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J. P. QUITTER

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TUNING MEANS FOR MAGNETRONS

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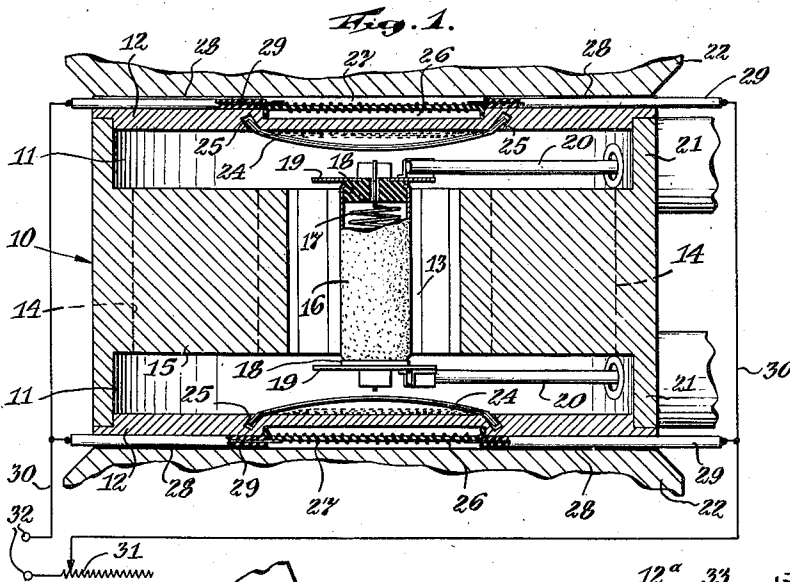


Fig. 3.

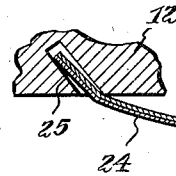


Fig. 4.

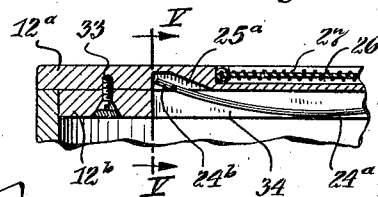


Fig. 5.

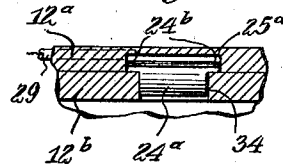


Fig. 6.

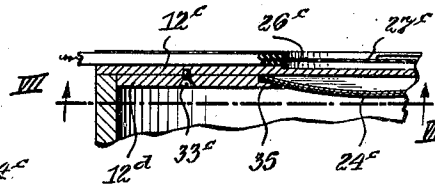


Fig. 2.

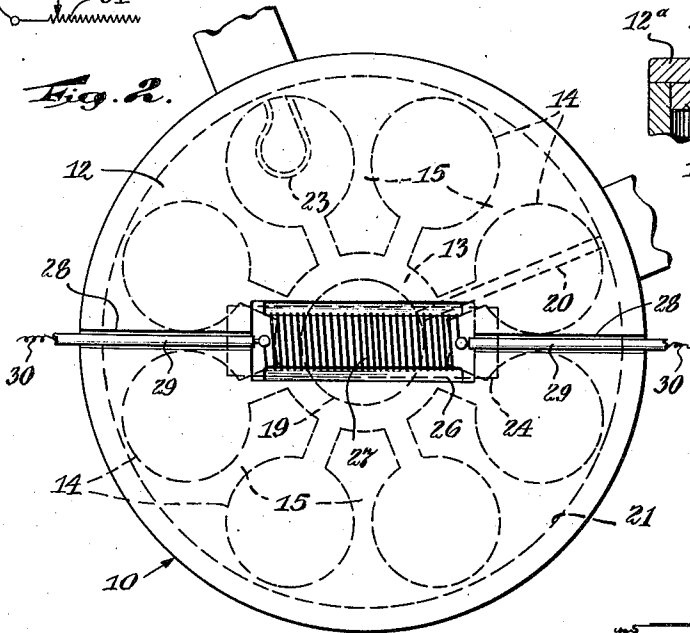
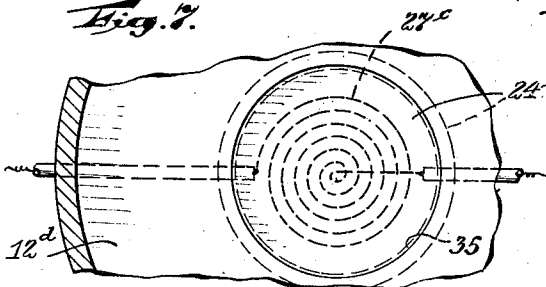


Fig. 7.



