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TUNABLE OSCILLATOR

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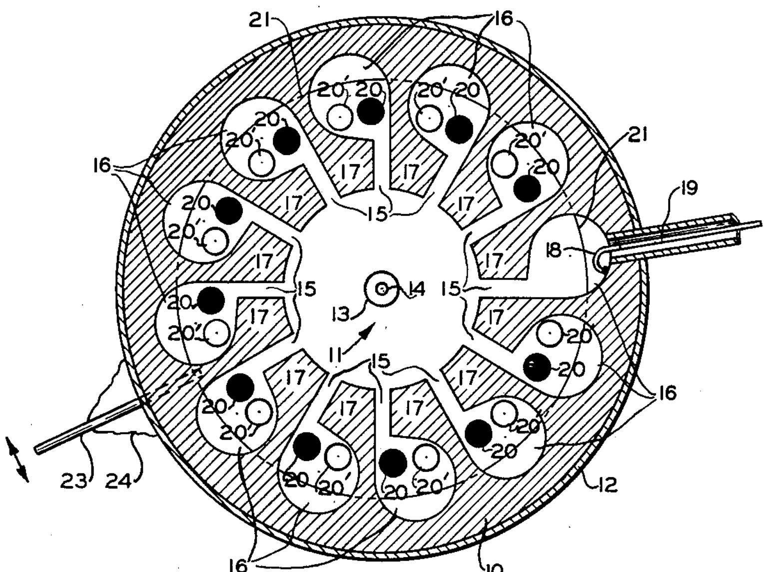

FIG.1.

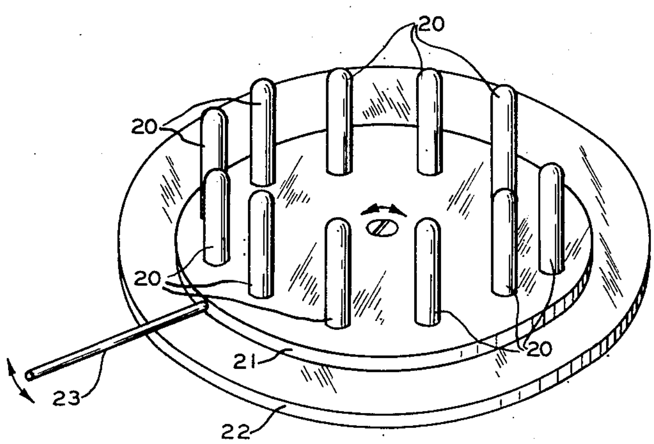

FIG.2.

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TUNABLE OSCILLATOR

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4 Claims. (Cl. 250—27.5)

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This invention pertains to magnetron oscillators and more particularly to magnetrons wherein the geometry of the internal structure determines the frequency of the oscillations generated.

One form of oscillator in extensive use incorporates a resonant structure comprising a plurality of cavities, longitudinally disposed and evenly spaced in a circular pattern about the cathode and encompassed by the inner wall of a cylindrical anode, all being symmetrical with respect to the longitudinal axis of the tubular cathode. The operating frequency of such plural cavity magnetrons is chiefly determined by the dimensions of the cavities.

In the production of such plural cavity magnetrons it is often difficult to construct the component parts to dimensions which generate a desired frequency within narrow limits, especially when the oscillations generated are of extremely short wave lengths in the order of centimeters. Accordingly, it becomes desirable that a simple mechanical arrangement be contrived for tuning the magnetron after it has been assembled to shift its operating frequency to an exact predetermined value, even though, as originally constructed, said frequency deviates from said predetermined value. Moreover, it is also advantageous that this tuning be effected when the magnetron oscillator is actually in operation without necessitating its removal from position between the customary magnetic pole pieces.

It is, therefore, the principal object of this invention to provide a magnetron of the foregoing type incorporating simple but effective tuning means.

Another object of this invention is to provide a magnetron of this type wherein the frequency of oscillation may be adjusted while the magnetron is in operation and positioned between the poles of its associated magnet.

For a better understanding of the invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawing, wherein like parts are designated by like reference numbers. The scope of the invention will be pointed out in the annexed claims.

In the accompanying drawing:

Figure 1 is a transverse section taken through a megnetron incorporating the invention, and

Figure 2 shows in greater detail the tuning mechanism for the magnetron disclosed in Figure 1.

Referring now to the drawing and more par-

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ticularly to Figure 1, the magnetron illustrated comprises a cylindrical anode block 10, having a center bore 11, encompassed by a tubular shell 12, preferably made of copper. Within the central bore 11 and concentric with the anode block 10 is mounted a tubular cathode 13, which is of the indirectly-heated-oxide coated thermionic type. Fitted coaxially within the cathode 13 is a filament 14 for heating same. A plurality of slots 15 radiating from the central bore 11 are cut longitudinally through the anode block 10, each of said slots terminating eccentrically in a circular cavity 16, also cut longitudinally through the anode block 10. In this manner, the anode structure is provided with a plurality of wedge-shaped projections 17, the arcuate faces of which function as anode sections in cooperation with the cathode 13.

