

Sept. 24, 1946.

P. L. SPENCER

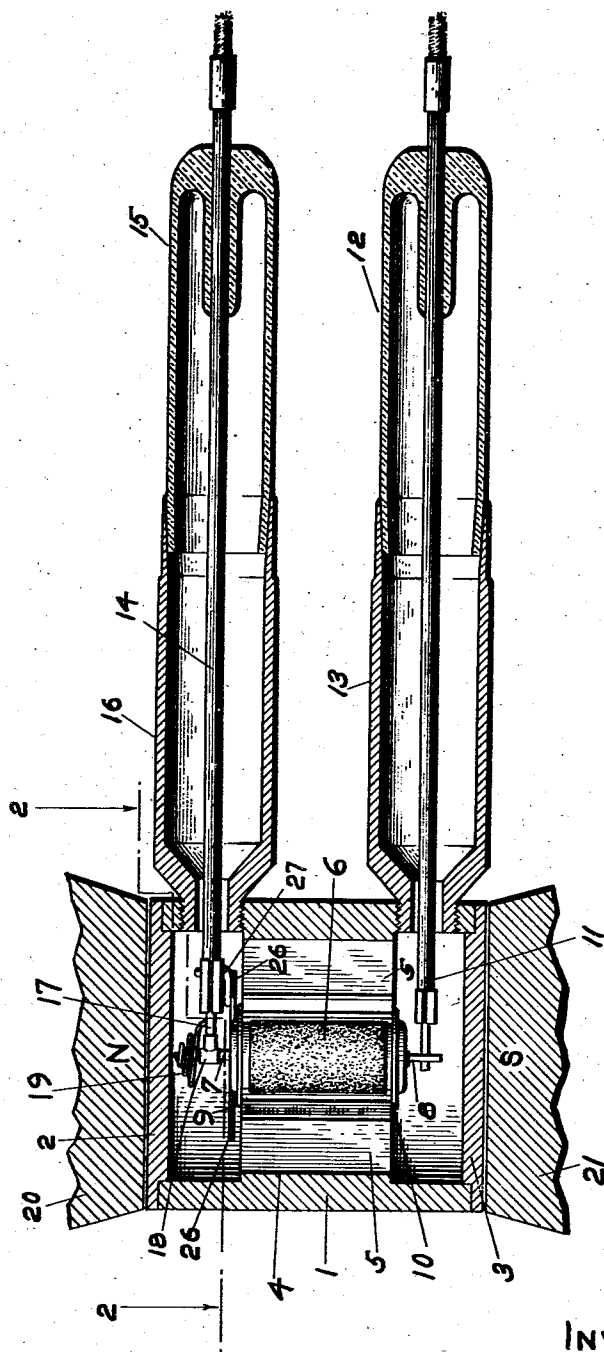
2,408,238

SPACE DISCHARGE DEVICE

Filed June 7, 1943

2 Sheets-Sheet 1

FIG. 1.



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FIG. 2.

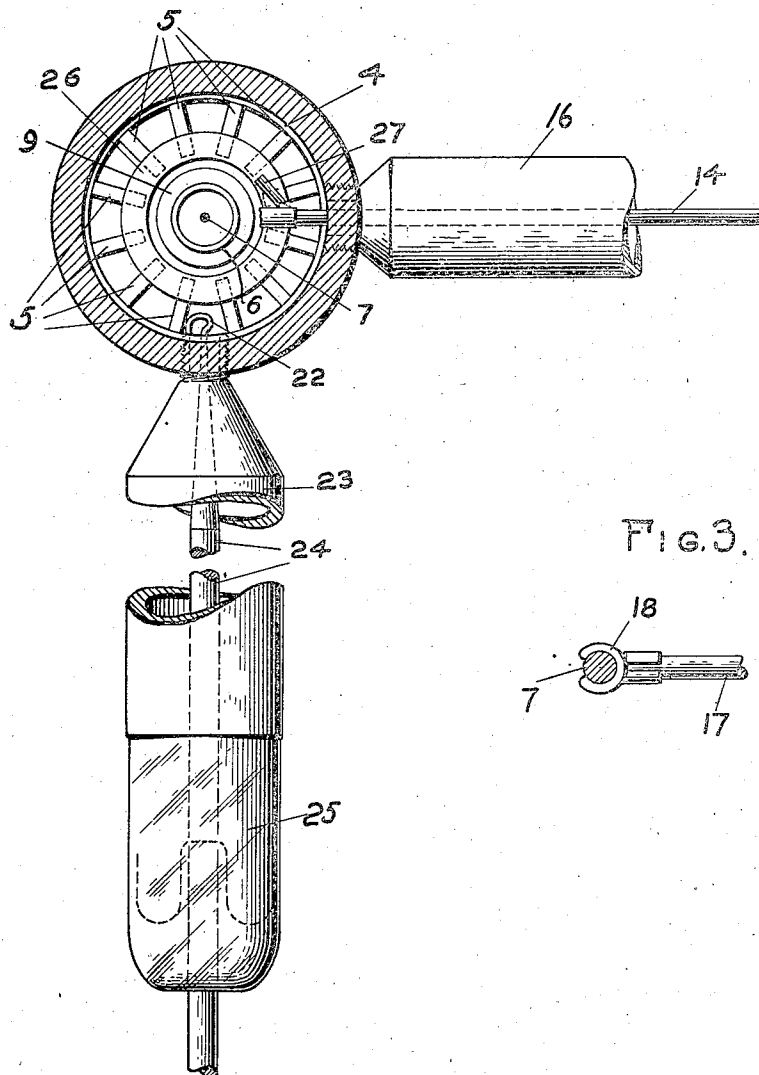
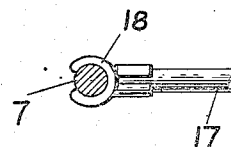


