

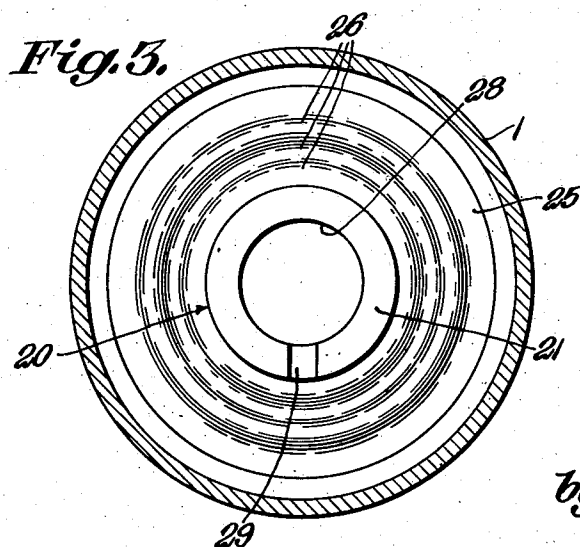
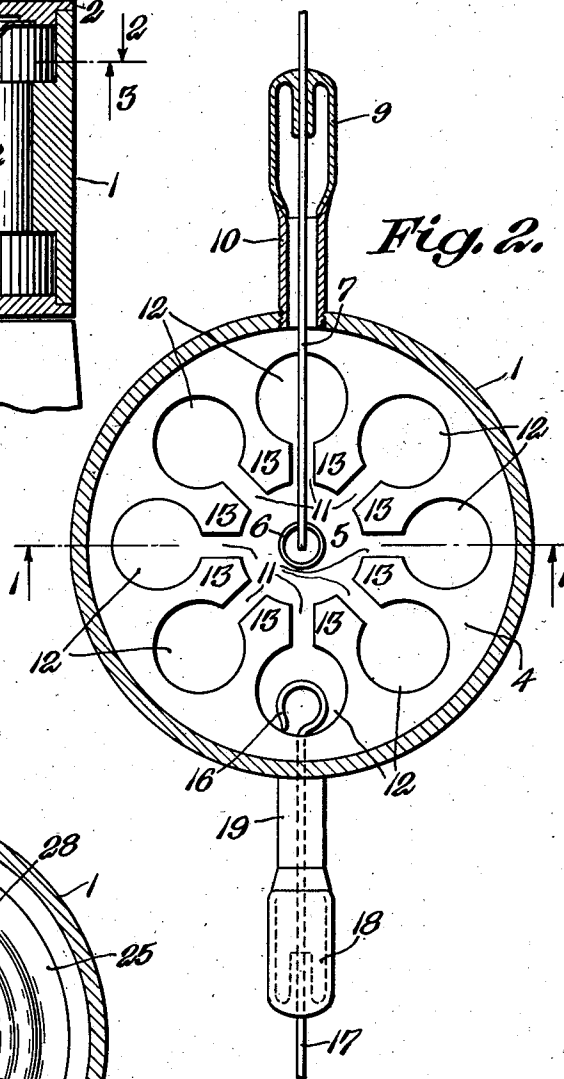
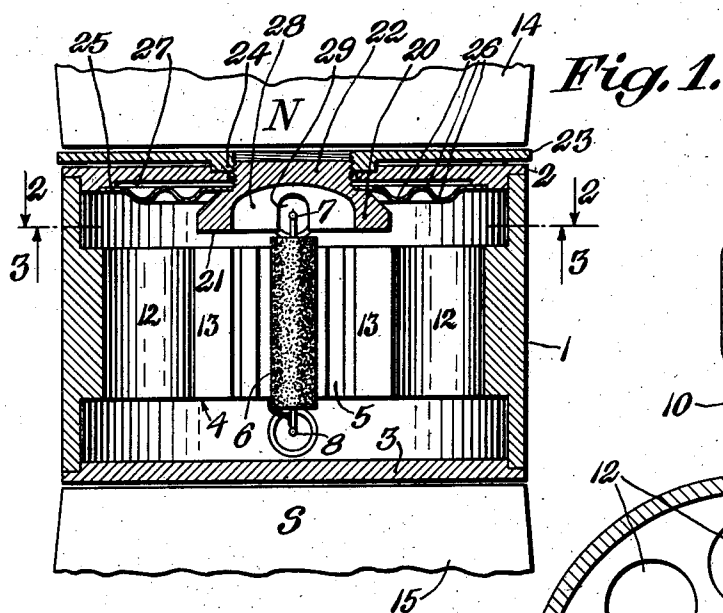
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TUNABLE MAGNETRON

