Sept. 24, 1946. P. L. SPENCER 2,408,234

TUNABLE MAGNETRON

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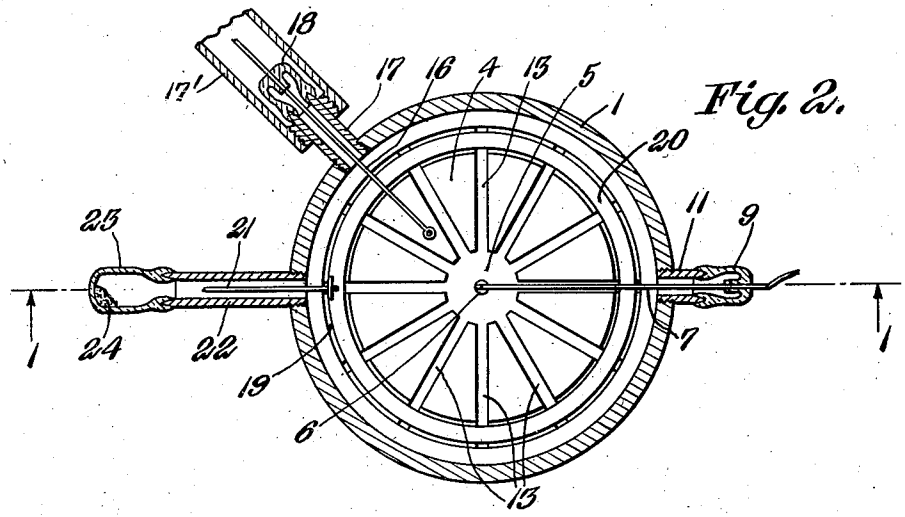


Fig. 2.

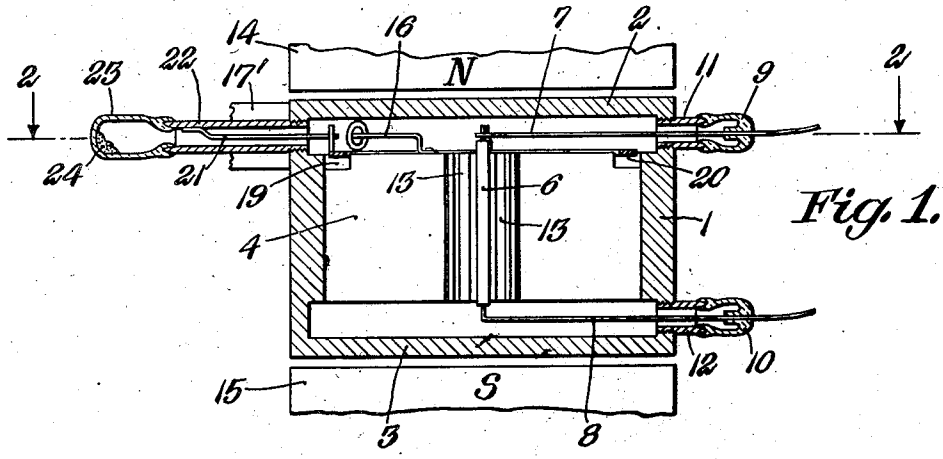


Fig. 1.

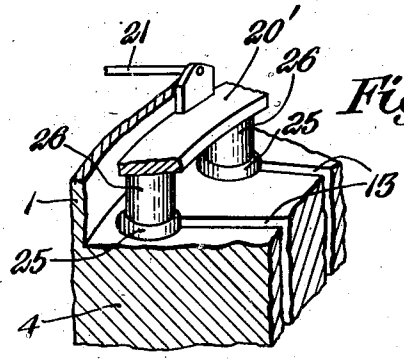


Fig. 3.

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TUNABLE MAGNETRON

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14 Claims. (Cl. 250—27.5)

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This invention relates to a magnetron, and more particularly to a magnetron in which the dimensions of the internal structure determine the frequency of the oscillations produced.