INVENTOR
J. P. QUITTER.
BY *J. P. Quitter*
ATTORNEY

UNITED STATES PATENT OFFICE

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TUNING MEANS FOR MAGNETRONS

John P. Quitter, Cincinnati, Ohio, assignor to
Westinghouse Electric Corporation, East Pitts-
burgh, Pa., a corporation of Pennsylvania

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13 Claims. (Cl. 250—27.5)

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This invention relates to magnetrons and more particularly magnetrons of the general character disclosed in prior applications assigned to the same assignee as the present application and filed in the names of E. C. Okress and I. E. Mouromtseff, S. N. 462,132, and E. C. Okress, S. N. 460,376.

Magnetrons of the character indicated provide a centrally disposed cathode circumferentially surrounded by an anode divided into segments by radiating resonant cavities. Fundamentally there must be at least two cavities, and in practice the number of cavities is in excess of two but even in number, such as four, six, eight and so on. Such magnetrons are fabricated by appropriate consideration of mathematical calculation to produce a definite rate of oscillation and wave-length of output. Inability to tune the magnetron after assembly is one of the outstanding deficiencies of this type of oscillator and imposes a limitation on use and adaptability of the magnetron in the field.

From a general aspect, the invention here involved is to provide for greater adaptability of the magnetron to fields of utility.

More specifically, the invention seeks to provide a magnetron which shall be tunable after assembly.

The invention accordingly contemplates provision of means for tuning a magnetron while in use and over a range of wave-lengths which will enable undesired wave-lengths to be tuned out and obtain oscillation at a distinctly different frequency.

In greater detail, an object of the invention is to accomplish tuning without extending any moving parts through the envelope, which, more generally stated is to avoid endangering the vacuum seal of the magnetron.

A further object of the invention is to afford electrical control of the tuning.

Yet another object of the invention is to employ heat expansion of a member within the magnetron to vary the internal capacitance for tuning purposes.

Of the same general character, an object of the invention is to provide a bimetallic heat-deformable member within the magnetron controlled by heat applied at will exterior to but effective within the magnetron cavity end-space.

Still further objects will appear as the description proceeds, both by direct recitation thereof and by implication from the context.

Referring to the accompanying drawing in

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which like numerals of reference indicate similar parts throughout the several views:

Figure 1 is a longitudinal-diametric sectional view of a magnetron showing my invention incorporated as part thereof;

Figure 2 is a plan of the magnetron;

Figure 3 is a sectional view corresponding to a small part of Fig. 1, on magnified scale, and showing the mounting of the deformable member in the magnetron end plate;

Figure 4 is a view similar to Fig. 3 and showing a modified construction of member and mounting therefor;

Figure 5 is a sectional view on line V—V of Fig. 4;

Figure 6 is a further sectional view similar to Fig. 3, and showing another construction of deformable member and heater therefor; and

Figure 7 is a sectional view on line VII—VII of Fig. 6, looking upward as indicated by the arrows.

In the specific embodiment of the invention illustrated in said drawing, and devoting attention initially to Figures 1 and 2, a magnetron body 10 is shown of generally cylindrical configuration and provided with end-spaces 11 sealed vacuum-tight by end-plates 12. Within the magnetron and in direct communication with and between said end-spaces, is an axial cavity 13 from which radiate suitable resonant cavities 14 thereby constituting a plurality of radiating segments 15 forming the split anode. Within and axially of the central or axial cavity 13 is a cathode 16, here shown as cylindrical and hollow for purposes of indirect heating thereof by a coiled heater 17 extending co-axially through the cathode. End insulators 18 are provided for the cathode, the ends of the heater extending through the insulators, and over the outer ends of the insulators are metallic plates 19 spaced by the insulators from the said cathode. The ends of the heater filament are connected to the said plates, and also connected to said plates are appropriate lead-in wires 20 sealed vacuum-tight where passing to the exterior of the magnetron. It is usual practice, and here so shown, to extend the lead-in wires 20 for the filament radially through the end spaces 11 and out through a flange portion 21 forming a rim at the edge of the body portion of the magnetron. In most respects, the magnetron as above-described is in accordance with the construction of magnetron shown in the joint application of E. C. Okress and I. W. Mouromtseff and sole application of E. C. Okress above identified. Such a magnetron, as in the present in-

