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ELECTRON DISCHARGE DEVICE OF THE CAVITY RESONATOR TYPE

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Fig. 1.

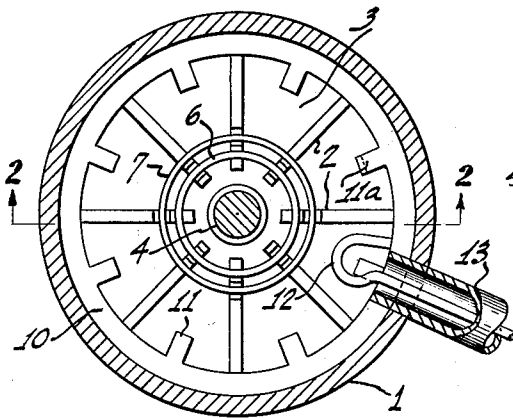


Fig. 3.

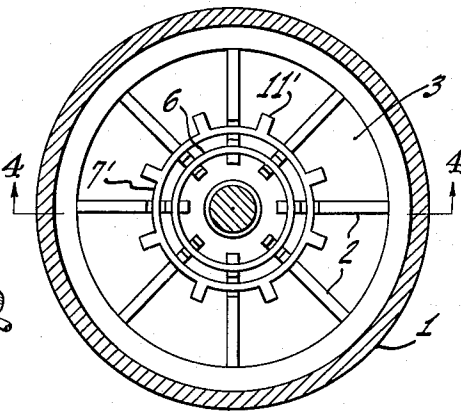


Fig. 2.

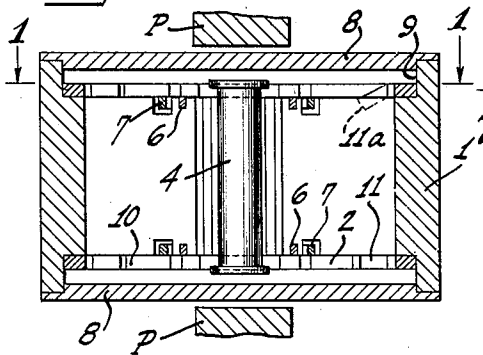
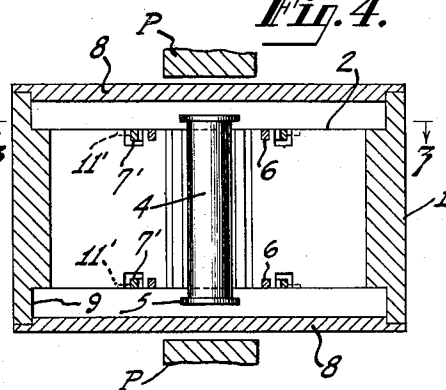


Fig. 4.



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ELECTRON DISCHARGE DEVICE OF THE
CAVITY RESONATOR TYPEWellesley J. Dodds, Cranbury, N. J., assignor to
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15 Claims. (Cl. 315—39)

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My invention relates to high frequency electron discharge devices employing cavity resonators, and particularly to such devices of the magnetron type, although not limited to the latter.

It is the object of my invention to provide means for pre-tuning cavity resonators during or after manufacture thereof.

In magnetron oscillators of the cavity resonator type, the generated frequency is determined largely by the form and dimensions of the cavity resonator structure, as distinguished from earlier magnetrons of the single or plural anode plate types wherein the generated frequency is determined by the distributed inductance and capacitance of the anode circuit. Hence, the resonant frequency of the cavity resonator magnetron is necessarily limited during manufacture to a given value, or at least to a rather limited range of values. However, the resonant frequency can be varied within certain limits after manufacture of the magnetron by deforming the cavity resonator structure or moving conducting members toward or away from the cavity resonators. In conventional cavity type magnetrons the cavity resonators are usually formed by conducting anode vanes or walls which extend radially inward from a cylindrical anode ring or shell and define a cylindrical cathode space at their inner ends. The outer closed end of each cavity resonator constitutes a predominantly inductive region and the inner open end constitutes a predominantly capacitive region.

In accordance with my invention, I provide adjacent either the inductive or capacitive regions one or more conducting elements movable a predetermined amount into or out of these regions in order to pre-tune the cavity magnetron to a desired frequency, either during or after manufacture thereof.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims, but the invention itself will best be understood by reference to the following description taken in connection with the accompanying drawing in which Fig. 1 is a transverse section, taken along the line 1—1 of Fig. 2, of a cavity resonator magnetron embodying my invention; Fig. 2 is a longitudinal section taken along the line 2—2 of Fig. 1; and Figs. 3 and 4 are sections similar to Figs. 1 and 2, respectively, of a modification.

