Feb. 20, 1951 W. C. BROWN 2,542,899

CAVITY RESONATOR ELECTRON DISCHARGE DEVICE

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FIG. 1.

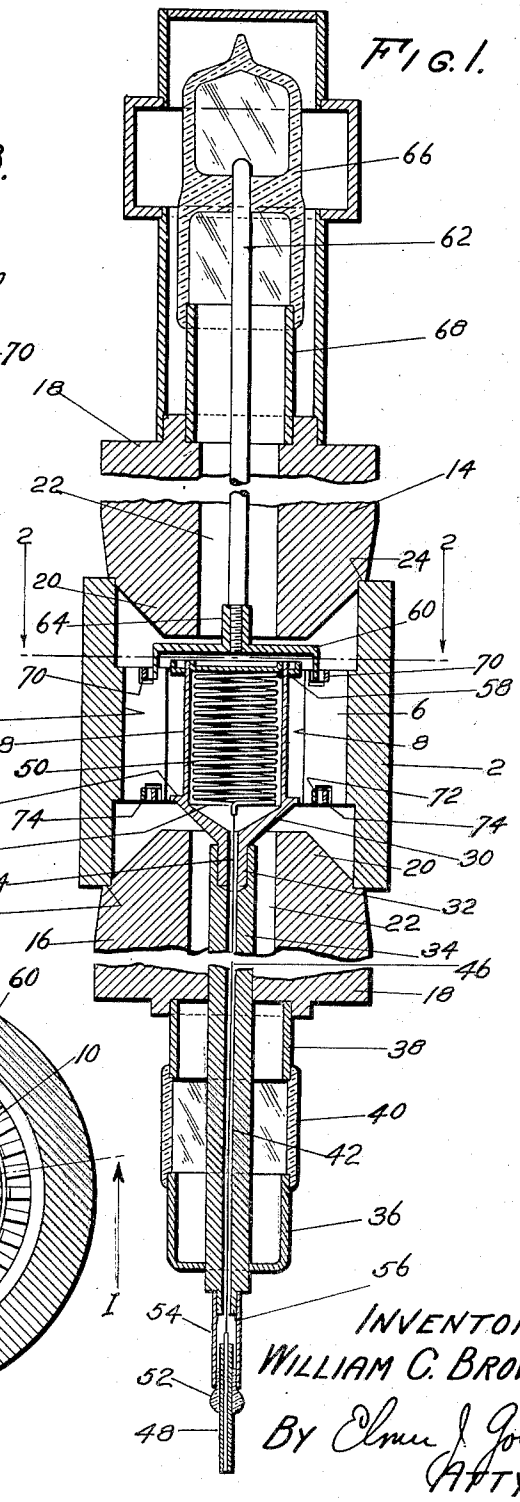


FIG. 3.

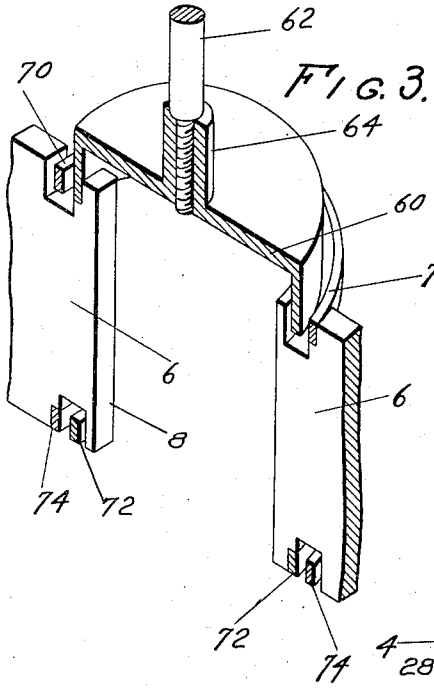
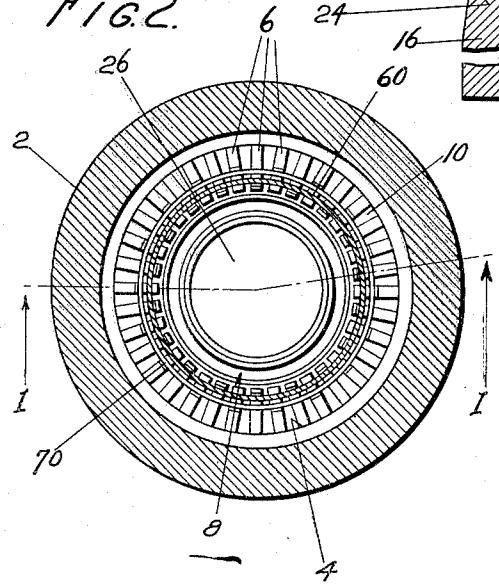