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TUNABLE MAGNETRON

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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 often 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 lengths 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 predetermined value. It is also desirable that this tuning may be accomplished while the magnetron is actually in operation, without the necessity of removing it from position between the usual magnetic pole

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 is to devise a magnetron of this kind in which the frequency of oscillation may be adjusted while the magnetron is in operation and in position between the poles of its associated magnet.

The foregoing and other objects of this invention will be best understood from the following description of an exemplification thereof, reference being had to the accompanying drawing, wherein

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

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

Fig. 3 is a cross-section taken approximately along line 3—3 of Fig. 1.

The magnetron illustrated in the drawing comprises an envelope 1 which is preferably made of a block of conducting material, such as copper. This block forms the anode of the magnetron. It likewise has hollow end sections which are covered by caps 2 and 3 likewise of conducting material, such as copper. Between the hollow end sections of the block 1 is located a central bridging portion 4 provided with a central bore 5 within which is supported centrally thereof a cathode 6 which may be of the indirectly-heated oxide-coated thermionic type. The cathode is supported by a pair of lead-in conductors 7 and 8. The conductor 7 is sealed through a glass seal 9

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mounted at the outer end of a pipe 10 hermetically fastened within the wall of the block 1 adjacent the upper hollow end section. The lead-in conductor 8 is likewise sealed through a similar glass seal and pipe, not illustrated, adjacent the lower hollow end section. A plurality of slots 11 extend radially from the central bore 5, and each of said slots terminates in a circular opening 12 extending through the bridging portion 4. In this way the anode structure is provided with a plurality of wedge-shaped arms 13, the faces of which cooperate as anode sections with the cathode 6.

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. These oscillations may be led out from the tube by means of a coupling loop 16 extending into one of the cylindrical openings 12, and having one end thereof fastened to the inner wall of said opening. The other end of the coupling loop 16 is connected to the lead wire 17 which passes through a glass seal 18 mounted at the outer end of a pipe 19 likewise hermetically fastened through the wall of the envelope 1. An additional conducting pipe, not shown, may be electrically connected to the pipe 19 and form with the wire 17 a concentric line through which the high frequency oscillations generated by the magnetron may be conducted to a suitable utilization circuit.

A capacity exists between the cathode 6 and the face of each anode section 13. Also capacitances exist between the side walls of each of the slots 11. The inner walls of the openings 12 constitute inductances. The anode, therefore, is so designed and spaced relative to the cathode that the inductances and capacitances described constitute circuits which are tuned. It is desired that these circuits shall be resonant at a definite predetermined frequency at which the device is to be operated. The device is intended to operate so that each opening 12 and its adjacent arms form a circuit tuned to the frequency at which each of the other openings 12 and its adjacent arms oscillate.

It is often difficult to predetermine the dimensions of the structure exactly so as to cause the anode structure to oscillate at exactly the desired predetermined frequency. However, means may be provided whereby the normal frequency of oscillation of the magnetron can be adjusted over fairly wide range even after the magnetron has been completed. For example, I have described and claimed a tuning arrange-

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ment in my copending application, Serial No. 425,071, filed December 31, 1941. In accordance with my present invention, this type of tuning is utilized in an arrangement which is very sturdy and which is capable of performing the tuning even while the magnetron is in place between the pole pieces 14 and 15.

