

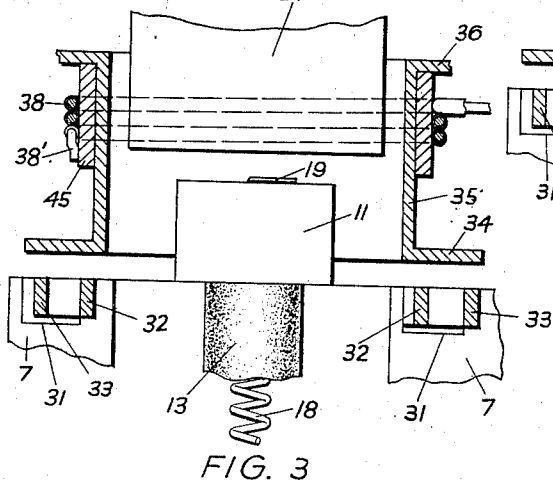
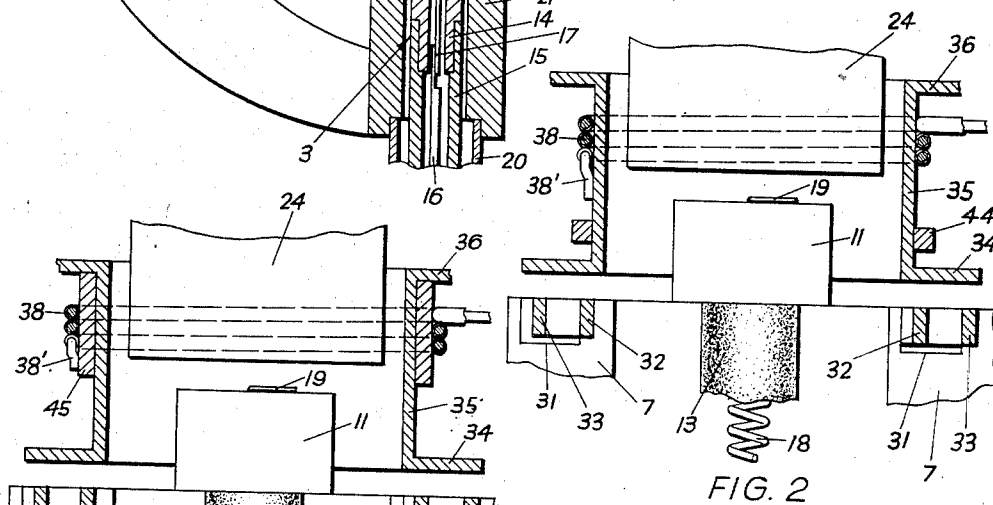
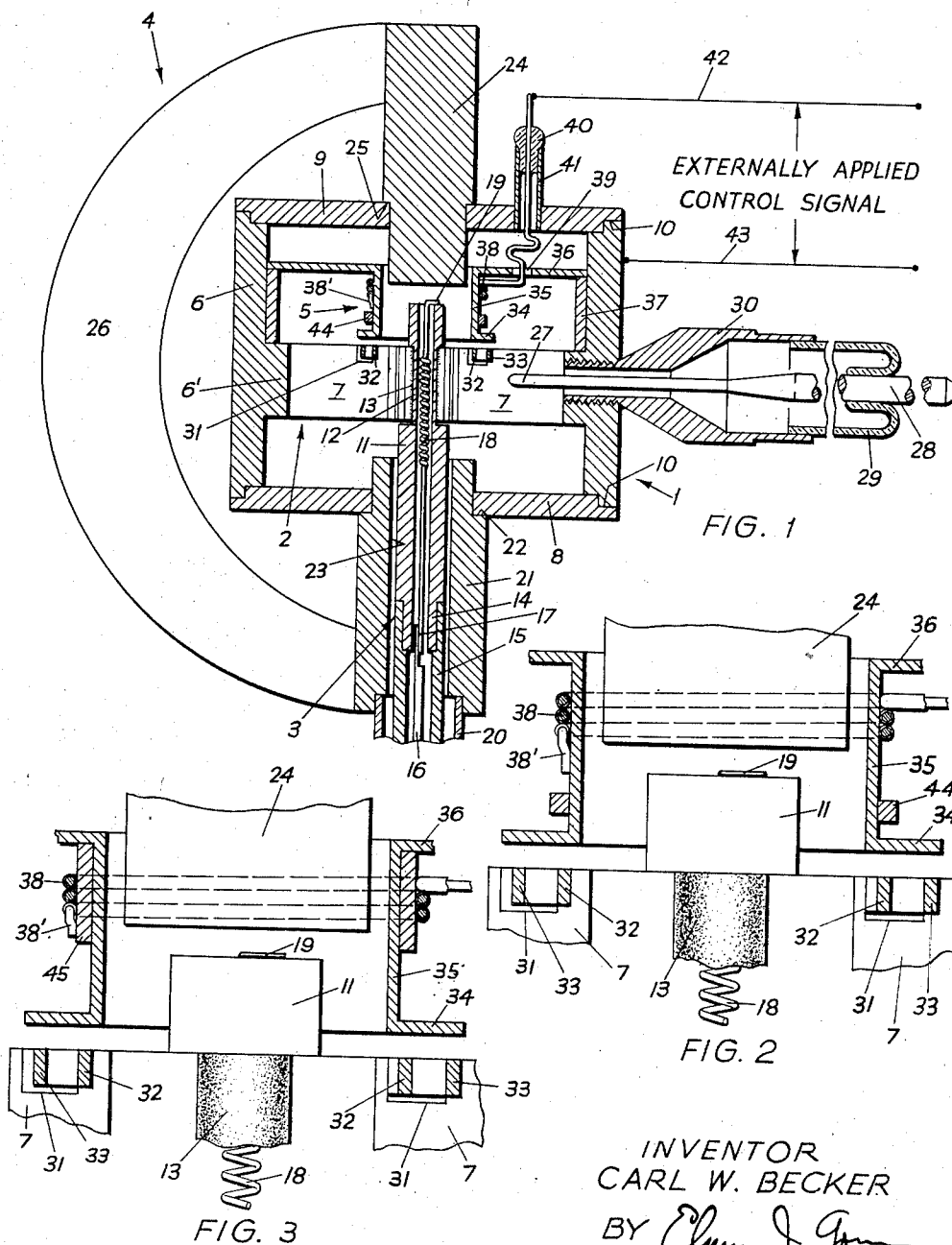
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TUNABLE MAGNETRON

