Sept. 21, 1948. H. L. STEELE, JR 2,449,794

ELECTRON DISCHARGE DEVICE

Filed Oct. 12, 1944

Fig. 1.

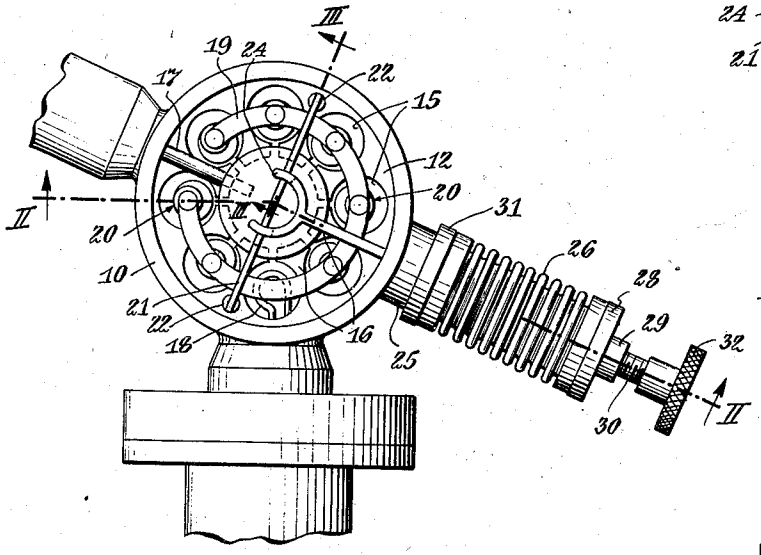


Fig. 3.

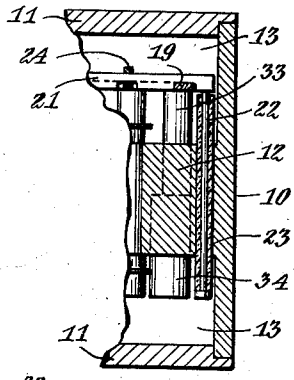


Fig. 4.

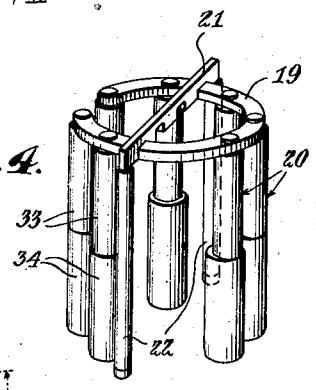


Fig. 2.

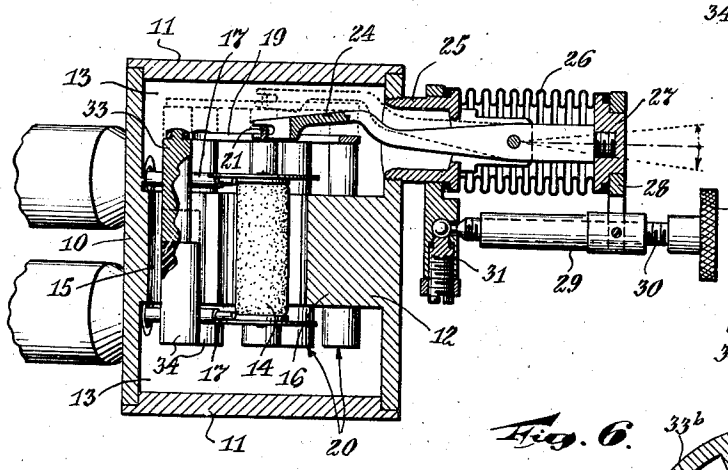


Fig. 7.

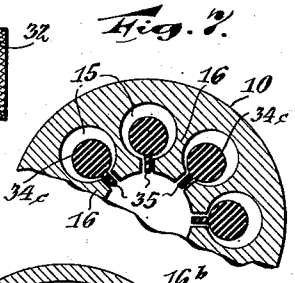


Fig. 6.