Referring to Figs. 1 and 2, a cylindrical vane-type cavity resonator magnetron is shown in

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which 1 is a cylindrical metal shell provided with a cylindrical aperture therethrough. A series of evenly spaced metal vanes 2 is attached to the shell 1 within said aperture to extend radially inwardly, with the inner ends spaced from the axis of the shell to form a cylindrical central cathode space. The vanes 2, together with the inner wall of the shell 1, provide cavity resonators 3 uniformly disposed around the cathode space and opening thereinto. The inner ends of the vanes 2 constitute equally-spaced parallel anode segments.

An elongated thermionic cathode 4, which may be indirectly heated, is centrally mounted, in insulated relation to the anode structure, in the cathode space by suitable means, not shown. End plates or "hats" 5 are provided at the ends of the cathode to serve as electrostatic shields for the ends of the cathode space. The cathode 4 is adapted when heated to supply electrons in the cathode space for exciting the cavity resonators in a manner to be described.

The anode vanes may be strapped together, in order to favor operation of the magnetron in the so-called π mode in which adjacent cavity resonators oscillate at 180° phase difference, by means of conducting strapping rings 6 and 7. The ring 6, located near the inner ends of the vanes 2 is attached to alternate vanes and passes freely through notches in the other alternate vanes. Similarly, the ring 7 is attached to the other alternate vanes outside of the ring 6 and passes freely through notches in the vanes to which the ring 6 is attached.

In order to complete a vacuum enclosure for the magnetron, the cylinder 1 is recessed at each end as shown at 9 and end plates 8 are sealed to the ends of the cylinder by suitable means such as brazing.

Means for producing a magnetic field in the cathode space axially thereof is provided. Such means may consist of magnet pole pieces P disposed outside the end plates 8, as shown in Fig. 2. Any other suitable means, such as an electromagnet coil coaxially disposed with respect to the anode structure, may be used instead of the pole pieces P.

The operation of the magnetron described thus far is conventional. The anode structure, including the cylinder 1 and vanes 2, is biased positively with respect to the cathode and electrons supplied by the cathode 4 and attracted toward the positive anode structure are deflected by the axial magnetic field and caused to follow spiral paths within the cathode space. When

the potential of the anode and the strength of the magnetic field are suitably chosen, the cloud of electrons sweeps past the anode segments at the inner end of the vanes 2 and induces radio frequency voltages in the anode segments, and an oscillatory electromagnetic field is set up in each of the cavity resonators, at a frequency determined by the apparent inductance and capacitance of the anode resonator structure. Since the resonators are coupled together through the cathode space and around the lateral edges of the vanes through the end spaces of the magnetron the resonant frequency of the magnetron is the same for all of the resonators even though the resonators may differ slightly in shape or size.

In accordance with the invention, in order to provide means for changing the resonant frequency of the cavity resonators after manufacture, a metallic tuning member or ring 10 is fixedly mounted in the recessed portion 9 at each end of the shell 1 adjacent the lateral edges of the vanes 2, as shown in the drawing. The rings 10 are provided with deformable tuning elements in the form of inwardly-projecting integral lugs or tabs 11 each of which is disposed adjacent the rear end of a cavity resonator 3. Each of the lugs 11 is bendable out of the plane of the ring 10 toward or away from the corresponding cavity resonator 3. In the drawing only one of the lugs, 11a, is shown bent into the corresponding cavity resonator 3. However, it is understood that preferably all of the lugs 11 would be bent an equal amount either toward or away from the cavity resonators, depending upon whether it is desired to increase or decrease the resonant frequency. Since the lugs 11 in Figs. 1 and 2 are disposed adjacent the outer ends of the cavity resonators, the change is made in the apparent inductance of the cavity resonators. When the lug is bent into the cavity resonator, the apparent inductance is decreased which causes an increase in the resonant frequency of the cavity resonator. Bending the lug out of the cavity resonator increases the apparent inductance and decreases the resonant frequency.

High frequency energy may be extracted from the anode cavity resonator structure by any suitable means, such as a coupling loop 12 forming a part of a coaxial transmission line 13.

Instead of changing the apparent inductance, the apparent capacitance of the cavity resonator may be changed by locating a tuning member or ring adjacent the inner, predominantly capacitative region of the cavity resonators. This modification of the invention is shown in Figs. 3 and 4 wherein the same reference numerals are applied to the parts identical with the corresponding parts illustrated in Figs. 1 and 2. In this form, bendable tuning lugs 11' are provided integral with the outer strapping ring 7' which serves also as the tuning member. The lugs 11' may have the same thickness as the ring 7', but preferably are made thinner, as shown in Fig. 4, to render them more flexible. As in Fig. 1, the cavity resonator is tuned by bending the lugs 11' into or out of the cavity resonators. When the lugs 11' are bent into the cavity resonators, the apparent capacitance of the cavity resonators is increased, resulting in a decrease in the resonant frequency. It is of course understood that the lugs 11' could be provided on the inner strapping ring 6 if desired.