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TUNABLE MAGNETRON

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This invention relates to electron-discharge devices, and more particularly to damping means for tunable electron-discharge devices.

While not limited thereto, the present invention is especially suitable for damping the tuning means used in electron-discharge devices of the so-called magnetron type.

An object of this invention is to provide movable means, for tuning an electron-discharge device in response to an external signal, which is aperiodic or which changes its position by one-way movements and not by a series of oscillations.

Another object is to provide a movable electron-discharge tube tuning device with means for damping out the natural resonant frequency of said movable device, whereby overshooting of said device on quick movements is prevented.

A further object is to so design said damping means that its operation utilizes the leakage field already existing in an electron-discharge device of the magnetron type.

The foregoing and other objects of the invention will be best understood from the following description of some exemplifications thereof, reference being had to the accompanying drawing, wherein:

Fig. 1 is a fragmentary longitudinal sectional view taken substantially through the center of a tunable magnetron made in accordance with the principles of the invention;

Fig. 2 is an enlarged, fragmentary view of a portion of Fig. 1; and

Fig. 3 is an enlarged, fragmentary view, similar to Fig. 2, but showing a modified form thereof.

The present invention constitutes an improvement over that described in my copending application, Serial No. 586,969, filed April 6, 1945.

Referring, now, more in detail to one of the illustrative embodiments of the present invention, and with particular reference to Figs. 1 and 2 of the drawing showing the same, the numeral 1 generally designates an electron-discharge device of the so-called magnetron type. Said device comprises an anode structure 2, a cathode structure 3, magnetic means 4 for establishing a magnetic field in a direction perpendicular to the path of the electron-flow between said cathode and anode structures, and tuning means 5.

In the device shown, the anode structure 2 includes a cylindrical body 6 made of highly conductive material, such as copper, said body being provided with an interior, annular boss 6', in turn provided with a multiplicity of radially-

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disposed, interiorly-extending anode members in the form of vanes 7, each adjacent pair of said vanes, together with that portion of said cylindrical body lying therebetween, constituting a resonant line, preferably, a quarter-wave line whose output end is shorted, and whose natural resonant frequency is, as is well known in the art to which the present invention relates, a function of the geometry of the physical elements making up the same. The anode members 7 will be further described when referring, in a later portion of this specification, to the details of the tuning means 5.