FIG. 3.



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SPACE DISCHARGE DEVICE

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7 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 often difficult to construct the component parts thereof within sufficiently accurate limits which will produce a desired frequency within narrow limits, particularly when the oscillations generated are of extremely short wave lengths of the order of centimeters. Therefore it is desirable that some arrangement be devised for adjusting the magnetron after it has been completed to bring its frequency of oscillation to an exact predetermined value, even though in the initial form of the magnetron said frequency may deviate somewhat from said predetermined value.

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

Another object is to accomplish the foregoing with substantially no increase in the complexity of the tube structure so as to make the tube completely interchangeable with those forms which do not contain such an adjusting or tuning arrangement.

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 drawings, wherein:

Fig. 1 is a vertical section through a magnetron incorporating my invention;

Fig. 2 is a cross-section taken approximately along line 2—2 of Fig. 1, with certain parts thereof broken away; and

Fig. 3 is an enlarged section of a detail of the supporting structure at the top of the cathode shown in Fig. 1.

The magnetron illustrated in the drawings comprises a tubular envelope 1 made of a cylinder of conducting material, such as copper. The ends of the envelope are covered by caps 2 and 3 likewise formed of conducting material, such as copper, and hermetically soldered in place on the ends of the envelope 1. The envelope 1 is formed with a central annular projection 4. A plurality of radial plates 5 are soldered in place along the inner surface of the projection 4. These plates may be stamped out of a sheet of highly-conductive copper. The inner ends of the plates 5 form anode faces which cooperate with a cathode 6 supported substantially centrally of said anode faces. The cathode 6 is preferably of the indirectly-heated oxide-coated thermi-

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onic type having an outer conducting cylinder coated with electron emissive oxides and having an internal heater, the end conductors 7 and 8 of which project from the opposite ends of the cathode structure 6. One of the conductors 8 may be electrically connected to the external cathode sleeve, while the end conductor 7 is insulated from said sleeve. Light conducting shields 9 and 10 may be supported adjacent the upper and lower ends of the cathode 6 so as to prevent electron beams from being projected out toward the end caps 2 and 3. The cathode 6 is supported by a cathode and heater lead-in conductor 11 welded to the end conductor 8, which as described above is electrically connected to the cathode and to one end of the cathode heater. The lead-in conductor 11 is sealed through a glass seal 12 mounted at the outer end of a conducting pipe 13 hermetically fastened through the wall of the envelope 1 adjacent the lower end thereof. A second lead-in conductor 14 is sealed through a similar glass seal 15 mounted at the outer end of a conducting pipe 16 likewise hermetically sealed through the wall of the envelope 1 at the upper end thereof. The inner end of the lead-in conductor 14 carries a connecting rod 17, the outer end of which in turn carries a split sleeve 18. As shown in Fig. 3, the split sleeve 18 surrounds the end conductor 7 snugly so as to afford a supporting and steadying action to the upper end of the cathode structure. However, the engagement between the split sleeve 18 and the end conductor 7 is sufficiently loose so as to permit said sleeve 18 to slide readily up and down along said conductor 7. In order to insure a good electrical connection between the lead-in conductor 14 and the end conductor 7, a flexible electrical connector 19 has one end thereof welded to the end conductor 7 and the other end thereof welded to the rod 17.

