

Dec. 3, 1946.

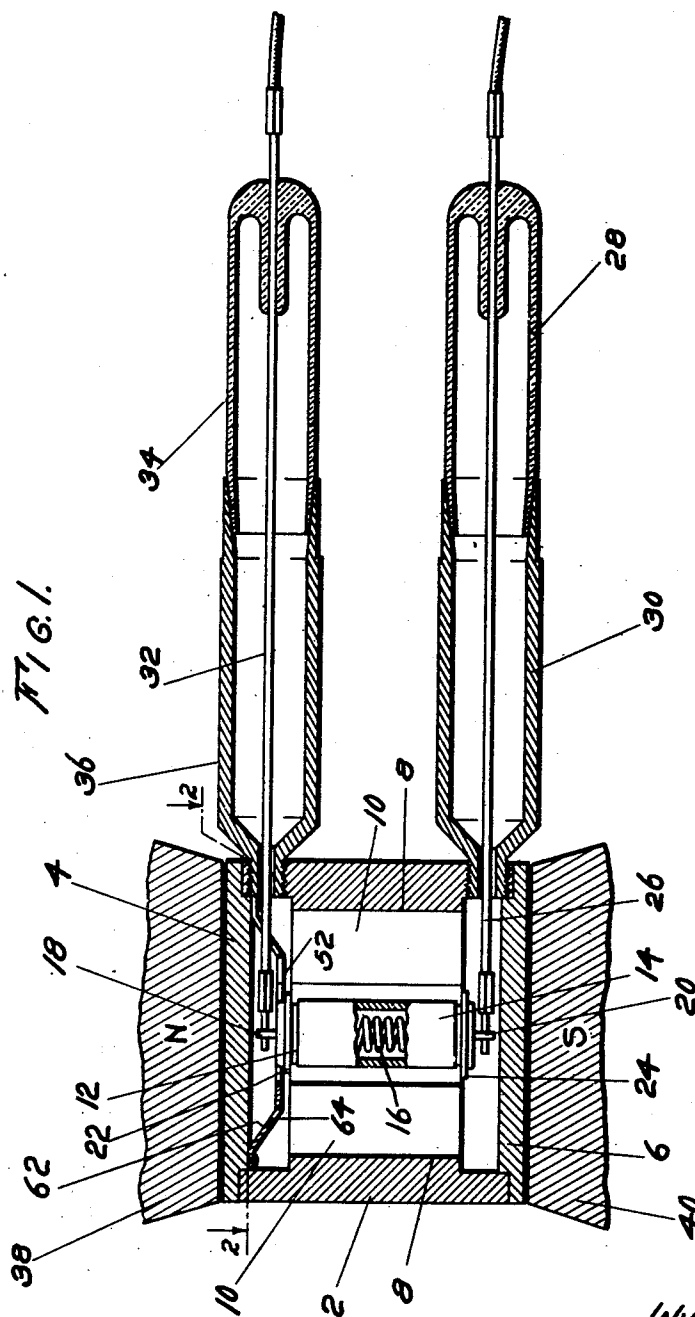
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ELECTRON DISCHARGE DEVICE OF THE MAGNETRON TYPE