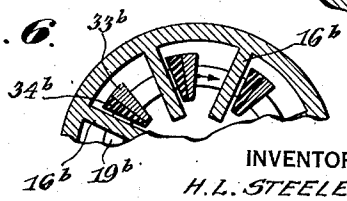
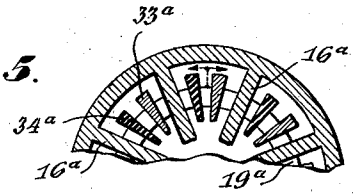


Fig. 5.



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ELECTRON DISCHARGE DEVICE

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This invention relates to electron discharge devices of the character known as magnetrons, and more particularly to tuning means for the same.

A recent development in this art has been termed "crown of thorns" as somewhat descriptive of a tuning means for a magnetron, and consists of a plurality of metallic prongs, one in each of several resonant cavities of a magnetron, and carried from a movable support so the several prongs may be moved longitudinally and simultaneously in the cavities. Presence of metallic prongs of such a device raises the resonant frequency of the output from the normal frequency the device would have without the prongs or with the prongs withdrawn, but provides no means for lowering the resonant frequency to one below the normal frequency of the device.

Broadly stated, then, an object of the present invention is to provide a tuning means for a magnetron which will accomplish tuning by a "crown of thorns" construction in a wider range than accomplished by the known device.

Likewise of general nature, the invention contemplates tuning means, which will tune to a frequency lower than the normal resonant frequency of the magnetron.

More in detail, the invention has for an object to provide a movable tuning means within a magnetron which may be tuned either to frequencies above or below normal resonant frequency of the magnetron.

Another object of the invention is to effect progressive tuning or frequency change in either direction from normal resonant frequency of the magnetron.

Other objects of the invention will appear to those skilled in the art as the description progresses, both by direct recitation thereof and by inference from the context.

Referring to the accompanying drawings in which like numerals of reference indicate similar parts throughout the several views;

Figure 1 is a plan with cover or end plate removed of a magnetron constructed in accordance with and showing the tuning means of the present invention;

Figure 2 is a sectional view taken on line II—II of Fig. 1, but with the cover or end plate in position;

Figure 3 is a detail sectional view of a part of the magnetron as on line III—III of Fig. 1, showing ring-supporting means;

Figure 4 is a perspective view of the ring and its associated prongs and supporting means;

Figures 5 and 6 are cross sectional views of

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modified constructions of magnetron cavities and showing two modified constructions of tuning means therein; and

Figure 7 is a cross sectional view of magnetron cavities of the type shown in Figure 1, but with a modified construction of tuning means therein.

In its general aspects and applicable to all constructions herein shown, the invention provides movable means within one of the end spaces of the magnetron here shown as a discontinuous ring from which extend a plurality of tuning elements. Each tuning element passes longitudinally into one of the resonant cavities of the magnetron, and is shown as in part comprising a metallic portion and in part a dielectric portion and each portion is at least in part always within the cavity. While the drawing shows one of the tuning elements in each resonant cavity except the one having the output loop therein, it is within the scope of the invention to utilize the tuning elements in any number of the resonant cavities desired and for range of tuning which the number employed will accomplish.

Referring now specifically to the embodiment of the invention illustrated in the several figures, the reference numeral 10 designates a cylindrical metallic magnetron body the ends whereof have cover or end plates 11 sealed thereon that the interior may be evacuated. Within and as an integral part of said body is the usual magnetron anode structure 12 of generally cylindrical shape but shorter than the outer part of the body so as to provide end spaces 13 between the anode and said end plates 11. The anode structure is axially hollow to provide a cathode cavity for a cathode 14 and radiating from this cathode cavity are a plurality of resonant cavities 15, each having, in the forms shown in Figures 1 to 3 inclusive, a cylindrical portion parallel to the cathode cavity. The walls between cavities are generally designated segments or vanes 16. The ends of the cathode cavity and the ends of said resonant cavities, in all forms shown, open into the end spaces 13. Cathode 14 passes axially through the cathode cavity, adequately spaced from the anode, and is supported as usual from lead-in rods 17 entering the end cavities at the sides thereof. An output loop 18 is situated in one end space, passing out through the side wall of the body portion.