In order to produce such tuning, a tuning member 20 is disposed with a lower annular conducting face 21 held in juxtaposed position adjacent the anode arms 13 at one side of the structure. The member 20 is provided with an upper threaded extension 22 which receives a central threaded portion of a plate 23. Surrounding the central threaded portion of the plate 23 is a depending cylindrical projection 24 which fits rotatably into a corresponding central opening extending through the cap 2. In order to maintain a hermetical seal and at the same time permit adjustment of the tuning member 20, a diaphragm 25 is provided. The diaphragm 25 has a central opening which fits over the threaded portion 22 so that said diaphragm may be hermetically sealed onto a shoulder formed on the tuning member 20 at the base of said extension 22. The outer edge of the diaphragm 25 is likewise hermetically sealed onto a shoulder formed adjacent the outer edges of the cap 2. The diaphragm 25 is preferably provided with a plurality of corrugations 26 so as to lend flexibility to said diaphragm, thus permitting a considerable motion of the central portion thereof which carries the tuning member 20. The cap 2 is cut away at 27 to permit such movement of the diaphragm. The tuning member 20 is likewise cut away at 28 to permit the upper end of the cathode 6 to extend therein. The member 20 is also provided with a slot 29 which allows for the passage of the lead-in conductor 7. The outer edge of the plate 23 preferably extends slightly beyond the sides of the adjacent pole piece 14, and carries knurling which permits the plate 23 to be readily turned in order to perform the desired tuning. Of course it is understood that the magnetron is completed in the usual manner, and is completely evacuated. Therefore, a pressure will be exerted on the plate 23 and the extension 22 of the member 20 which will tend to press said tunable structure inwardly against the body of the magnetron. This provides a biasing force which maintains the tunable structure firmly in whatever position is determined by the degree of turning of the plate 23.

When the magnetron has been completed it is placed between the magnetic poles 14 and 15 and connected into a suitable oscillating circuit, whereupon the system starts to generate oscillations. If it is found that the wave length generated by the magnetron deviates from the exact value desired as, for example, that fixed by the constants of the associated circuit, the magnetron may be tuned to that exact frequency merely by turning the plate 23. The threaded relationship between this plate and the member 20 causes said member 20 to be raised or lowered, depending upon the direction of the rotation of the plate 23. I have found that such a structure produces an ample range of variation for all practical purposes in order to bring such a device in exact tuning with the frequency which the device is intended to generate.

In accordance with my present understanding of the operation of this invention, varying the position of the conducting face 21 will vary the

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capacitances of the anode structure as described above without affecting the inductances thereof to the same degree. Therefore, varying said capacitances will tune the natural frequency of the magnetron in the manner desired.

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. For example, the conducting surfaces moved adjacent elements of the anode structure might be disposed adjacent other portions of said anode structure. Likewise elements which vary the inductance of the oscillating portions of the anode structure might be adjusted in accordance with the principles of my invention.

What is claimed is:

1. An electron discharge device comprising a sealed envelope containing an elongated cathode, adjacent anode elements, and a hollow resonator interconnecting said anode elements, a tuning element within said envelope adjacent said hollow resonator, said tuning element being mounted upon a flexible diaphragm hermetically sealed in a wall of said envelope, the median plane of said diaphragm being substantially perpendicular to the longitudinal axis of said cathode, and adjustable means connected to said diaphragm for flexing said diaphragm in a direction substantially perpendicular to said median plane for adjusting the position of said tuning element.

2. An electron discharge device comprising a sealed envelope containing a cathode, adjacent anode elements having elongated electron-receiving faces disposed about a common axis, and a hollow resonator interconnecting said anode elements, a tuning element within said envelope adjacent said hollow resonator, said tuning element being mounted upon a flexible diaphragm hermetically sealed in a wall of said envelope, said wall being transverse to said axis, the median plane of said diaphragm being substantially parallel with the plane of that wall of the envelope in which said diaphragm is sealed, and adjustable means connected to said diaphragm for flexing said diaphragm in a direction substantially perpendicular to said median plane for adjusting the position of said tuning element.

3. An electron discharge device comprising a sealed envelope containing a cathode, adjacent anode elements having elongated electron-receiving faces disposed about a common axis, and a hollow resonator interconnecting said anode elements, a tuning element within said envelope adjacent said hollow resonator, said tuning element being mounted upon a flexible diaphragm hermetically sealed in a wall of said envelope, said wall being transverse to said axis, the median plane of said diaphragm being substantially parallel with the plane of that wall of the envelope in which said diaphragm is sealed, and adjustable means connected to said diaphragm external to said envelope for flexing said diaphragm in a direction substantially perpendicular to said median plane for adjusting the position of said tuning element.