The anode structure 2 is closed at its ends, for example, by end plates 8 and 9, with the junctions between the cylindrical body 6 of said structure, and said plates 8 and 9, hermetically sealed, as at 10.

The cathode structure 3, which is coaxial with the anode structure 2, includes a cathode sleeve 11, conventionally made of nickel, or the like, provided with a reduced portion 12 whose length, preferably, is coextensive with the width of the anode members 7, said reduced portion 12 being provided with a highly electron-emissive coating 13, for example, of the well-known alkaline-earth metal oxide type.

In order properly to support the cathode sleeve 11 with respect to the anode members 7, said sleeve may be reduced, as at 14, to fit into an elongated, electrically-conductive tubular member 15. A glass seal (not shown) disposed within the tubular member 15, together with one or more glass beads (not shown) also disposed within said tubular member, supports a lead-in conductor 16 which passes through said member 15 and has its upper end connected, as at 17, to one terminal of a cathode heating filament 18. The other terminal of said filament may be connected, as at 19, to the cathode sleeve 11.

In order to convey current to the filament 18, the lead-in conductor 16 is connected by a conductor (not shown) to one terminal of a suitable source of E. M. F. (not shown), the other terminal of said source of E. M. F. being connected by a suitable conductor (not shown) to tubular member 15.

Cathode 3 is supported with respect to the anode structure 2, and insulated therefrom, by any suitable means (not shown), such, for example, as shown in my copending application referred to above. Said supporting and insulating means may include a tubular bushing 20 secured to a tubular pole piece 21, constituting one of the components of the magnetic means 4.

Said pole piece 21 may be hermetically sealed, as at 22, into the end plate 8, and be provided with a central bore 23 whereby the cathode structure 3 may enter the device.

Another tubular pole piece 24 may be hermetically sealed, as at 25, into the end plate 9, said pole piece and the pole piece 21 being fixed, for example, to the opposite ends of a horseshoe magnet 26 (only partially shown), whereby an appropriate magnetic field may be established, as previously indicated, in a direction perpendicular to the path of the electron-flow between the cathode structure 3 and anode structure 2.

Now, by suitably heating the cathode, and applying a proper potential between said cathode and the anode, the device can be made to generate electrical oscillations of a wavelength determined, primarily, by the capacitance and inductance built into said device as a function of the geometry thereof, and more especially, of the dimensions of the above referred to resonant lines defined by the anode structure.

In order to extract power from the device I may, for example, introduce a loop 27 into any one of the spaces defined by any two adjacent anode members 7, said loop coupling with the magnetic component of the above-mentioned electrical oscillations. Said loop may, in turn, be connected to a conductor 28 supported in a glass seal 29 fused into an outlet pipe 30, said pipe being threaded and hermetically sealed into the cylindrical body 6 of the anode structure 2.

Each anode member 7 is provided with a slot 31 adapted to receive concentric conducting straps 32 and 33 which are, in turn, adapted alternately to contact successive anode members. Said straps present a capacitance therebetween which enters into the determination of the natural resonant frequency of the device, and when the anode members are thus inter-connected, spurious oscillations which may be present are suppressed.

It has been found that, by moving another conducting member with respect to the anode members 7, or with respect to the straps 32 and 33 thereof, the distributed capacitance, or, with appropriate modifications, the distributed inductance, of the device, or both, may be altered whereby said device may be tuned to frequencies other than the natural resonant frequency thereof.

Said additional conducting member is provided in the form of an annular flange 34 formed at the lower end of a hollow, cylindrical core or reed 35. Said core is preferably made of a conducting material which has a relatively high Young's modulus, such as Nichrome, so that the core is stiff and when mounted has a relatively high natural resonant frequency. Said core or reed depends from a flexible diaphragm 36 which is secured, at its periphery, to a supporting ring 37, mounted within the body 6 upon the ledge presented by the boss 6' thereof. Wound upon the core and firmly secured thereto is a coil 38 of insulated wire, one end, 38', of said coil being electrically connected to the core, and the other end thereof passing through an opening 39 in the diaphragm 36, and out of the device, through a glass seal 40 fused into a pipe 41 which is hermetically sealed into the end plate 9.