FIG. 2.



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CAVITY RESONATOR ELECTRON DISCHARGE DEVICE

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9 Claims. (Cl. 315—40)

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This invention relates to electron discharge devices having a plurality of cavity resonators, and more particularly to those for generating oscillations of short wave lengths.

As the power delivered by such a device is dependent upon the number of cavity resonators it contains, and as the wave length of the oscillations generated by a cavity resonator is shorter or longer according as the cavity is smaller or larger, it follows that to obtain increased power with a device for generating ultra-short waves will require a considerable increase in the number of cavity resonators contained in the device. Experience has shown, however, that there is a limit beyond which an increase in the number of cavity resonators is liable to give rise to objectionable phenomena, such as the generation of spurious oscillations, and a decrease in the effectiveness of cavities remote from the cavity coupled to the usual type of output coupling device, very little, if any of the energy generated in these remote cavities reaching said output coupling device.

One of the objects of the present invention is to enable the number of cavity resonators, and therefore the generation of power of short wave length in electron discharge devices of the general type referred to, to be materially increased without giving rise to the objectionable phenomena referred to.

Another object of the invention is to provide an electron discharge device of the aforesaid general type comprising a symmetrical coupling for all of the resonant cavities.

A further object of the present invention is to provide an electron discharge device having an output coupling which shall exert its energy absorbent power equally with respect to each of the cavity resonators of the device.

These objects of the present invention and such other aims and objects thereof as may hereinafter appear will be best understood from the following description, taken in connection with the accompanying drawing of a short wave, high power generating electron discharge device incorporating one illustrative embodiment of the invention herein presented for illustrative purposes.

In the drawing:

Fig. 1 is a central, longitudinal section of said short wave, high power electron discharge device incorporating one illustrative embodiment of the invention, taken on line 1—1 of Fig. 2;

Fig. 2 is a horizontal cross-section of the device on line 2—2 of Fig. 1; and

Fig. 3 is a perspective view showing the energy absorbent part of the output coupling and how it cooperates with the resonant cavities.

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The illustrative embodiment of the present invention shown comprises an anode structure including a cylindrical member 2 having upon its inner surface a central, cylindrical projection 4 to which are soldered a plurality of suitably spaced, radially disposed anode arms 6, the inner edge surfaces of which constitute anode faces 8 to receive electrons from the cathode. Each pair of said anode arms 6, with the intervening portion of said cylindrical projection 4, constitutes a cavity resonator 10. (See Fig. 2.) Said cylindrical member 2 is hermetically sealed at both ends, thus forming an hermetically sealed envelope or enclosure. In the illustrative embodiment of the invention shown, pole pieces 14 and 16 are conveniently used for this purpose, said pole pieces each conveniently comprising a cylindrical portion 18 terminating in a substantially conical portion 20 projecting into the opposite ends, respectively, of said cylindrical member 2. Each of said pole pieces comprises an axial bore 22 and said conical portions 20 are each encircled by a slot 24 rectangular in cross-section and engaged by the rectangular edge of the inner wall of said cylindrical member 2 to which it is soldered, preferably with silver solder, thus completing the hermetical sealing of the envelope. Said cylindrical member 2 and anode arms 6 will preferably be made of copper, said arms being conveniently stamped from a sheet of highly conductive copper. The aforesaid anode faces 8 cooperate with a cathode 26 supported substantially centrally of said anode faces 8, said cathode being preferably of the indirectly heated, thermionic type and comprising a conductive wall 26 of nickel or other suitable conductive material, which may be coated with an electron-emissive coating of barium and strontium oxide or other suitable electron-emissive coating material. Said cathode is supported by a suitable support 30 which may be integral with said cathode sleeve 26. Said support 30 is provided with a central cylindrical portion 32 securely seated in the inner end of a conductor 34 extending axially of the axial bore 22 of the pole piece 16 and sealed through a conductive sleeve 36. Said sleeve 36 is connected to another conductive sleeve 38 by a glass seal 40, said sleeve 38 being soldered at its inner end to the outer end of said pole piece 16. Said conductor 34 and said cathode support 30 are provided with axially aligned bores 42 and 44, respectively. A lead-in wire 46 extends axially of said bores and is connected at its outer end