4. An electron discharge device comprising a sealed envelope containing a cathode, adjacent anode elements having elongated electron-receiving faces disposed about a common axis, and a hollow resonator interconnecting said anode elements, a tuning element within said envelope adjacent said hollow resonator, said tuning element being mounted upon a flexible diaphragm hermetically sealed in a wall of said envelope,

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said wall being transverse to said axis, the median plane of said diaphragm being substantially parallel with the plane of that wall of the envelope in which said diaphragm is sealed, a threaded extension extending exteriorly of said envelope and carried by said diaphragm, and a cooperatively threaded member engaging said extension and adapted upon rotation thereof to move said extension in a direction substantially perpendicular to said median plane for adjusting the position of said tuning element.

5. An electron discharge device comprising a sealed envelope containing a cathode, adjacent anode elements having elongated electron-receiving faces disposed about a common axis, and a hollow resonator interconnecting said anode elements, a tuning element within said envelope adjacent said hollow resonator, said tuning element being mounted upon a flexible diaphragm hermetically sealed in a wall of said envelope, said wall being transverse to said axis, the median plane of said diaphragm being substantially parallel with the plane of that wall of the envelope in which said diaphragm is sealed, a threaded extension extending exteriorly of said envelope and carried by said diaphragm, and a cooperatively threaded member, rotatably mounted on said envelope, engaging said extension and adapted upon rotation thereof to move said extension in a direction substantially perpendicular to said median plane for adjusting the position of said tuning element.

6. An electron discharge device comprising a sealed envelope containing a cathode, adjacent anode elements, and a hollow resonator interconnecting said anode elements, a tuning element within said envelope adjacent said hollow resonator, said tuning element being mounted upon a flexible diaphragm hermetically sealed in a wall of said envelope, the median plane of said diaphragm being substantially parallel with the plane of that wall of the envelope in which said diaphragm is sealed, a threaded extension extending exteriorly of said envelope and carried by said diaphragm, and a centrally threaded plate, rotatably mounted on said envelope, engaging said threaded extension, and adapted upon rotation thereof to move said extension in a direction substantially perpendicular to said median plane for adjusting the position of said tuning member, the plane of rotation of said plate being substantially parallel with said median plane.

7. A magnetron comprising a sealed envelope containing a cathode, adjacent anode elements, and a hollow resonator interconnecting said

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anode elements, a tuning element within said envelope adjacent said hollow resonator, said tuning element being mounted upon a flexible diaphragm hermetically sealed in a wall of said envelope, the median plane of said diaphragm being substantially parallel with the plane of that wall of the envelope in which said diaphragm is sealed, a threaded extension extending exteriorly of said envelope and carried by said diaphragm, a centrally threaded plate, rotatably mounted on said envelope, engaging said threaded extension, and adapted upon rotation thereof to move said extension in a direction substantially perpendicular to said median plane for adjusting the position of said tuning member, and a magnet pole adjacent said plate for impressing a magnetic field on said magnetron, the edges of said plate extending beyond the sides of said pole to afford ready adjustment of said plate.

8. An electron discharge device comprising a sealed envelope containing an elongated cathode, an adjacent multiplex anode structure, said anode structure comprising a conducting ring member from which a plurality of spaced anode arms project inwardly toward a common central region in which the cathode is supported, the spaces between said anode arms each defining a hollow resonator having an opening along one side communicating with said central region, a tuning element within said envelope adjacent said hollow resonators, said tuning element being mounted upon a flexible diaphragm hermetically sealed in a wall of said envelope, and adjustable means connected to said diaphragm for flexing said diaphragm for adjusting the position of said tuning element.

9. An electron discharge device comprising a sealed envelope containing an elongated cathode, an adjacent multiplex anode structure, said anode structure comprising a conducting ring member from which a plurality of spaced anode arms project inwardly toward a common central region in which the cathode is supported, the spaces between said anode arms each defining a hollow resonator having an opening along one side communicating with said central region, a tuning element within said envelope adjacent said hollow resonators, said tuning element being mounted upon a flexible diaphragm hermetically sealed in a wall of said envelope, and adjustable means connected to said diaphragm external to said envelope for flexing said diaphragm for adjusting the position of said tuning element.

PERCY L. SPENCER.