The core 35 and the coil 38 carried thereby should be so disposed with respect to the pole piece 24 that said coil is within the leakage field existing between said pole piece 24 and the pole piece 21. Hence, upon application of an external

signal between conductors 42 and 43, respectively connected to the coil 38 and body 6, the current flowing in said coil, and the leakage field above referred to, interact to move said core, and the flange 34 carried thereby, with respect to the anode members 7. The result of this movement is, as previously indicated, an alteration of the distributed capacitance of the device, and a consequent tuning thereof.

In the device as thus far described, there is no provision for damping or braking the movements of the core or reed 35. As a consequence, when said reed is moved rapidly, it has a tendency to overshoot—that is, to go beyond its new rest position, after which it executes a series of mechanical oscillations, at its natural mechanical resonant frequency, about its new rest position, before it finally comes to rest at said position.

In order to eliminate or eradicate these movements, I proceed as follows:

Core 35 has mounted thereon, below coil 38 but within the leakage magnetic field of the device 1, a continuous metallic ring 44, preferably of copper, which acts as a short-circuited turn or damping ring. When core 35 moves in the leakage field of the device, ring 44 moves therein also, causing eddy currents to be produced in said ring, which currents, due to the extremely low resistance of said ring, produce an appreciable force which opposes the motion of the ring. Therefore, ring 44 acts as a magnetic brake or damping means for movements of core 35, serving to damp vibrations or oscillations of the core at its resonant frequency; as a result, the core is rendered aperiodic, so that on quick movements thereof, it will not overshoot its new rest position, but will change from its old to its new rest position by a one-way movement and not by a series of oscillations. The movements of the core are not damped to any noticeable extent by the material of the core itself, because the high resistance of Nichrome prevents the setting up of any substantial eddy currents therein.

As a result of the aperiodic characteristics of the moving tuning means, when the magnetron output is being frequency-modulated by an external signal, spurious frequency changes, which might be set up by oscillations of the moving core at its mechanical resonant frequency, are eliminated.

In the modification shown in Fig. 3 of the drawing, the electron-discharge device 1 is essentially the same as that shown in Figs. 1 and 2, and like parts have been designated with like reference numerals.

The difference between these two embodiments is in the damping means. In the modified damping means of Fig. 3, the coil 38 is wound on a copper bobbin 45, which bobbin is in the leakage field of the device 1; the bobbin 45 with the winding 38 thereon is slipped over the Nichrome reed or core 35.

Like the damping ring 44, the bobbin 45 is disposed within the leakage field existing between the pole pieces 21 and 24, and its mode of functioning (as a damping means) is, likewise, similar.

This completes the description of the aforesaid illustrative embodiments of the present invention. It will be noted from all of the foregoing that I have provided damping means for tuning means for an electron-discharge device of the magnetron type, which renders said tuning means aperiodic; which makes use of the

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leakage field already existing in such devices; and which damps out the natural resonant frequency of the moving tuning means, to thereby eliminate spurious movements of said tuning means.

Of course, it is to be understood that this invention is not limited to the particular details as described above, as many equivalents will suggest themselves to those skilled in the art. It is accordingly desired that the appended claims be given a broad interpretation commensurate with the scope of this invention within the art.

What is claimed is:

1. The combination with an electron discharge device which incorporates a cathode, an anode spaced from said cathode, and means for establishing a magnetic field in a direction substantially perpendicular to the path of the electron flow between said cathode and said anode, said device producing oscillations having a natural resonant frequency determined by the configuration of said device: of means, supported within said device and movable with respect to said anode, for tuning said device to a frequency other than said natural resonant frequency; and means, supported within said device by said movable means, for damping the movements of said movable means.

2. The combination with an electron discharge device which incorporates a cathode, an anode spaced from said cathode, and means for establishing a magnetic field in a direction substantially perpendicular to the path of the electron flow between said cathode and said anode, said device when energized producing oscillations having a natural resonant frequency determined by the configuration of said device: of means, supported within said device and movable with respect to said anode, for tuning said device to a frequency other than said natural resonant frequency; and additional highly electrically-conductive means, supported by said movable means within the path of the magnetic lines of force of said magnetic means, cooperable with said lines of force for damping the movements of said movable means.