stance, is appropriately associated with an electro-magnet the poles 22 of which are situated adjacent and on the outside of the magnetron end-plates 12. The poles should be very close to the end plates for maximum efficiency, and it is accordingly a desideratum of the present invention to avoid necessity of materially increasing such spacing.

In order to tune the frequency to an output 23, I provide means for varying the internal capacity of the magnetron. The means preferred is a metallic member 24 of deformable character, and in all views shown as a bi-metallic member deformable by application of heat thereto and capable of returning to original condition by discontinuance of the application of heat thereto. As shown, application of heat to the member causes it to retract from the electrodes, but it might likewise be situated with the two metals in reverse order and thereby caused to approach the electrodes when said member is heated.

According to the specific embodiment illustrated in Figures 1, 2 and 3, the metallic deformable member 24 is a strip of bimetal normally bowed lengthwise and having its ends inserted in sloping slots 25 cut in the inside of the end-plates or covers for the magnetron body. Said slots 25 do not extend through the covers and accordingly do not disturb or endanger the vacuum within the magnetron body. The metallic deformable member 24 fits loosely in slots 25, allowing freedom for the desired motion, without permitting unwanted vibrations or other uncontrollable movement. The length of slots 25 and deformable member 24 are such that once assembled, will not come apart of their own accord.

Location of the deformable member or bi-metallic strip is preferably in a diametric direction so that its middle part is directly opposed to the nearby end of the cathode and corresponding end of the heater filament. Since the flexing due to heat will be in a direction toward the cover, there is no likelihood of the strip engaging or electrically shorting with either the filament or cathode.

At the outside of the end plate or cover, extending in the same direction as the bimetallic strip, is shown an elongated hollow 26 receiving a fiat electrical resistance heater 27 therein. From the ends of said hollow are shown grooves 28 receiving lead-wires 29 for the heater. These lead wires are shown connected through a suitable circuit 30 including a rheostat 31 or other control device to terminals 32 representative of any desired source of electrical supply.

In use of a magnetron incorporating my invention, tuning is effected by applying a heating current through terminals 32, thereby heating the heating coil 27 which in turn transfers the heat by conduction through the thinned part of cover plate 12 to the adjacent bimetal strip or member 24. By virtue of the different coefficients of expansion of the metals constituting the said member, the heat causes the member to bend to a flatter condition, as indicated to maximum degree by the dotted line position. This change of position of the member with respect to the electrodes alters the inter-electrode capacity and therefore the frequency. Decrease of capacity increases the frequency and therefore decreases or instigates a shorter wave-length. Since in the present showing the deformable member is moved a greater distance from the electrodes as a result of its being heated, the capacity is lowered and the wave-length shortened. As shown, it is pref-

erable to employ a deformable member in each end-space 11, thereby giving greater range of change of frequency and wave-length. While both heaters for the two deformable members have been arbitrarily shown as connected in parallel and controlled by a single control means or rheostat, it is to be understood that other circuit arrangement may be provided for separately controlling the current to the heaters and thereby increase the delicacy of tuning by use thereof.

Furthermore, modifications as to the structure and mounting of the deformable member may be made within the scope of the invention. Considering first a modification of the mounting, reference will now be made to Figures 4 and 5 wherein the magnetron structure in general remains as before, the essential difference residing in the end plate. As shown, the end plate is composed of an outer lamination 12^a and an inner lamination 12^b secured flatwise together by screws 33 which do not pass entirely through both laminations and therefore do not jeopardize the vacuum within the envelope. The inner lamination has a slot 34 in a diametric direction substantially as long as bimetal strip or deformable member 24^a and approximately the same width as the body portion of said member. Said member, however, has lateral end tabs 24^b which overlap the face of the inner lamination and therefore prevent the ends of the member from being drawn through the slot. The outer lamination 12^a has a sloping slot 25^a for reception of said end and tabs of the deformable member. The other end of the deformable member is of like construction and similarly mounted. Since the tabs prevent dislodgement of the deformable member, the slot 25^a in this instance may provide for a loose engagement of the deformable member, thereby enabling the said member to deform under heat change with greater facility. A heater 27, as before is provided in proximity to and lengthwise of the deformable member at the exterior of the outer lamination in a groove 26 as before. Illustration of this form of the invention has been made to indicate an assembly of the two metals forming the deformable member such that said member will bow inward when heated and thereby increase the capacity and wave-length. The extra spacing afforded by the sloping slot enables the ends of the deformable member to slide closer together when the body of said member bows to a curvature of smaller radius.