In magnetrons of this kind it is difficult to construct the component parts thereof to dimensions which will produce a desired frequency within narrow limits, particularly when the oscillations produced are of extremely short wave length, of the order of centimeters. Therefore, it is desirable that some simple arrangement be devised for tuning the magnetron after it has been completed to bring its frequency of oscillation to an exact predetermined value even though, as originally constructed, said frequency may deviate somewhat from said desired predetermined value.

An object of this invention is to devise a magnetron of the foregoing type in which simple but effective tuning means are provided.

Another object of this invention is to devise a magnetron of the foregoing type which is simple in construction and yet rugged enough to withstand severe usage.

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

Fig. 1 is a vertical cross-section through a magnetron incorporating my invention, taken along line 1—1 of Fig. 2;

Fig. 2 is a cross-section taken along line 2—2 of Fig. 1; and

Fig. 3 is a fragmentary perspective view of another modification of my invention.

In the embodiment illustrated in Figs. 1 and 2, the magnetron comprises an envelope 1 which is preferably made of a block of conductive material, such as copper. This block forms the anode of the magnetron. Said block has hollow end sections which are covered by end caps 2 and 3 likewise of conductive material, such as copper. Between the hollow end sections of the block 1 is the central bridging portion 4. The portion 4 is provided with a central bore 5 within which is supported substantially at the center thereof a cathode 6 of the thermionic type. The cathode 6 is supported by a pair of cathode lead-in conductors 7 and 8 sealed through glass seals 9 and 10 mounted at the outer ends of pipes 11 and 12 hermetically fastened within the walls of the block 1 adjacent the upper and lower hollow end sections. A plurality of slots 13 extend radially from the central bore 5 to within a short distance of the outer wall of the block 1.

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A capacity exists between the cathode 6 and each of the wedge-shaped sections of the bridging portion 4. Also capacitances exist between the side walls of each of the slots 13. The walls of the slots 13 likewise form inductances. The anode, therefore, may be so designed and so spaced relative to the cathode that the inductances and capacitances described will constitute circuits which are tuned, and thus resonant at substantially the frequency at which the device is to be operated.

When such a magnetron is placed between suitable magnetic poles 14 and 15 to create a longitudinal magnetic field and the device is energized, oscillations are set up whose frequency and consequently whose wave length are determined primarily by the dimensions of each of the slots 13 as described above. The oscillations produced in these slots reinforce each other, and may be led out from the tube by means of a coupling conductor 16 fastened to the central bridge portion 4 near the central bore 5 between two of the slots 13. The coupling conductor 16 leads out from the magnetron through a glass seal 18 at the outer end of a pipe 17 likewise hermetically fastened through the wall of the envelope 1 adjacent the upper hollow portion thereof. An additional conducting pipe 17' may be fastened to the pipe 17 outside of the seal 18 so as to form with the coupling conductor 16 a concentric line through which the high frequency oscillations generated by the magnetron may be conducted away and utilized.

Such a magnetron as I have described may be constructed so as to produce oscillations having a wave length of the order of three centimeters. In accordance with my invention I provide means whereby this frequency can be adjusted exactly over a fairly wide range even after the magnetron has been completed. For this purpose I cut a groove 19 adjacent the back ends of the slots 13 and one end of the central bridging portion 4. If desired a similar slot could be cut at the lower end of said central bridging portion. I have found that the provision of such a slot decreases the frequency of the oscillations generated by the magnetron to an appreciable degree. The effect seems to be that cutting this slot increases the inductance of each of the oscillating loops within the magnetron. This feature in itself provides a convenient way of adjusting the frequency of a magnetron after the central bore 5 and the slots 13 have been cut.

I have also found that if a ring 20 of a conducting material such as copper is introduced

into said slot 19, the frequency of the oscillations produced is increased. The introduction of the ring 20 seems to have the effect of decreasing the inductance of each of the oscillating loops within the magnetron, and thus causing a higher frequency to be generated. The ring 20 is supported on a rather stiff conducting rod 21, the outer end of which is secured to the inner wall of a conducting pipe 22 likewise hermetically fastened in the wall of the envelope 1 adjacent the upper hollow portion thereof. The outer end of the pipe 22 may have sealed thereon a glass bulb 23 within which may be contained some gettering material 24. During evacuation of the tube, the getter 24 may be flashed by inductive heating to clean up residual gases within the magnetron.