· Filed May 27, 1944

2 Sheets-Sheet 1



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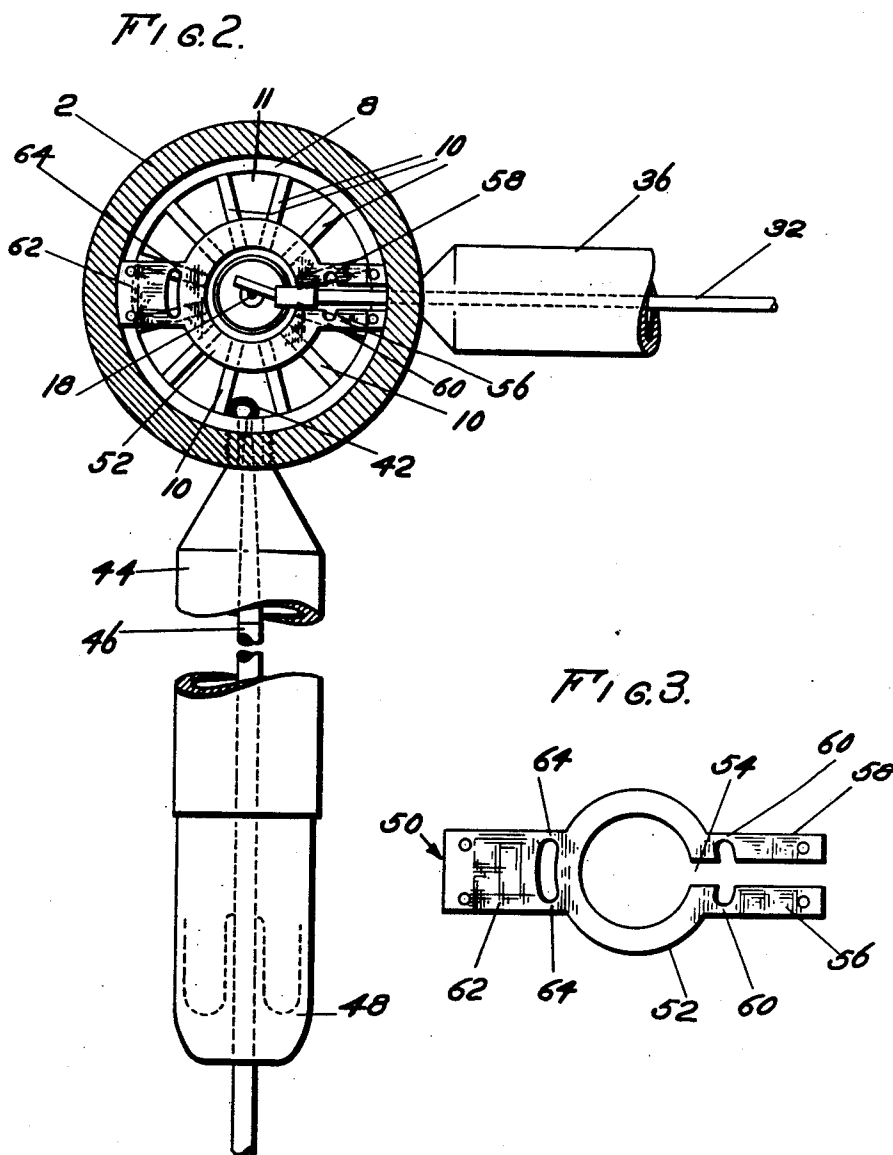
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UNITED STATES PATENT OFFICE

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ELECTRON DISCHARGE DEVICE OF THE MAGNETRON TYPE

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Application May 27, 1944, Serial No. 537,694

14 Claims. (Cl. 250—27.5)

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The present invention relates to electron discharge devices, such as magnetrons, and more particularly to those in which the frequency of the oscillations produced is determined by the dimensions of the internal structure.

In devices of the aforesaid type, variations in temperature tend to produce variations in the dimensions of the internal structure that are sufficient to cause large variations in frequency, whereby frequencies of oscillations produced by the device are outside the permissible frequency tolerances.

This may be objectionable, particularly in beacon operation, where the tube must be held within close frequency tolerances under all conditions.

An object of the present invention is to provide a device of the above specified type comprising simple, reliable means for keeping the frequencies within permissible frequency tolerances under varying temperature conditions.

The aforesaid object and such other objects and aims of the present invention as may hereinafter appear will be best understood from the following description, taken in connection with the accompanying drawings of one embodiment of the invention herein presented for illustrative purposes.

In the drawings:

Fig. 1 is a vertical section through a magnetron embodying one illustrative embodiment of my invention;

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

Fig. 3 is a bottom plan view of the frequency stabilizing member.

The illustrative embodiment of the invention shown in the drawings comprises a cylindrical envelope 2, closed at both ends by caps 4 and 6 hermetically soldered in place on the ends of said envelope. Said envelope 2 and said caps 4 and 6 are made of copper or other suitable conductive material, and said envelope is formed with a central annular projection 8 upon its inner surface to which are soldered a plurality of suitably spaced radially disposed plates 10. The inner ends of said plates form anode faces which cooperate with a cathode 12 supported substantially centrally of said anode faces. Said plates 10 may be stamped out of a sheet of highly conductive copper. The cathode 12 will preferably be of the indirectly heated, oxide-coated, thermionic type provided with an outer conducting sleeve 14, coated with electron-emissive oxides, and an internal heater 16 of which the end conductors 18 and 20 project from the opposite ends

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of the cathode structure 12. One of said conductors, the conductor 20 for example, may be electrically connected to said outer cathode sleeve 14 while the other conductor will be insulated from said sleeve. To prevent electron beams from being projected outwardly toward the end caps 4 and 6, light, conducting shields 22 and 24 may be supported adjacent the upper and lower ends of cathode 12. The cathode 12 is preferably supported by a cathode and heater lead-in conductor 26 welded to the end of conductor 20, which, as above stated, is electrically connected to the cathode 12 and to one end of the cathode heater 16. The lead-in conductor 26 is sealed through a glass seal 28 mounted at the outer end of a conducting pipe 30 extending through the wall of the envelope 2 and hermetically fastened therein adjacent the lower end thereof. A second lead-in conductor 32 is sealed through a similar glass seal 34 mounted at the outer end of a conducting pipe 36 likewise hermetically sealed through the wall of the envelope 2 at the upper end thereof. The inner end of said lead-in conductor 32 may be welded to the outer end of said conductor 18.