In carrying out the present invention, the tuning means includes a crown, shown alone in Fig. 4, said crown being fabricated with a broken or partial ring 19, which may be either of metal or of insulator material, centered on an axis which in use is coaxial with the axis of the cath-

ode and anode of the magnetron. When the crown is assembled in the magnetron, said ring is within one aforementioned end space 13. Projecting from the ring, in parallelism to the said axis, are a plurality of metallic prongs 20 evenly spaced in an annular series, except that there may be one prong omitted in the series corresponding to the cavity having the output loop, but otherwise there is shown one prong on the ring for each resonant cavity 15 of the magnetron. The number of prongs employed, however, may be varied as desired. All of the prongs have the same relation to their respective resonant cavity walls or vanes at any given position of the crown, and movement axially of the crown makes a corresponding change of position for all of said prongs with respect to the fixed vanes. For instance, one position of the crown vanes is shown in solid lines in Fig. 2 and another position thereof is shown by adjacent dotted lines. Furthermore, the prongs are free of contact from the cylindrical wall of the magnetron body as well as from the cavity walls or vanes.

The crown has, as a part thereof, a mount by which it is retained coaxial, and in Figures 1–4 is shown supported to be movable or slidable axially. Said mount is illustrated as providing a cross-bar or yoke 21 diametrically across and secured to the ring and extending therebeyond where depending guide rods or legs 22 are rigidly attached. The cross-bar or yoke 21 may be metal or insulative material, and said legs 22 may likewise be insulative. As shown, said legs are constructed with metal cores having insulating sleeves held thereon in suitable manner. Use of such insulation as well as use of insulating material for the rings and yoke have the advantage that they will avoid setting up induction current flow and likewise will insure that the operating means described herein below may be at ground direct current potential. Said legs 22 slide in holes 23 in the magnetron body portion and not only prevent rotation of the crown in Figs. 1 to 4 but also keep the ring perpendicular to the axis of the magnetron body.

In order to slidably adjust the crown for tuning purposes, a lever 24 is shown as having an inner forked end each tine of which is bifurcated for engaging above and below said cross-bar or yoke 21, said lever projecting in a generally radial direction from engagement with said yoke to a distance outside of the magnetron body. Said lever, however, is enclosed within a housing 25 which includes a flexible portion 26 by which vacuum sealing of the magnetron interior is maintained but by which said lever is permitted to pass to the exterior and be there under control of the operator. Pivoting of said lever is effected by a suitable pivot pin crosswise of a saw-slit boss forming part of said housing and located within said flexible portion 26.

Inasmuch as said lever 24 must be held securely in adjusted position, retaining as well as adjusting means are provided for the purpose. As shown, the lever has a head 27 thereon to which flexible housing portion 26 is secured and also on which is secured a bracket 28 which provides a forked end laterally of the lever. A sleeve 29 extending in the same general direction as the lever is pivotally carried by said forked end of bracket 28 so as to swing in the same plane in which the lever swings. Longitudinally through the sleeve, and in threaded engagement therewith, is an adjusting screw 30 having a ball and socket connection with a bracket 31 fixed with respect to the magnetron. The outer end of the adjusting screw has a knurled knob 32 or other convenient manipulation means. By appropriate operation of the said knob, lever 24 is swung up or down and the crown prongs 20 correspondingly raised or lowered.

Said prongs are formed each with an upper and a lower portion 33, 34 respectively of different material. As shown, the upper portion 33, which depends to approximately mid height of the cavity when the lever is at its neutral or mid-position, is preferably coaxial with the cavity and is metallic. The lower portion 34 of the prong is shown of greater diameter than the upper portion 33 and is axially eccentric thereto and of insulative or dielectric material. The eccentricity is in a direction which locates the prong portion closer to the cavity wall at the side thereof having the gap opening into the cathode cavity, that is, so the dielectric prong portion is close to and parallel with said gap. It is within the scope of my invention to omit the metallic portion of the prong, and apply the dielectric portion directly to the ring, or to interchange the metallic and dielectric portions. Furthermore, as shown in Figure 7, the dielectric portion 34c may be provided with a longitudinal rib 35 within the constricted portion of the resonant cavity where it will intercept the most concentrated region of magnetic E-lines and has a more pronounced capacitative effect. In this connection it will now be understood that eccentricity of the dielectric portion as shown in Figs. 1–4 as well as eccentricity and rib of Fig. 7, situates the dielectric in closer proximity to the region of highest capacity, and presence of the dielectric thereat has the greatest effect in lowering the resonant frequency of the device.