Instead of employing a strip of bimetal to constitute the deformable member, a disc or other shape of bimetal may be employed, as shown in Figures 6 and 7. Here again, the cover plate is constructed as an outer lamination 12^c and an inner lamination 12^d held together by screw or other means 33^c. The inner lamination has a circular opening therethrough, the inner margin whereof has a peripheral ledge 35 projecting radially inward with respect to the opening and forming means for supporting the edge of a bimetal disc 24^c. A spiral form of heater 27^c is situated in a circular recess 26^c at the center part of the outer lamination 12^c in proximity to said bimetal disc, the heat from the heater passing through the thinned portion of the lamination and serving as before as means for deforming the disc or member 24^c. Whether the heat further bows the disc or causes it to become flatter depends upon relationship of the two metals constituting the bimetal disc. The invention contemplates either motion, although to prevent rattling and vibration of the deformable member, it

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is preferably made to peripherally fit the opening provided therefor, and in that event it is best that the deformation resulting from heat be a further bulging of the member with consequent increase in capacity with the magnetron electrodes and increase of wave length.

I claim:

1. A magnetron having electrodes therein and an end-plate opposite ends of the electrodes, said end plate having diametrically opposite and sloping slots in the inner face thereof, and a bimetal deformable member having ends mounted in said sloping slots said member having its middle part bowed away from the plate and adapted to be varied in amount of bowing thereof by change of heat effective thereon.

2. A magnetron having electrodes therein and an end-plate opposite ends of the electrodes, said end plate having diametrically opposite and sloping slots in the inner face thereof and a bimetal deformable member having ends mounted in said sloping slots said member having its middle part bowed away from the plate and adapted to be varied in amount of bowing thereof by change of heat effective thereon, said bimetal member substantially fitting within said slots and held substantially immovable therein.

3. A magnetron having electrodes therein and an end-plate opposite ends of the electrodes, said end plate having diametrically opposite and sloping slots in the inner face thereof, and a bimetal deformable member having ends mounted in said sloping slots said member having its middle part bowed away from the plate and adapted to be varied in amount of bowing thereof by change of heat effective thereon, said bimetal member being free to move in said slots as the bimetal member bows.

4. A magnetron having electrodes therein and a laminated end-plate opposite ends of the electrodes, the inner of the laminations of said end-plate having a diametrically disposed slot and the next adjacent lamination having sloping slots directed into said diametrically disposed slot, and a deformable strip having tabs located in said sloping slots and a bowed body portion extending from said sloping slots into the said diametrically disposed slot.

5. A magnetron having electrodes therein and a laminated end-plate opposite ends of the electrodes, the inner of the laminations having an opening therein opposite the ends of the electrodes, said opening having a peripheral ledge next its inner face, and a deformable disc having its margin carried by said ledge, and the mid-part of said disc being free to bow toward and from the said electrodes.

6. A magnetron having electrodes therein, and capacity-changing means in said magnetron, said means comprising a strip of bimetal entirely within said magnetron and having capacitative coupling with and extending crosswise of the ends of said electrodes, said bimetal strip being deformable by heat and thereby changeable in its physical and capacitative relationship to said electrodes.

7. A magnetron comprising an anode body symmetrical about an axis and having flanges at the ends of said body projecting coaxially thereto beyond the anode body, end plates on said flanges closing the ends of said magnetron and providing end spaces between said body and end plates, said anode body having an axially central cavity therethrough opening into said end spaces and having resonant cavities paralleling

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the central cavity and opening at their ends into said end spaces and opening laterally into said central cavity, a cathode in the central cavity, one of said end plates having an opening only partially through said plate at the inside thereof, a capacitative member entirely within said magnetron and having a part thereof located in said opening and a part projecting from said opening into said end space, and means carried by said one of said end plates adjacent said member for varying the relation of said member with respect to the anode body.