When such a magnetron is placed between suitable magnetic poles 38 and 40 to create a longitudinal magnetic field, and the device is energized, oscillations will be set up which may be led out from the tube by a coupling loop 42 extending into the space between two of said plates 10. One end of said coupling loop is connected to the inner end of a conducting pipe 44, hermetically sealed through the wall of the envelope 2 substantially midway between the ends thereof, and its other end is connected to a conductor 46 which passes through said pipe 44 and is sealed through a glass seal 48 mounted at the outer end of said pipe 44. For the purpose of simplicity the pipe 44 is shown as broken away at its central portion, but it is understood that said pipe may be substantially of the same length as pipes 30 and 36 of Fig. 1. An additional conducting pipe, not shown, may be electrically connected to said pipe 44 and form with said conductor 46 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 or plates 10, together with the portion of the projection 8 between them, form an oscillating cavity 11. A capacitance exists between the cathode 12 and the end faces of said anode arms 10. Capacitances also exist between the side walls of each oscillating cavity. The conductive path around each cavity, afforded

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by the side walls thereof, constitutes an inductance. The anode, therefore, is so designed and spaced relatively to the cathode that the inductances and capacitances described constitute tuned circuits. It is desired that these circuits shall be resonant at definite predetermined frequencies at which the device is to be operated. The device is intended to operate so that each oscillating cavity 11 is tuned to the frequency at which each of the other oscillating cavities 11 oscillates.

As stated in the beginning of this specification, one of the objects of the present invention is to provide simple and reliable means which will make it possible to hold the frequencies of oscillations produced by devices of the general type referred to within permissible frequency tolerances under varying temperature conditions.

In the illustrative embodiment of the present invention shown in the drawings, said means comprises a member of relatively thin metal or other suitable material adapted to expand and contract responsive to changes in temperature and herein indicated generally by the reference numeral 50. Said member herein conveniently comprises a flat, annular portion or ring 52 slotted at 54. This annular portion is supported by a plurality of opposed arms having their free ends secured to a suitable support, such as the cap 4 of the envelope 2 for example. Herein two parallel arms 56 and 58 are joined to the edge of said annular portion adjacent the opposite edge of said slot 54 by reduced portions 60 integral with said annular portion 52 and with said arms 56 and 58. A third arm 62 is joined to the edge of said annular member on the side diametrically opposed to arms 56 and 58 by reduced portions 64 integral with said annular portion and with said plate 62. Said arms 56, 58 and 62 are bent angularly to the plane of said annular portion at their points of junction with the edge of the latter. Said member 50 is firmly secured at the free ends of said arms 62, 56 and 58 by screws or any other suitable means to the underside of the cap 4 of the envelope 2 or other suitable support therefor, in such manner that when the device is assembled the flat, annular portion 52 of said member 50 will be in juxtaposition to the inner ends of the anode plates 10.

The space between arms 56 and 58 and the slot 54 in said annular portion 52 are provided to accommodate the inner end portion of lead-in conductor 32. Said member 50 may be made in any suitable manner, as by machine-stamping, for example.

The dimensions of said member 50, envelope 2 and cap 4 will vary with variations in temperature, thus varying the position of said annular portion 52 of said member 50 relatively to said anode plates 10 and to the oscillating cavities formed by the latter and the portions of the projection 8 between said plates.

I have discovered that by making said member 50 of a metal or other suitable material having a suitable coefficient of expansion in respect to that of the other parts of the magnetron structure above referred to, and particularly in respect to the part from which said member is suspended, and mounting said member 50 so that the angle formed by the inner surfaces of the arms 56, 58 and 62 with the surface of the support upon which said member is mounted is such that at a given temperature the frequency of oscillation generated by the device is at a predetermined value, then the resultant of the changes in the dimensions of the parts with variations in tem-

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perature, as set forth in the preceding paragraph, will cause an automatic adjustment of said member 50 relatively to said anode plates 10 and said oscillating cavities, that will keep the frequency of oscillations generated by the device within permissible frequency tolerances, irrespective of variations in temperature.