3. The combination with an electron discharge device which incorporates a cathode, an anode spaced from said cathode, and means for establishing a magnetic field between said anode and said cathode in a direction substantially perpendicular to the path of the electron flow between said cathode and said anode: of a reed, supported within said device and movable with respect to said anode, for tuning said device; and additional highly electrically-conductive means, supported by said reed and cooperable with said magnetic field, for damping the movements of said reed.

4. The combination with an electron discharge device which incorporates a cathode, an anode spaced from said cathode, and means for establishing a magnetic field in a direction substantially perpendicular to the path of the electron flow between said cathode and said anode: of a reed, supported within said device and movable with respect to said anode, for tuning said device; and additional highly electrically-conductive means, supported by said reed within the path of the magnetic lines of force of said magnetic means, cooperable with said lines of force for damping the movements of said reed.

5. The combination with an electron discharge device which incorporates a cathode, an anode

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spaced from said cathode, and means for establishing a magnetic field in a direction substantially perpendicular to the path of the electron flow between said cathode and said anode: of a reed, supported within said device and movable with respect to said anode, for tuning said device; means, supported by said reed within the magnetic lines of force of said magnetic means and receptive of an external signal, for establishing a signal-responsive magnetic field cooperable with said lines of force for controlling the movement of said reed; and additional highly electrically-conductive means, supported by said reed, for damping the movements of said reed.

6. The combination with an electron discharge device which incorporates a cathode, an anode spaced from said cathode, and means for establishing a magnetic field in a direction substantially perpendicular to the path of the electron flow between said cathode and said anode: of a reed, supported within said device and movable with respect to said anode, for tuning said device; a coil, supported by said reed within the path of the magnetic lines of force of said magnetic means and receptive of an external signal, for controlling the movement of said reed; and additional highly electrically-conductive means, supported by said reed, for damping the movements of said reed.

7. The combination with an electron discharge device which incorporates a cathode, an anode spaced from said cathode, and means for establishing a magnetic field in a direction substantially perpendicular to the path of the electron flow between said cathode and said anode: of a reed, supported within said device and movable with respect to said anode, for tuning said device; a coil, supported by said reed within the path of the magnetic lines of force of said magnetic means and receptive of an external signal, for controlling the movement of said reed; and a shorted turn of highly electrically-conductive wire, supported by said reed within the magnetic lines of force of said magnetic means, cooperable with said lines of force for damping the movements of said reed.

8. The combination with an electron discharge device comprising an evacuated envelope containing a cathode, an anode spaced from said cathode, and means for establishing a magnetic field in a direction substantially perpendicular to the path of the electron flow between said cathode and said anode, said device producing oscillations having a natural resonant frequency determined by the configuration of said device: of means, supported within said device and movable with respect to said anode, for tuning said device to a frequency other than said natural resonant frequency; and a short-circuited low-resistance electrical-conductor turn, supported by said movable means within said evacuated envelope and the path of the magnetic lines of force of said magnetic means, for damping the movements of said movable means.

9. The combination with an electron discharge device comprising an evacuated envelope containing a cathode, an anode spaced from said cathode, and means for establishing a magnetic field in a direction substantially perpendicular to the path of the electron flow between said cathode and said anode, said device producing oscillations having a natural resonant frequency determined by the configuration of said device: of means, supported within said device and movable with respect to said anode, for tuning said

device to a frequency other than said natural resonant frequency; means, supported by said movable means within said evacuated envelope and the path of the magnetic lines of force of said magnetic means and receptive of an external signal, for establishing a signal-responsive magnetic field cooperable with said lines of force for controlling the movement of said movable means; and a short-circuited low-resistance electrical-conductor turn, supported by said movable means within said evacuated envelope and the magnetic lines of force of said magnetic means, for damping the movements of said movable means.

10. The combination with an electron discharge device comprising an evacuated envelope containing a cathode, an anode spaced from said cathode, and means for establishing a magnetic field in a direction substantially perpendicular to the path of the electron flow between said cathode and said anode: of a reed, supported within said device and movable with respect to said anode, for tuning said device; a coil, supported by said reed within the magnetic lines

of force of said magnetic means and receptive of an external signal, for controlling the movement of said reed; and a short-circuited low-resistance electrical-conductor turn, supported by said reed within said evacuated envelope and the path of the magnetic lines of force of said magnetic means, for damping the movements of said reed.

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