When the magnetron has been completed, it is placed between the magnetic poles 14 and 15 and connected into a suitable oscillating circuit. The wave length of the oscillations generated is then measured. If it is found that the wave length so generated deviates from the exact value desired, the magnetron may be tuned to that exact frequency by bending the tube 22 so as to move the rod 21, thus raising or lowering the ring 20. The tube 22 is of the proper stiffness so that when bent into any position, it remains fixed in that position. I have found, for example, that in one size magnetron, the range through which the device could be tuned represented a change of wave lengths from 3.2 to 3.5 centimeters. This is an ample range of variation for all practical purposes in order to bring such a device into exact tuning with the frequency which the device is intended to generate.

Instead of constructing the magnetron with straight-sided slots 13, the inductance of the oscillating section of the magnetron may be increased as shown in Fig. 3. In this figure the same reference numerals are applied where the elements are identical with those shown in Figs. 1 and 2. In this embodiment the outer ends of the slots 13 terminate in cylindrical openings 25, thus causing the magnetron to generate longer wave lengths. The magnetron is provided with a ring 20' similar to the ring 20 in the embodiment of Figs. 1 and 2, but carrying conducting plugs 26 of some suitable material, such as copper. The plugs 26 are located opposite the ends of the openings 25 so that they may be caused to project into the ends of said holes to any predetermined extent. The adjustment of the position of the plugs 26 performs substantially the same tuning action as described above in connection with the adjustment of the position of the ring 20. As the plugs 26 project further into the openings 25, the inductance of the oscillating sections of the magnetron decreases, while moving said plugs away from the openings 25 increases said inductance.

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 the invention within the art.

What is claimed is:

1. An electron discharge device comprising a cathode, an anode disposed adjacent said cathode, said anode having electron-receiving portions adjacent said cathode, and a plurality of grooved portions spaced from said first portions forming inductances which together with the interelectrode capacitances constitute a tuned circuit, said anode having cut-away localized portions in said grooved portions providing localized sections of said grooved portions, each of said localized grooved portions having a length differing from the rest of the respective grooved portion for predetermining the inductances of said grooved portions, and a conductive member supported adjacent said cut-away portions.

2. An electron discharge device comprising a cathode, an anode disposed adjacent said cathode, said anode having electron-receiving portions adjacent said cathode, and a plurality of grooved portions spaced from said first portions forming inductances which together with the interelectrode capacitances constitute a tuned circuit, said anode having cut-away localized portions in said grooved portions providing localized sections of said grooved portions, each of said localized grooved portions having a length differing from the rest of the respective grooved portion for predetermining the inductances of said grooved portions, and a conductive member supported adjacent said cut-away portions, said conductive member being adjustable toward and away from said cut-away portions to vary said inductances.

3. An electron discharge device comprising an electrode having arms bounding a cavity and forming an inductance, said arms having juxtaposed surfaces forming a capacitance, another electrode adjacent the outer ends of said arms, one of said arms having a cut-away localized portion for predetermining said inductance, and a conductive member supported adjacent said cut-away portion, said conductive member being adjustable toward and away from said cut-away portion to vary said inductance.

4. A magnetron comprising an anode having arms bounding a cavity and forming an inductance, said arms having juxtaposed surfaces forming a capacitance, a cathode adjacent the outer ends of said arms, means for producing a magnetic field about said cathode, one of said arms having a cut-away localized portion for predetermining said inductance, and a conductive member supported adjacent to and spaced from said cut-away portion, said conductive member being adjustable toward and away from said cut-away portion to vary said inductance.

5. An electron discharge device comprising a cathode, an anode structure, said anode structure comprising a body of conducting material having substantially flat upper and lower faces parallel with each other, said body having a pair of electron-receiving portions extending between said faces and disposed adjacent said cathode, said body also having a groove extending from between said electron-receiving portions and likewise extending from one of said faces to the other, said groove forming a cavity resonator having capacity and inductance constituting a tuned circuit, said anode having a cut-away localized portion in one of said faces at a portion of said groove providing a localized section of said groove having a length differing from the rest of said groove for predetermining the inductance of said cavity resonator, and a conductive member supported adjacent said cut-away portion, said conductive member being adjustable toward and away from said groove to vary said inductance.