In the illustrative embodiment of the invention, the angle formed by the upper surface of arms 56, 58 and 62 with the under surface of said cap 4 is an acute angle and I have found that in such case the coefficient of expansion of the member 50 should be less than that of the magnetron structure, more particularly of the support, herein cap 4, to which said member is secured. As the magnetron structure herein illustratively consists of copper, of which the coefficient of expansion is about 16, the member 50 will preferably be made of molybdenum which has a coefficient of expansion of about 4.

In accordance with my present understanding of the operation of the present invention, varying the position of the member 50 relatively to the oscillating cavity or cavities 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 frequency of the magnetron in the desired manner and thus keep the frequencies within the permissible tolerances.

The tube having been assembled with the tuning member 50 and with the arms 56, 58 and 62 at a predetermined preliminary angle to said cap 4 as above described, so that at a given temperature the frequency of oscillations generated by the device is at a predetermined value, a rise in temperature will expand the anode structure and its oscillating cavities and thus tend to reduce the frequency of the oscillations generated. This same rise in temperature, however, by expanding the cap 4 to which the arms of the tuning member 50 are attached, will tend to pull the inclined supporting arms of said tuning member in opposite directions, and to straighten out said member and lift the annular portion 52 away from said anode structure. This tends to increase the frequency. A fall in temperature will have the opposite effect, movements of said parts being reversed. If the metal or other suitable material of which the said tuning member is made, possesses the predetermined correct coefficient of expansion with respect to that of said cap 4 or other part to which said member is secured, and if the angle between the arms 56, 58 and 62 and the cap 4 is of the proper value, these relative adjustments of said anode structure and said tuning member will substantially compensate each other with the result that, as previously explained, the frequency of the oscillations generated by the device will be kept within permissible frequency tolerances, irrespective of changes in temperature.

It will be noted that the reduced portions 60, 64 by which the annular portion 52 of said tuning member 50 is joined to its supporting arms 56, 58 and 62 facilitate flexure of said tuning member and thus increase the ease and smoothness of its operation.

Wherever the expression "a plurality" occurs in this description and claims, it is to be construed as meaning two or more.

I am aware that the present invention can be embodied in other specific forms without departing from the spirit or essential attributes thereof, and I therefore desire the present description to

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be considered in all respects as illustrative and not restrictive, reference being had to the appended claims rather than to the aforesaid description to indicate the scope of the invention.

What is claimed is:

1. An electron discharge device comprising an envelope containing a cathode, an anode structure comprising a plurality of electron-receiving portions adjacent said cathode, and a cavity resonator interconnecting each pair of said electron-receiving portions, said resonators having inductance and capacitance, a tuning member, a support for said tuning member, said tuning member comprising a central portion adjacent said anode structure and provided with supporting arms angularly disposed thereto, said arms being joined to said support at a predetermined angle to the surface thereof to which they are joined, said support and said tuning member having different coefficients of expansion.

2. An electron discharge device comprising an envelope containing a cathode, an anode structure comprising a plurality of electron-receiving portions adjacent said cathode, and a cavity resonator interconnecting said electron-receiving portions, said resonator having inductance and capacitance, a tuning member, a support for said tuning member, said tuning member comprising a portion adjacent said anode structure, and supporting arms therefor joined to said support, said supporting arms forming a predetermined angle with the surface of said support to which they are joined, said support and said tuning member having different coefficients of expansion.

3. An electron discharge device comprising an envelope containing a cathode, an anode structure comprising a plurality of electron-receiving portions adjacent said cathode, and a cavity resonator interconnecting each pair of said electron-receiving portions, said resonators having inductance and capacitance, a tuning member, and a support for said tuning member, said tuning member having a lower coefficient of expansion than that of said support and comprising a portion adjacent said anode structure, and supporting arms joined to said support and forming an acute angle with the surface to which they are joined.

4. An electron discharge device comprising an envelope containing a cathode, an anode structure comprising a plurality of electron-receiving portions adjacent said cathode, and a cavity resonator interconnecting said electron-receiving portions, said resonator having inductance and capacitance, a tuning member, a support for said tuning member, said tuning member comprising a portion adjacent said anode structure, and supporting arms therefor joined to said support and forming a predetermined acute angle with the surface of said support to which they are joined, said tuning member having a lower coefficient of expansion than that of said support.