Presence of a metallic prong in a resonant cavity tends to raise the output frequency, whereas presence of a dielectric prong therein tends to lower the output frequency. At neutral position of the prongs in the cavities with appropriate distribution of metal and dielectric of the compound prong located in the cavities, the output frequency is substantially that for which the magnetron is designed for normal output. By lowering the prongs more of the metal portions thereof and less of the dielectric will be located in the cavities, thereby raising the frequency. Similarly, by raising the prongs, more of the dielectric portions and less of the metallic portions of the prong will be located in the cavities, thereby lowering the frequency. The transition of the metallic and dielectric portions in and out of the cavities is inverse and progressive, so that desired tuning may be obtained over a wide range above and below normal.

Instead of moving the combined metallic and dielectric prong longitudinally of the cavity, much the same effect can be secured by changing the relative relationship of the combination in respect to the side wall of the cavity. Thus, in Figures 5 and 6 the prongs are mounted on a ring 19a and 19b respectively, which oscillates on its axis, thereby moving one side or the other of each prong toward the cavity wall or vane 16a or 16b. In these two figures, the prongs are constructed with longitudinally adjacent metallic portions 33a and 33b and dielectric portions 34a and 34b, the showings differing in that said metallic and dielectric portions 33a and 34a in Figure 5 are spaced from each other, whereas in Figure 6 they are in contact with each other. Lateral displacement in one direction will bring

the metallic portion closer to its next contiguous vane, or cavity wall, whereas displacement in the opposite direction brings the dielectric portion closer to its next contiguous vane, or cavity wall, this difference in relation of metallic or dielectric portion to the respective vane having much the same effect as variation of the amount of each portion of the prongs longitudinally introduced as above described in connection with Figures 1 to 4 inclusive.

I claim:

1. A cavity resonator with a side wall, tuning means therefor comprising a prong in said cavity resonator, means at an end of said cavity resonator supporting said prong, said means being rotatable for revolving said prong within the confines of said cavity resonator and varying the capacitative relation of the prong to said side wall, said prong having one side in direction of rotation of one material and the other side in direction of opposite rotation of another material, and means connected to said means for rotating said prong.

2. A body portion, tuning means therefor comprising an axially movable ring, means connected with and for moving said ring, guide legs projecting from said ring slidably mounted in said body portion, and a circular series of prongs parallel to said legs and mounted on said ring and movable therewith.

3. An electron discharge device having a cathode and an anode around the cathode, said anode having cavity resonators radiating from the region around the cathode, said cavity resonators having substantially cylindrical portions axially parallel to the cathode, and tuning means having substantially cylindrical portions in said cavity resonators coaxial therewith and having other portions eccentric to said cavity resonators and in closer proximity to the said region radiating from the cathode than said cylindrical portions.

4. A magnetron having an anode body formed with a circular series of cavity resonators each opening at opposite ends of the anode body, a tuning means comprising a crown having a circular series of parallel prongs each of which has one end portion of one material and the other end portion of another material meeting and joined substantially midway of the length of said prong, and each said prong having a length greater than that of the cavity resonator whereby ends of the said prong protrude from both ends of the cavity resonator and the joined ends of the different materials are within said resonator, and means projecting from and for moving the crown in parallelism to the prongs for changing the proportion of the different materials of said end portions directly included within the cavity resonator.

5. A magnetron having an anode body formed with a circular series of cylindrical and parallel cavity resonators each opening at opposite ends of the anode body, a tuning means comprising a crown having a circular series of parallel prongs each of which is within and parallel to a cavity resonator and of greater length than said cavity resonator to project from both ends thereof, each of said prongs having its opposite end portions of different material with the inner ends of the different material end portions joined together and within the cavity resonator, means supporting said crown movably and maintaining the said prongs in parallelism to the cavity resonators, and means projecting from and for moving said crown for changing the proportion of the different materials of said end portions directly included within the cavity resonator.