6. A magnetron comprising a cathode, means adjacent said cathode for producing a magnetic field about said cathode, an anode structure, said anode structure comprising a body of conducting

material having substantially flat upper and lower faces parallel with each other, said body having a plurality of pairs of electron-receiving portions extending between said faces and disposed adjacent said cathode, said body also having a plurality of grooves extending from between said electron-receiving portions and likewise extending from one of said faces to the other, each of said groovès forming a cavity resonator having capacity and inductance constituting a tuned circuit, said anode having cut-away localized portions in one of said faces at a portion of each of said grooves providing localized sections of said grooves, each having a length differing from the rest of said grooves for predetermining the inductances of said cavity resonators, and a conductive member supported adjacent each of said cut-away portions.

7. An electron discharge device comprising a sealed envelope containing an elongated cathode, an anode structure having adjacent anode elements defining a transverse cavity resonator, an adjustable tuning element within said envelope adjacent said cavity resonator, said tuning element comprising a conductive member, and means connected to said tuning element for adjusting the position of said conductive member toward and away from said cavity resonator.

8. A magnetron comprising a cathode surrounded by an anode block, said block having a central cathode space and interconnecting spaces forming coupled cavity resonators, said block also having a pair of anode arms forming opposite sides of each of said cavity resonators, an adjustable tuning element within said envelope adjacent said cavity resonators, said tuning element comprising a conductive member, and means connected to said tuning element for adjusting the position of said conductive member toward and away from said cavity resonators.

9. An electron discharge device comprising a sealed envelope containing an elongated cathode, an anode structure having adjacent anode elements defining a transverse cavity resonator, an adjustable tuning element within said envelope adjacent said cavity resonator, said tuning element comprising a conductive member, and means operable externally of said envelope and connected to said tuning element for adjusting the position of said conductive member toward and away from said cavity resonator.

10. A magnetron comprising a cathode surrounded by an anode block, said block having a central cathode space and interconnecting spaces forming coupled cavity resonators, said block also having a pair of anode arms forming opposite sides of each of said cavity resonators, an adjustable tuning element within said envelope

adjacent said cavity resonators, said tuning element comprising a conductive member, and means operable externally of said envelope and connected to said tuning element for adjusting the position of said conductive member toward and away from said cavity resonators.

11. An electron discharge device comprising a sealed envelope containing an elongated cathode, an anode structure having adjacent anode elements defining a transverse cavity resonator, an adjustable tuning element within said envelope adjacent said cavity resonator, said tuning element having a conductive element projecting into said cavity resonator, and means connected to said tuning element for adjusting the position of said conductive member toward and away from said cavity resonator.

12. A magnetron comprising a cathode surrounded by an anode block, said block having a central cathode space and interconnecting spaces forming coupled cavity resonators, said block also having a pair of anode arms forming opposite sides of each of said cavity resonators, an adjustable tuning element within said envelope adjacent said cavity resonators, said tuning element having conductive elements projecting into said cavity resonators, and means connected to said tuning element for adjusting the position of said conductive member toward and away from said cavity resonators.

13. A magnetron comprising a cathode surrounded by an anode block, said block having a central cathode space and interconnecting spaces forming coupled cavity resonators, said block also having a pair of anode arms forming opposite sides of each of said cavity resonators, said anode arms having cut-away portions disposed intermediate the ends of said anode arms providing each of said anode arms with a longitudinal dimension at said cut-away portion less than the longitudinal dimension of the rest of said anode arm.

14. An electron discharge device comprising a cathode and an anode structure, said anode structure comprising an envelope enclosing said cathode, said anode structure also comprising a pair of electron-receiving faces spaced from each other adjacent the cathode and being interconnected by a cavity resonator, a conductive member supported adjacent said cavity resonator, said conductive member being mounted on a supporting rod connected at its outer end to a deformable tube sealed to and extending beyond said envelope whereby the position of said conductive member may be adjusted by deforming said tube.

PERCY L. SPENCER.