5. An electron discharge device comprising an envelope containing a cathode, an anode structure comprising a plurality of electron-receiving portions adjacent said cathode, a cavity resonator interconnecting each pair of said electron-receiving portions, said resonators having inductance and capacitance, and a tuning member carried by said envelope adjacent said anode structure and having a preselected coefficient of expansion, said envelope having a coefficient of expansion different from that of said tuning member, said tuning member and said anode structure being relatively adjustable by variations in

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the dimension of said tuning member and in the dimensions of said envelope, caused by variations in temperature, to vary the capacitance of said resonators and tune the frequency of oscillations generated by said device and keep the frequency within permissible frequency tolerances, irrespective of varying temperature conditions.

6. An electron discharge device comprising an envelope containing a cathode, an anode structure comprising a plurality of electron-receiving portions adjacent said cathode, a cavity resonator interconnecting each pair of said electron-receiving portions, said resonators having inductance and capacitance, and a tuning member carried by said envelope adjacent said anode structure and having a preselected lower coefficient of expansion than that of said envelope, said tuning member and said anode structure being relatively adjustable by variations in the dimension of said tuning member and in the dimensions of said envelope, caused by variations in temperature, to vary the capacitance of said resonators and tune the frequency of oscillations generated by said device and keep the frequency within permissible frequency tolerances, irrespective of varying temperature conditions.

7. An electron discharge device comprising an envelope containing a cathode, an anode structure comprising a plurality of electron-receiving portions adjacent said cathode, a cavity resonator interconnecting said electron-receiving portions, said resonator having inductance and capacitance, and a tuning member carried by said envelope adjacent said anode structure, said tuning member and said envelope having different coefficients of expansion, and said tuning member and said anode structure being relatively adjustable by variations in the dimension of said tuning member and in the dimensions of said envelope, caused by variations in temperature, to vary the capacitance of said resonators and tune the frequency of oscillations generated by the device and keep the frequency within permissible frequency tolerances, irrespective of varying temperature conditions.

8. An electron discharge device comprising an envelope containing a cathode, an anode structure comprising a plurality of electron-receiving portions adjacent said cathode, a cavity resonator interconnecting each pair of said electron-receiving portions, said resonator having inductance and capacitance, a tuning member, a support for supporting said tuning member adjacent said anode structure, said tuning member and said support having different coefficients of expansion, said tuning member and said anode structure being relatively adjustable by variations in the dimension of said tuning member and in the dimensions of said support, caused by variations in temperature, to vary the capacitance of said resonators and tune the frequency of oscillations generated by said device and keep the frequency within permissible frequency tolerances, irrespective of varying temperature conditions.

9. An electron discharge device comprising an envelope containing a cathode, an anode structure comprising a plurality of electron-receiving portions adjacent said cathode, a cavity resonator interconnecting each pair of said electron-receiving portions, said resonator having inductance and capacitance, and a tuning member comprising a plurality of arms projecting at an angle thereto from opposite sides thereof and secured at an acute angle to said envelope with said member adjacent said anode structure, said tuning mem-

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ber having a preselected coefficient of expansion that is lower than that of said envelope, said tuning member and said anode structure being relatively adjustable by variations in the dimension of said tuning member and in the dimensions of said envelope, caused by variations in temperature, to vary the capacitance of said resonators and tune the frequency of oscillations generated by said device and keep the frequency within permissible frequency tolerances, irrespective of varying temperature conditions.

10. A magnetron comprising an envelope containing a cathode, an anode structure adjacent said cathode and having inductance and capacitance, and a tuning member carried by said envelope and mounted at a predetermined distance from said anode structure and possessing a predetermined coefficient of expansion that is different from that of said envelope, said tuning member and said anode structure being relatively adjustable by variations in the dimension of said tuning member and in the dimensions of said envelope due to changes in temperature.

11. A magnetron comprising an envelope containing a cathode, an anode structure adjacent said cathode and having inductance and capacitance, and a tuning member carried by said envelope adjacent said anode structure and having a coefficient of expansion different from that of

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said envelope and of said anode structure, said tuning member and said anode structure being relatively adjustable by variations in the dimension of said tuning member and in the dimensions of said envelope, caused by variations in temperature, to vary the capacitance of said anode structure and tune the frequency of oscillations generated by said magnetron and keep the frequency within permissible frequency tolerances, irrespective of variations in temperature.

12. A tuning member for magnetrons, said tuning member consisting of a flat portion provided with opposed supporting arms angularly disposed to said flat portion and connected to the latter by reduced portions integral with said flat portion and with said arms.

13. A tuning member for magnetrons, said tuning member consisting of a flat, annular portion and opposed supporting arms integral with said annular portion located on opposite sides thereof and inclined to the plane thereof.

14. A tuning member for magnetrons, said tuning member comprising a flat, annular portion, opposed supporting arms for said annular portion inclined to the plane thereof, and flexible connections between said arms and said annular portion.

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