to a lead-in conductor 48, its inner end portion terminating in a helically wound cathode heater wire 50 contained within said cathode 26 and connected at its upper end to the interior surface of said conductive cathode sleeve 28. Said lead-in conductor 48 is sealed through a glass seal 52 in the outer end of a metal sleeve 54, the inner end of which is soldered to the reduced end 56 of said conductor 34. The lead-in conductor 48 thus serves to heat the cathode, while electrical connection to the cathode wall may be made at conductor 36. Light, protective shields 58 of tantalum or other suitable metal may be provided at each end of said cathode 26 to prevent electron beams from being projected outwardly toward said pole pieces 14 and 16 from said cathode. Said shields may be supported in any suitable manner. Herein said shields are conveniently made integral with said cathode wall 28.

If the above described device he energized and a longitudinal magnetic field be excited within the device by suitable means, as for example by supplying said pole pieces 14 and 16 with a magnetic field from an external magnet, oscillations will be generated in the cavity resonators 10 which may be led out of the device to a suitable utilizing circuit by means comprising an output coupling device.

The present invention contemplates the provision of novel means for this purpose, comprising an output coupling device which shall absorb the energy generated in the cavity resonators symmetrically from all of said cavities. In the illustrative embodiment of the invention herein shown, said coupling conveniently comprises an electrically conductive member preferably of copper in the form of a circular cap 60, which engages alternate anode arms 6 at one end of the anode structure. The energy thus collected by said coupling cap 60 is led out through a coaxial line formed by a central conductor 62 and said pole piece 14, said pole piece being copper-plated within the bore 22 for the purpose, whence it can be supplied to any suitable utilizing circuit through any suitable conventional wave guide or the like. Said central conductor 62 has its inner end electrically connected to the center of said circular cap 60 by screw-threaded connection with the hub 64 of said cap, the other end of said conductor 62 being sealed in a glass seal 66 hermetically sealed to one end of an electrically conductive sleeve 68 of suitable sealing metal, the other edge of said sleeve 68 being soldered to the upper edge of the axial bore 22 of said pole piece 14.

For the best results the dimensions of said coaxial line should be such as to produce a substantial impedance match between the tube and the load.

Said coupling cap 60, by its connection with alternate anode arms 6 at one end of the anode structure, replaces one of the straps, herein the inner strap 69, used to arrest the generation of spurious oscillations. (See Fig. 3.) The other or outer strap connecting the intervening anode arms at that end of the anode structure is shown at 70. At the other end of the anode structure those anode arms to which the coupling cap 60 is connected are connected by an outer strap 74, and the intervening arms to which the strap 70 is connected are interconnected by an inner strap 72.

In operation the polarity of the anode arms is constantly shifting, alternate anode arms being always of the opposite polarity to that of the intervening arms. By its connection with the alternate anode arms the coupling cap 60 carries off the energy from all of said alternate arms to the conductor 62, while that from the intervening anode arms is carried off to the pole piece 14, said conductor and said pole piece forming the central and outer conductors respectively of a coaxial line through which the energy collected by said coupling cap 60 is caused to flow out due to the difference of potential of said two conductors. By the simple, compact structure used, applicant obtains the same result as though a separate coupling loop were provided within each separate resonant cavity, but without the complicated structure and planning such an arrangement would entail. Each cavity resonator is connected directly to the central coaxial conductor and not indirectly through one or more other cavity resonators. The coupling cap exerts its energy absorbent power to its full capacity upon each of the resonant cavities.

