn, may be connected across the secondary winding of a filament transformer 44. The primary of said transformer may be connected to a suitable source (not shown) of filament voltage.

The lead-in conductor 42 may enter the cathode member 37 through a conducting bushing 45 which is fastened to said cathode member, and the lead-in conductor 43 may enter said cathode member through an insulating bushing 46 which is, likewise, fastened to said cathode member.

The lead-in conductors 42 and 43 may enter the device itself, respectively, through glass seals 47 and 48 fused into the outer ends of pipes 49 and 50 which are threadedly engaged and hermetically sealed into the end plate 13.

In order to cause the electrons emitted by the cathode 37 to pass to the straps 33 and 34, I connect the lead-in conductor 42, through a tuning or modulation signal source 51, to the negative terminal of a suitable biasing voltage source 52, the positive terminal of the latter being grounded and, therefore, at the same potential as the straps 33 and 34.

It will be noted that the electron-paths between the cathode 37 and the straps 33 and 34 are within the magnetic field, more particularly the leakage field, between the pole pieces 20 and 30. It will also be noted that said electron-paths are within the radio-frequency field between said straps 33 and 34. Hence, by adjusting the intensity of said magnetic field so that the orbital frequency of the electrons emitted by the cathode 37 is slightly different, either lower or higher, than the frequency of said radio-frequency field, a space charge of appreciable density is built up within the spaces between the cathode 37 and the straps 33 and 34. I believe that the introduction of this space charge alters the dielectric constant of the high-capacitance regions intermediate the cathode 37 and the straps 33 and 34, and this, in turn, alters said capacitance, resulting in a change in the resonant frequency of the device.

Inasmuch as it is preferable to keep alternating current out of the voltage source 52, the negative terminal thereof may be connected, through a bypass capacitor 53, to ground.

In order to extract power from the device, I provide a loop 54 which may be introduced into any one of the cavity resonators defined by the anode structure 6, said loop entering said device through a glass seal (not shown) fused into a pipe 55 threaded and hermetically sealed into the cylindrical body 10.

This completes the description of the aforesaid illustrative embodiment of my present invention. It will be noted from all of the foregoing that I have provided a simple and inexpensive electronic tuning means for an electron-discharge device of the so-called magnetron type, said tuning means being disposed in a high capacitance region of the cavity resonators of such discharge device, and enabling greater frequency deviation than it has heretofore been possible to attain. Other advantages of my present invention will

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readily occur to those skilled in the art to which the same relates.

What is claimed is:

1. An electron-discharge device comprising: a cathode; an anode structure, spaced from said cathode, and provided with a plurality of anode members; each pair of adjacent anode members, together with that portion of said anode structure lying therebetween, defining a cavity resonator; a pair of spaced conducting members electrically connected to points of opposite polarity on each such cavity resonator; an electron-source disposed intermediate said conducting members for creating a space charge therebetween; and means adjacent said electron-source and said conducting members for establishing a magnetic field transversely of the path between said electron-source and said conducting members.

2. An electron-discharge device comprising: a cathode; an anode structure, spaced from said cathode, and provided with a plurality of anode members; each pair of adjacent anode members, together with that portion of said anode structure lying therebetween, defining a cavity resonator; a pair of spaced, annular conducting members electrically connected to points of opposite polarity on each such cavity resonator; an annular, electron-emitting electrode disposed intermediate said conducting members for creating a space charge therebetween; and means adjacent said electron-emitting electrode and said conducting members for establishing a magnetic field transversely of the electron-path between said electrode and said conducting members.

3. A tunable electron-discharge device comprising: a cathode; an anode structure, spaced from said cathode, and incorporating a cavity resonator; a pair of spaced conducting members electrically connected to points of opposite polarity on said cavity resonator; an electron-source disposed intermediate said conducting members for creating a space charge therebetween; means adjacent said electron-source and said conducting members for establishing a magnetic field transversely of the path between said electron-source and said conducting members; and means connected between said electron-source and said anode structure for varying the density of said space charge.

4. A tunable electron-discharge device comprising: a cathode; an anode structure, spaced from said cathode, and incorporating a cavity resonator; a pair of spaced conducting members electrically connected to points of opposite polarity on said cavity resonator; an electron-source disposed intermediate said conducting members for creating a space charge therebetween; means adjacent said electron-source and said conducting members for establishing a magnetic field transversely of the path between said electron-source and said conducting members; and means connected between said electron-source and said anode structure for establishing a variable electric field between said electron-source and said conducting members.

5. A tunable electron-discharge device comprising: a cathode; an anode structure, spaced from said cathode, and provided with a plurality of anode members; each pair of adjacent anode members, together with that portion of said anode structure lying therebetween, defining a cavity resonator; a pair of spaced conducting members

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electrically connected to points of opposite polarity on each such cavity resonator; an electron-source disposed intermediate said conducting members for creating a space charge therebetween; means adjacent said electron-source and said conducting members for establishing a magnetic field transversely of the path between said electron-source and said conducting members; and means connected between said electron-source and said anode structure for varying the density of said space charge.

6. A tunable electron-discharge device comprising: a cathode; an anode structure, spaced from said cathode, and provided with a plurality of anode members; each pair of adjacent anode members, together with that portion of said anode structure lying therebetween, defining a cavity resonator; a pair of spaced conducting members electrically connected to points of opposite polarity on each such cavity resonator; an electron-source disposed intermediate said conducting members for creating a space charge therebetween; means adjacent said electron-source and said conducting members for establishing a magnetic field transversely of the path between said electron-source and said conducting members; and means connected between said electron-source and said anode structure for establishing a variable electric field between said electron-source and said conducting members.

7. A tunable electron-discharge device comprising: a cathode; an anode structure, spaced from said cathode, and provided with a plurality of anode members; each pair of adjacent anode members, together with that portion of said anode structure lying therebetween, defining a cavity resonator; a pair of spaced, annular conducting members electrically connected to points of opposite polarity on each such cavity resonator; an annular, electron-emitting electrode disposed intermediate said conducting members for creating a space charge therebetween; means adjacent said electron-emitting electrode and said conducting members for establishing a magnetic field transversely of the path between said electrode and said conducting members; and means connected between said electron-emitting electrode and said anode structure for varying the density of said space charge.

8. A tunable electron-discharge device comprising: a cathode; an anode structure, spaced from said cathode, and provided with a plurality of anode members; each pair of adjacent anode members, together with that portion of said anode structure lying therebetween, defining a cavity resonator; a pair of spaced, annular conducting members electrically connected to points of opposite polarity on each such cavity resonator; an annular, electron-emitting electrode disposed intermediate said conducting members for creating a space charge therebetween; means adjacent said electron-emitting electrode and said conducting members for establishing a magnetic field transversely of the electron-path between said electrode and said conducting members; and means connected between said electron-emitting electrode and said anode structure for establishing a variable electric field between said electrode and said conducting members.

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No references cited.