In either of the modifications shown the tuning ring may be incorporated in a conventional magnetron of the type shown. This may be done at

the time of manufacture and assembly of the parts of the magnetron, to pre-tune the magnetron, and also to provide means for tuning the magnetron to a desired frequency after manufacture. Instead, the ring may be incorporated in a magnetron of the type shown after manufacture. In either case, this structure provides a simple means for tuning the magnetron cavity resonator structure without deforming the cavity resonator structure itself, as has been done previously.

A convenient and easy method of setting the lugs of the tuning ring is to provide a machine having a horizontal support for the tuning ring, or the magnetron block with the tuning ring attached, and a vertically-movable carriage having a circular series of projections arranged to engage the bendable lugs 11 of the tuning ring 10. By moving the carriage a predetermined amount it is thus possible to bend all of the lugs 11 the same amount out of the plane of the ring, to pre-tune the cavity resonator structure to a predetermined desired frequency. In this way a large number of magnetrons may be tuned to the same frequency in a mass production manner and the frequency may be changed to a different desired frequency merely by changing the limit of travel of the carriage.

While the invention has been described as applied to a cavity resonator magnetron for the purpose of illustration, the principles thereof have wider application. The invention can be applied to other electron discharge devices employing cavity resonators, for example, to velocity modulation tubes.

Hence, it will be understood that various changes and modifications may be made without departing from the spirit and scope of the invention as set forth in the following claims.

What I claim as new is:

1. An electron discharge device comprising a cavity resonator having predominantly inductive and capacitative regions therein determining its normal resonant frequency, and means for changing said resonant frequency comprising a conducting member rigidly mounted adjacent but outside of said resonator and having a deformable tab disposed adjacent one of said regions and bendable into or out of said one of said regions to change the reactance thereof.

2. An electron discharge device according to claim 1, wherein said deformable tab is adjacent and bendable into or out of said predominantly inductive region.

3. An electron discharge device according to claim 1, wherein said deformable tab is adjacent and bendable into or out of said predominantly capacitative region.

4. An electron discharge device comprising a series of similar adjacent cavity resonators open at one end and closed at the other, said open and closed ends constituting predominantly capacitative and inductive regions, respectively, determining the normal resonant frequency of the resonators, and means for changing said resonant frequency comprising a conducting strip mounted adjacent but outside of one end of said resonators and having a deformable tab bendable into or out of said resonators to change the reactance thereof.

5. An electron discharge device according to claim 4, wherein said strip is mounted adjacent the closed ends of said resonators to change the effective inductance thereof.

6. An electron discharge device according to

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claim 4, wherein said strip is mounted adjacent the open ends of said resonators to change the effective capacitance thereof.

7. A magnetron anode structure comprising a plurality of similar radially-extending cavity resonators closed at their outer ends and opening into a central cathode space, the closed and open ends of said resonators constituting predominantly inductive and capacitative regions, respectively, determining the normal resonant frequency of said resonators, and means for changing said resonant frequency comprising a conducting ring mounted adjacent one end of said resonators and having deformable tabs bendable into or out of said resonators to change the reactance thereof.

8. A magnetron anode structure according to claim 7, wherein said ring is mounted adjacent the closed ends of said resonators to change the effective inductance thereof.

9. A magnetron anode structure according to claim 7, wherein said ring is mounted adjacent the open ends of said resonators to change the effective capacitance thereof.

10. A magnetron anode structure comprising a cylindrical block having a central aperture, a plurality of spaced, radially extending anode vanes mounted in said aperture and spaced from the central axis of said block and forming an annular series of similar cavity resonators closed at their outer end and opening into a central space, the closed and open ends of said resonators constituting predominantly inductive and capacitative regions, respectively, determining the normal resonant frequency of said resonators, means comprising a conducting ring mounted adjacent one end of said resonators, and means for changing said resonant frequency comprising radially-extending deformable tabs integral with

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said ring and bendable into or out of said resonators to change the reactance thereof.

11. A magnetron anode structure according to claim 10, wherein said ring is connected to the lateral edges of alternate ones of said anode vanes adjacent the inner ends thereof, whereby said ring serves also as a strapping ring for favoring operation of said magnetron in the π -mode wherein adjacent resonators oscillate 180° out of phase.

12. A tuning member for a cavity magnetron comprising a conducting ring having a plurality of evenly spaced integral tabs normally lying in the plane of said ring, said tabs being bendable to a position partially out of said plane.

13. A magnetron tuning member according to claim 12, wherein said tabs project inwardly from said ring.

14. A magnetron tuning member according to claim 12, wherein said tabs project outwardly from said ring.

15. A magnetron anode structure according to claim 10, wherein said ring is mounted on said cylindrical block adjacent but outside of said closed ends of said resonators and said tabs are movable into or out of said predominantly inductive regions to change the effective inductance thereof.

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