Wherever the expression "a plurality" occurs, 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 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 hermetically sealed at both ends by pole pieces and containing a cathode, an anode including a plurality of anode arms having electron-receiving portions adjacent said cathode, and energy-generating cavity resonators interconnecting said electron-receiving portions, electrically conductive straps connecting alternate anode arms at each end of said anode, a conductor connected to one of said straps and extending axially of a bore provided axially in one of said pole pieces, said pole piece being electrically conductive, said conductor and said pole piece forming the center conductor and the outer conductor, respectively, of a coaxial line through which oscillations generated by the device may be conducted out of the device.

2. An electron discharge device comprising a cathode, an anode including a plurality of anode arms having electron-receiving portions adjacent said cathode, energy-generating cavity resonators interconnecting said electron-receiving portions, a pair of electrically conductive straps connecting, respectively, alternate and intervening anode arms, said straps being concentrically disposed and lying in a substantially common plane, and an output coupling including one of said straps.

3. An electron discharge device comprising a cathode, an anode including a plurality of anode arms having electron-receiving portions adjacent said cathode, energy-generating cavity resonators interconnecting said electron-receiving portions, a pair of electrically conductive straps connecting, respectively, alternate and intervening anode arms at each end of said anode, the straps at each end of said anode being concentrically disposed and lying in a substantially common plane, and an output coupling including one of said straps.

4. An electron discharge device comprising an

hermetically sealed, electrically-conductive envelope containing a cathode and including an anode provided with a plurality of anode arms having electron-receiving portions adjacent said cathode and energy-generating cavity resonators interconnecting said electron-receiving portions, an electrically conductive strap connecting alternate anode arms, a second electrically conductive strap connecting intervening anode arms, and a coaxial line comprising a center conductor and an outer conductor for conducting energy generated by the device out of the latter, said center conductor being connected to said conductive strap connecting alternate anode arms, and said outer conductor being connected to said intervening anode arms.

5. An electron discharge device comprising an hermetically sealed electrically-conductive envelope containing a cathode and including an anode including a plurality of alternate and intervening anode arms having electron-receiving portions adjacent said cathode and energy-generating cavity resonators interconnecting said electron-receiving portions, means for exciting a longitudinal magnetic field within the device, an electrically conductive strap connecting said alternate anode arms, and a coaxial line comprising a center conductor and an outer conductor for conducting energy generated by the device out of the latter, said center conductor being connected to said conductive strap, said outer conductor being connected to said intervening anode arms.

6. An electron discharge device comprising: a cathode, a hollow, open-ended anode, including a plurality of cavity resonators, surrounding said cathode, pole pieces hermetically sealed to said anode at the open ends thereof, and an output coupling engaging each of said cavity resonators.

7. An electron discharge device comprising: a cathode, a hollow, open-ended anode, including a plurality of cavity resonators, surrounding said cathode, pole pieces hermetically sealed to said

anode at the open ends thereof, an energy absorbing member engaging each of said cavity resonators, and a conductor engaging said energy absorbing member and passing out of said device through a bore in one of said pole pieces.

8. An electron discharge device comprising: a cathode, a hollow, open-ended anode, including a plurality of cavity resonators, surrounding said cathode, pole pieces hermetically sealed to said anode at the open ends thereof, and an output coupling engaging each of said cavity resonators, one of said pole pieces being electrically conductive and defining, together with said output coupling, a transmission line.

9. An electron discharge device comprising: a cathode, a hollow, open-ended anode, including a plurality of cavity resonators surrounding said cathode, pole pieces, one of which is electrically conductive, hermetically sealed to said anode at the open ends thereof, an energy absorbing member engaging each of said cavity resonators, and a conductor engaging said energy absorbing member and passing out of said device through a bore in one of said electrically conductive pole pieces, said conductor and said electrically conductive pole piece constituting a transmission line.

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