8. A magnetron comprising an anode body symmetrical about an axis and having flanges at the ends of said body projecting coaxially thereto beyond the anode body, end plates on said flanges closing the ends of said magnetron and providing end spaces between said body and end plates, said anode body having an axially central cavity therethrough opening into said end spaces and having resonant cavities paralleling the central cavity and opening at their ends into said end spaces and opening laterally into said central cavity, a cathode in the central cavity, one of said end plates having an opening only partially through said plate at the inside thereof, a capacitative member entirely within said magnetron and having a part thereof located in said opening and a part projecting from said opening into one of said end spaces, and a heater carried by said one of said end plates for expanding said member and thereby varying the relation of said member with respect to the anode body in a direction longitudinally of the cathode.

9. A magnetron having a central cavity, a circular series of equally spaced segments radiating from said cavity and providing a circular series of equally sized and equally spaced resonant cavities therebetween paralleling said central cavity, end plates providing complete closures at opposite ends of the magnetron and opposite the ends of both said central cavity and resonant cavities and spaced therefrom thereby providing end spaces within said magnetron, said central cavity and resonant cavities opening at their ends into said end spaces for coupling the magnetic fields of the resonant cavities, a capacitative member entirely within said magnetron and having a part thereof within one of said end spaces for varying the effective magnetic fields of the resonant cavities, and means supporting said member movably and confining movement of said member substantially to a direction longitudinally to all said cavities.

10. A magnetron comprising an anode body having flanges at its periphery in continuation of the peripheral surface of said body, end plates on said flanges closing the ends of said magnetron and providing end spaces between said anode body and end plates, said anode body having a central cavity and cavity resonators paralleling each other and axially at right angles to the said end plates and opening into said end spaces, a cathode in said central cavity, and a capacitative member entirely within said magnetron mounted on one of said end plates at the inside thereof and with only the opposite ends of said member in contact with said one of said end plates, the entire mid portion between said opposite ends of said member being flexible and movable toward and from the anode body for varying the capacitative relation of said member to the anode and cavity resonators by flexure of the member itself.

11. A magnetron having electrodes therein,

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and capacity-changing means in said magnetron, said means comprising a strip of bimetal entirely within said magnetron and having capacitative coupling with and extending crosswise of one of said electrodes, said bimetal strip being deformable by heat and thereby changeable in its physical and capacitative relationship to said one of said electrodes, and a heater in proximity to and paralleling said strip of bimetal for obtaining desired deformation of said strip by application of heat thereto.

12. A magnetron having electrodes therein, and capacity-changing means in said magnetron, said means comprising a strip of bimetal entirely within said magnetron and having capacitative coupling with and extending cross-wise of one of said electrodes, said bimetal strip being deformable by heat and thereby changeable in its physical and capacitative relationship to said one of said electrodes, and a heater exterior to said magnetron and in proximity to and paralleling said strip of bimetal for obtaining desired deformation of said strip by conduction of heat thereto from said heater.

13. In a magnetron having an anode body and an end plate closing an end of the magnetron and having an end space between said anode body

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and end plate, a heat-variable capacitative member entirely within said magnetron and carried at the inner side of said end plate, and a heater entirely exterior to the magnetron and carried at the outer side of said end plate in proximity to said member for conduction of heat by said end plate from said heater to said member.

JOHN P. QUITTER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,408,237	Spencer	Sept. 24, 1946
2,374,810	Fremlin	May 1, 1945
2,027,367	Blair	Jan. 14, 1936
2,115,521	Fritz et al.	April 26, 1938
2,288,812	Linder	July 7, 1942
1,884,591	Davis	Oct. 25, 1932
1,969,955	Thomas	Aug. 14, 1934
2,252,118	Dallenbach et al.	Aug. 12, 1941
2,167,201	Dallenbach	July 25, 1939
1,559,714	Lilienfeld	Nov. 3, 1925
2,216,170	George	Oct. 1, 1940