When such a magnetron is placed between suitable magnetic poles 20 and 21 to create a longitudinal magnetic field and the device is energized, oscillations are set up. These oscillations may be lead out from the tube by means of a coupling loop 22 extending into the space between two of the plates 5. One end of the coupling loop 22 is connected to the inner end of a conducting pipe 23 hermetically sealed through the wall of the envelope 1 substantially midway between the ends thereof. The other end of the coupling loop 22 is connected to a conductor 24 which passes through said pipe 23 and is sealed through a glass seal 25 mounted at the outer end of said pipe. For the purposes of simplicity, in Fig. 2 the pipe

23 is broken away at its central portion, but it is understood that said pipe may be substantially of the same length as the pipes 13 and 16 of Fig. 1. An additional conducting pipe, not shown, may be electrically connected to the pipe 23 and form with the conductor 24 a concentric line through which the high frequency oscillations generated by the magnetron may be conducted to a suitable utilization circuit.

Each pair of anode arms 5 together with the portion of the projection 4 between them form an oscillating cavity. A capacitance exists between the cathode 6 and the end faces of the anode arms 5. Also capacitances exist between the side walls of each oscillating cavity. The conductive path around each cavity afforded by the side walls thereof constitutes an inductance. The anode, therefore, is so designed and spaced relative to the cathode that the inductances and capacitances described constitute tuned circuits. 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 oscillating cavity is tuned to the frequency at which each of the other oscillating cavities oscillate.

It is often difficult to predetermine the dimensions of the structure 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 a fairly wide range even after the magnetron has been completed. For example, I have described and claimed a tuning arrangement 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 of simplified but nevertheless effective construction. In order to produce such tuning, a light flat metal ring 26 is held in juxtaposed position adjacent the inner ends of the anode arms 5. The ring 26 is supported by the inner end of the rod 14 by means of a connecting member 27 welded to the ring 26 and to the lead-in conductor 14. In order to adjust the position of the ring 26, the pipe 16 may be bent slightly. It will be noted that the lead-in conductor 14 is supported by the seal 15 at a point considerably removed from the position at which the ring 26 is connected to said lead-in conductor. Therefore, a slight bending of the pipe 16 will produce a relatively large movement of the ring 26. Such bending of the pipe 16 gives a permanent set thereto, and fixes the position of the ring 26 in its proper relation with respect to the anode arms 5 so as to result in the desired tuned condition of the magnetron structure. As already pointed out, during this movement of the lead-in conductor 14, the split sleeve 13 slides on the end conductor 7 and in the final position of adjustment forms a support for the upper end of the cathode structure so that in conjunction with the support afforded by the lead-in conductor 11, the cathode structure is rigidly and accurately supported in place.

It will be noted that the adjustment or tuning described above is in the nature of a "factory" adjustment to be made at the time that the magnetron is completed in the factory. It will further be noted that when the tube is completed, it is identical, in so far as outside appearance and dimensions are concerned with tubes which do not have such a tuning adjustment. Therefore, tubes made in accordance with my in-

vention are completely interchangeable with such other tubes. However, by incorporating my invention in the structure, a sufficient degree of tuning is afforded, so that those tubes, which otherwise might deviate from the desired frequency to such an extent as to make them commercially unacceptable, are readily brought into the proper range, thus greatly reducing the percentage of discarded tubes which otherwise might exist.

In accordance with my present understanding of the operation of the invention, varying the position of the conducting ring 26 will vary the 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 desired manner.

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 surface which is 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 supported and adjusted in accordance with the principles of my invention.

What is claimed is:

1. An electron discharge device comprising an envelope containing a cathode and an anode, said anode having a plurality of electron-receiving portions adjacent said cathode, and a cavity resonator interconnecting each pair of electron-receiving portions, said cathode having a pair of electrical terminals, said cathode being rigidly supported within said envelope and provided with an external electrical connection for one of its terminals, a lead-in conductor for the other of said terminals sealed through the wall of said envelope, a flexible electrical conductor connecting said lead-in conductor with the other of said terminals, and a tuning member for said cavity resonator carried by said lead-in conductor, the connection between said lead-in conductor and the wall of said envelope being sufficiently adjustable to provide an adjusting movement of said lead-in conductor and the tuning member carried thereby.