6. A magnetron having an anode body formed with a circular series of cylindrical and parallel cavity resonators each opening at opposite ends of the anode body, a tuning means comprising a crown having a circular series of parallel prongs each of which is within and parallel to a cavity resonator and of greater length than said cavity resonator to project from both ends thereof, each of said prongs having one end portion of metal and its opposite end portion of a dielectric with the inner ends of the metal and dielectric portions joined together and with the joint within the cavity resonator, means supporting said crown movably and maintaining the said prongs in parallelism to the cavity resonators, and means projecting from and for moving said crown for changing the proportion of the different materials of said end portions directly included within the cavity resonator.

7. A magnetron having an anode body formed with a circular series of cavity resonators each opening at opposite ends of the anode body, a tuning means comprising a crown having a circular series of parallel prongs each of which has one end portion of metal and the other end portion of a dielectric meeting and joined substantially midway of the length of said prong, and each said prong having a length greater than that of the cavity resonator in which situated, whereby ends of said prong protrude from both ends of the cavity resonator, and means at one end of the anode body for moving the several prongs longitudinally thereby changing the proportion of the metal portion and of the dielectric portion of the prongs directly included within the cavity resonators.

8. A magnetron having an anode body formed with a circular series of cylindrical and parallel cavity resonators each opening at opposite ends of the anode body, said anode body having guide holes therein opening at one end of the same and parallel to said cavity resonators, a ring opposite one end of said anode body overlying the axial centers of said cavity resonators, prongs projecting from said ring into said cavity resonators parallel to the axes thereof and out of contact therefrom, guiding legs carried from said ring parallel to said prongs and projecting into said guide holes, and means connected with said ring for moving the ring in a direction longitudinally of said prongs and legs.

9. A magnetron having an anode body formed with a circular series of cylindrical and parallel cavity resonators each opening at opposite ends of the anode body, said anode body having guide holes therein opening at one end of the same and parallel to said cavity resonators, a ring opposite one end of said anode body overlying the axial centers of said cavity resonators, prongs projecting from said ring into said cavity resonators parallel to the axes thereof and out of contact therefrom, guiding legs carried from said ring parallel to said prongs and projecting into said guide holes, means insulating said legs from the anode body, and means connected with said ring for moving the ring in a direction longitudinally of said prongs and legs.

10. A tuning means comprising a ring having a circular series of prongs projecting therefrom, said prongs being parallel to each other and perpendicular to the ring, each prong comprising portions of substantially equal lengths of conduc-

tive material and of dielectric material and all of the conductive portions having like relation to the ring and all of the dielectric portions having each the same relation as all other dielectric portions to the said ring.

11. A tuning means comprising a ring having a circular series of prongs projecting therefrom, said prongs being parallel to each other and perpendicular to the ring, each prong comprising portions of conductive material and of dielectric material mounted end to end and with one of said portions interposed between and spacing the other portion remote from said ring.

12. A tuning means comprising a ring having a circular series of prongs projecting therefrom, said prongs being parallel to each other and perpendicular to the ring, each prong comprising a portion of conductive material next said ring at one end of said portion and having the other end of said portion remote from the ring, and each prong having a dielectric portion endwise against the said remote end of said portion of conductive material and thereby spacing the dielectric portion from the ring a distance equal to the length of said conductive portion.

13. A tuning means comprising a ring having a circular series of prongs projecting therefrom, said prongs being parallel to each other and perpendicular to the ring, a yoke extending across said ring, and guide legs projecting from said yoke in parallelism to said prongs.

14. A tuning means comprising a ring having a circular series of prongs projecting therefrom, said prongs being parallel to each other and perpendicular to the ring, a yoke extending across and at its ends beyond said ring thereby providing projecting ends for the yoke, and guide legs perpendicular to said yoke and parallel to said prongs and carried by said projecting ends of the yoke.

15. A tuning means comprising a ring having a circular series of prongs projecting therefrom, said prongs being parallel to each other and perpendicular to the ring, a yoke extending across the ring, guide legs projecting from said yoke in parallelism to said prongs, and insulating sleeves on said legs.

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