When the magnetron is disposed between suitable magnetic poles (not shown) to create a longitudinal magnetic field, and the tube is properly energized, oscillations are generated. These oscillations are extracted from the tube by means of a coupling loop 18 projecting into one of the cavities 16 and having one end thereof connected to the inner wall of said cavity. The other end of coupling loop 18 is connected to the inner lead 19 of a coaxial line provided with a suitable hermetical seal (not shown) at its terminal.

The circuit parameter of the magnetron comprises capacity existing between the side walls of each of the slots 15 as well as capacity between cathode 13 and the faces of projections 17, while the inner walls of cavities 16 constitute inductances. The anode 10, consequently, is so designed and spaced relative to the cathode 13 that the lumped inductances and capacitances described constitute resonant circuits. The magnetron is intended to operate so that each cavity 16 and its adjacent projections 17 form a circuit tuned to the frequency at which each of the other cavities 16 and its adjacent projections 17 oscillate.

It should be noted that because of the extremely high frequencies involved, the above anode areas cannot be simply regarded as presenting either pure capacitance or inductance, hence it is often difficult to predetermine the dimensions of the anode structure so as to obtain magnetron oscillations at exactly a desired frequency. For this reason means are provided whereby the normal frequency of oscillation of the magnetron can be adjusted over a moderately wide range after the magnetron has been assembled. These means comprise a plurality of pegs 20, preferably constructed of copper, each disposed within a cavity 16. Because of coupling loop 18, the number of pegs 20 is one less than the number of cavities 16, the cavity containing the loop 18 being without a peg. The pegs 20 are mounted with a fixed vertical orientation on a supporting disc 21, preferably made of steel. Means are provided for axially rotating disc 21 to an extent whereby the pegs 20 are shifted from one wall of cavity 16 to the other, thus varying the resonant frequency of the cavity for reasons to be discussed shortly. Circles 20′ designate the position of pegs 20 when fully shifted. Movement of disc 21 is effectuated by a raised point in its center which is received by a depression formed in the center of a round closure plate 22, with a slightly raised circular ridge on the disc 21, about half its diameter, acting as a track. The closure plate 22, preferably made of copper, serves to seal one end of copper shell 12, the other end being covered by another closure plate (not shown) to complete the envelope.

An arm 23 is attached to the periphery of disc 21 to enable axial rotation thereof. The arm 23 extends through metallic bellows 24 which are attached to shell 12 in order to hermetically seal the envelope at this position. In plactice, arm 23 may be coupled to a micrometer in order to calibrate the displacement of the arm in terms of frequency. The position of arm 23 is made such as not to overlap into a cavity 16 at its limits of displacement.

The effect of tuning pegs 20 upon the operating frequency of the magnetron will now be explained in accordance with the present understanding. In the position of the tuning pegs 20 as shown by the solid circles in Figure 1, the capacity effect predominates, that is to say, movement toward the adjacent wall of cavity 16 increases the capacity, and in consequence, the wave length. As peg 20 is shifted toward the opposing wall, the other limit of motion being indicated by circle 20′, it not only lessens the capacity effect but decreases the inductance, thus decreasing the wave length. The eccentric placing of slots 15 with respect to cavity 16 accentuates the effect just described, namely, capacitative toward the wall near where peg 20 is positioned and inductive toward the opposing wall.

The manner in which the variation of frequency is accomplished may also be explained by regarding the position taken by peg 20 as having a predominantly capacitative effect since it is in a position to partially reflect the energy from the central bore 11 and change the reflection coefficient so as to increase the capacity, thus increasing the wave length. In addition to the foregoing, each peg 20 may form a resonant circuit in itself making the length thereof critical. For this reason, it is desirable to have the peg structure nonresonant in length.

When the magnetron is in operation the whole anode block 10 is maintained at ground potential since the cathode 13 is given a high negative potential.

While there has been described what is at present considered a preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore aimed in the appended claims, to cover all such changes and modifications as fall within the true spirit and scope of the invention.

We claim:

1. A magnetron having a multiresonator anode with a plurality of cavity resonators symmetrically disposed around the axis of said magnetron, a plurality of tuning pins within said resonators, a mechanical member supporting said pins in spaced relation with respect to said anode and said resonators, and instrumentalities coupled to said mechanical member for axially rotating said member and said pins around said axis for adjusting the resonant modes of said resonators.

2. A magnetron having an anode provided with a plurality of slots and holes, said holes and slots forming a plurality of cavity resonators symmetrically disposed around the axis of said magnetron, a plurality of low resistance tuning pins inserted into said resonators, an axially positioned disk in spaced relationship with respect to said anode, said pins being fastened to and supported in spaced relationship with respect to said anode by said disk, and a mechanical arm coupled to said disc for axially rotating said disk and said pins around said axis for adjusting the resonant modes of said resonators.

3. A magnetron including a multiresonator anode composed of a plurality of radially disposed slots, the outer ends of said slots terminating in cylindrical resonators tangential to one side of said ends, said slots and resonators being symmetrically disposed around the circumference and the axis of said magnetron, tuning pins in said resonators, and a mechanical arm coupled to said pins for rotating said pins around said axis for changing the angular positions of said pins within said resonators.

4. A magnetron comprising an anode having a plurality of cavity resonators disposed around an axis, a plurality of tuning pins within said resonators, and means coupled to said pins for rotating said pins around said axis to adjust the resonant frequency of said resonators.

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