2. An electron discharge device comprising an envelope containing a cathode and an anode, said anode having a plurality of electron-receiving portions adjacent said cathode, and a plurality of cavity resonators interconnecting pairs of electron-receiving portions, said cathode having a pair of electrical terminals, said cathode being rigidly supported within said envelope and provided with an external electrical connection for one of its terminals, a lead-in conductor for the other of said terminals sealed through the wall of said envelope, a flexible electrical conductor connecting said lead-in conductor with the other of said terminals, and a tuning member for said cavity resonators carried by said lead-in conductor, the connection between said lead-in conductor and the wall of said envelope being sufficiently adjustable to provide an adjusting movement of said lead-in conductor and the tuning member carried thereby.

3. An electron discharge device comprising an envelope containing a cathode and an anode, said anode having a plurality of electron-receiving portions adjacent said cathode, and a cavity reso-

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nator interconnecting each pair of electron-receiving portions, said cathode having a pair of electrical terminals, a pair of lead-in conductors for said cathode sealed through the wall of said envelope, said cathode being supported by one of said lead-in conductors rigidly connected to one end of said cathode and electrically connected to one of said terminals, the other of said lead-in conductors being connected to the other of said cathode terminals by a flexible connection, and a tuning member for said cavity resonator carried by said last-named lead-in conductor, the connection between said last-named lead-in conductor and the wall of said envelope being sufficiently adjustable to provide an adjusting movement of said lead-in conductor and the tuning member carried thereby.

4. An electron discharge device comprising an envelope containing a cathode and an anode, said anode having a plurality of electron-receiving portions adjacent said cathode, and a cavity resonator interconnecting each pair of electron-receiving portions, said cathode having a pair of electrical terminals, a pair of lead-in conductors for said cathode sealed through the wall of said envelope, said cathode being supported by one of said lead-in conductors rigidly connected to one end of said cathode and electrically connected to one of said terminals, the other of said lead-in conductors being connected to the other of said cathode terminals by a flexible connection, and a tuning member for said cavity resonator carried by said last-named lead-in conductor, the connection between said last-named lead-in conductor and the wall of said envelope being sufficiently adjustable to provide an adjusting movement of said lead-in conductor and the tuning member carried thereby, said last-named lead-in conductor having a member in sliding engagement with a portion of said cathode for assisting in the support of said cathode in the adjusted position of said last-named lead-in conductor.

5. An electron discharge device comprising an envelope containing a cathode and an anode, said anode having a plurality of electron-receiving portions adjacent said cathode, and a cavity resonator interconnecting each pair of electron-receiving portions, said cathode having a pair of electrical terminals, said cathode being rigidly supported within said envelope and provided with an external electrical connection for one of its terminals, a lead-in conductor for the other of said terminals, said lead-in conductor extending

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through a seal mounted at the outer end of a tubular extension mounted on said envelope, a flexible electrical conductor connecting said lead-in conductor with the other of said terminals, and a tuning member for said cavity resonator carried by said lead-in conductor, said tubular extension being capable of being bent into predetermined set positions to provide an adjusting movement of said lead-in conductor and the tuning member carried thereby.

6. A magnetron comprising an envelope containing a cathode and an anode, means for producing a magnetic field about said cathode, said anode having a plurality of electron-receiving portions adjacent said cathode, and a cavity resonator interconnecting each pair of electron-receiving portions, said cathode having a pair of electrical terminals, said cathode being rigidly supported within said envelope and provided with an external electrical connection for one of its terminals, a lead-in conductor for the other of said terminals sealed through the wall of said envelope, a flexible electrical conductor connecting said lead-in conductor with the other of said terminals, and a tuning member for said cavity resonator carried by said lead-in conductor, the connection between said lead-in conductor and the wall of said envelope being sufficiently adjustable to provide an adjusting movement of said lead-in conductor and the tuning member carried thereby.

7. A magnetron comprising an envelope containing a cathode and an anode, said anode having a plurality of electron-receiving portions adjacent said cathode, and a cavity resonator interconnecting each pair of electron-receiving portions, said cathode having a pair of electrical terminals, said cathode being rigidly supported within said envelope and provided with an external electrical connection for one of its terminals, a lead-in conductor for the other of said terminals, said lead-in conductor extending through a seal mounted at the outer end of a tubular extension mounted on said envelope, a flexible electrical conductor connecting said lead-in conductor with the other of said terminals, and a tuning member for said cavity resonator carried by said lead-in conductor, said tubular extension being capable of being bent into predetermined set positions to provide an adjusting movement of said lead-in conductor and the tuning member carried thereby.

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