July 25, 1950 A. F. PEARCE 2,516,643

ELECTRON DISCHARGE DEVICE INCLUDING A HOLLOW RESONATOR

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Fig. 1

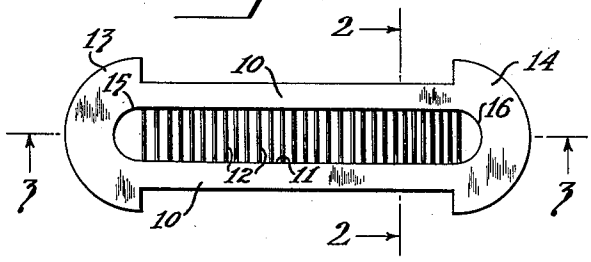

Fig. 2

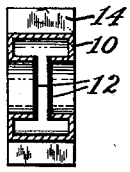

Fig. 3

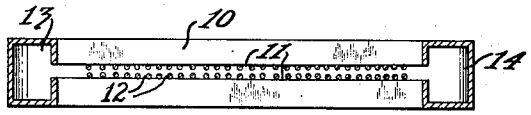

Fig. 4

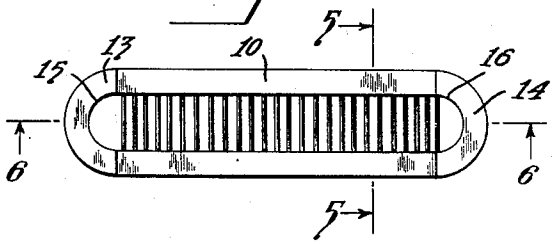

Fig. 5

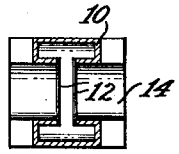

Fig. 6

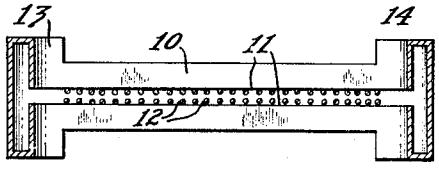

Fig. 7

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Fig. 8

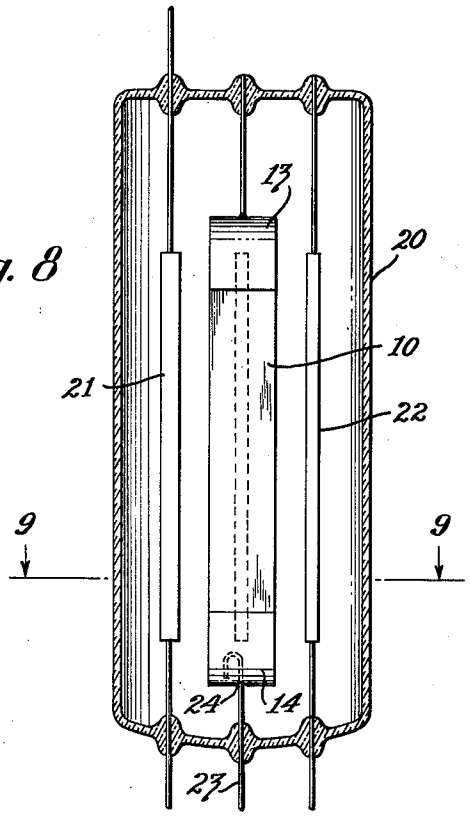
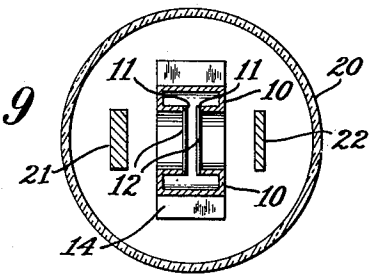


Fig. 9



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Patented July 25, 1950 2,516,643

UNITED STATES PATENT OFFICE

2,516,643

ELECTRON DISCHARGE DEVICE INCLUDING A HOLLOW RESONATOR

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Application November 29, 1946, Serial No. 713,002
In Great Britain June 11, 1943

Section 1, Public Law 690, August 8, 1946
Patent expires June 11, 1963

10 Claims. (Cl. 315—5)

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This invention relates to hollow electrical resonators and more particularly to resonators which have elongated apertures through which a ribbon shaped beam of electrons may pass in order to excite the resonator cavity.

In such resonators it is desirable that the alternating potential set up in the resonator should be constant at all points along the length of the apertures in the resonator. It is necessary to close the ends of the resonator in order to prevent the escape of energy from the otherwise open ends and usually the ends of the resonator of the kind referred to are closed by semi-circular portions of the same cross-sectional area as the resonator. It is found, however, with such a construction that if the length of the apertures is less than a wavelength of the operating frequency, the alternating potential is a maximum midway of the length of the apertures and decreases in amplitude towards the ends of the gap. If, however, the length of the apertures is equal to or greater than a wavelength of the operating frequency, then a plurality of points of maximum alternating potential will exist along the apertures with points of lower alternating potential therebetween.

An object of the present invention is to provide an improved resonator having elongated apertures with a view to maintaining the alternating potential more nearly constant along the length of the apertures.

Another object of the invention is to provide an electron discharge device utilizing the improved resonator.

An advantage of the invention is that hollow resonators having longitudinal apertures may be made in various forms with a more constant voltage distribution along the aperture.

Other objects and advantages will be apparent from the following description of the invention, pointed out in particularity in the appended claims and taken in connection with the accompanying drawings in which:

Fig. 1 is an elevation of a resonator constructed in accordance with one embodiment of the invention;

Fig. 2 is a cross-sectional view taken along the line 2—2 of Fig. 1 and looking in the direction of the arrows;

Fig. 3 is a longitudinal sectional view of Fig. 1 taken along the line 3—3;

Fig. 4 is an elevation of a further embodiment of the invention;

Fig. 5 is a cross-sectional view taken along the line 5—5 of Fig. 4;

Fig. 6 is a longitudinal sectional view taken along the line 6—6 of Fig. 4;

Fig. 7 is an elevation of the end portion of the resonator shown in Fig. 1 embodying a modification;

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Fig. 8 is a side elevational view partly in section of an electron discharge device incorporating the improved resonator; and

Fig. 9 is a cross-sectional view taken along the line 9—9 of Fig. 8.

Referring now to Figs. 1, 2, and 3 of the drawings, the resonator comprises two elongated hollow resonator sections 10 disposed parallel to each other the opposed walls of which are provided with elongated apertures 11 which together define two opposed elongated gaps across which a ribbon-shaped electron beam can pass. The opposite longitudinal edges of each of said apertures are joined by grid wires indicated at 12. The resonant frequency of such a resonator section is determined by its physical dimensions and the capacity at the gap thereof. As stated above, it is found that with a resonator of such form the alternating potential is not constant along the length of the apertures. In accordance with the invention with a view to maintaining the amplitude of the alternating potential more constant along the length of the apertures the ends of the resonator sections 10 are closed by resonator end portions 13 and 14, each of said portions constituting one-half of a toroidal resonator which is resonant at substantially the same frequency as the resonator sections 10. The ends of the opposed walls of the resonator sections 10 are connected by the semi-circular slotted walls 15 and 16, the end portions 13 and 14 thus each being one-half of a toroidal resonator having a central circular gap connecting the opposed ends of the apertures 11. Since the end portions 13 and 14 have substantially the same resonant frequency as the resonator sections 10, such will usually entail the necessity of making the end portions of larger cross-sectional area that the resonator sections 10. This is accomplished in Figs. 1, 2, and 3 of the drawings by making the radial depth of the portions 13 and 14 larger than the corresponding depth of the resonator sections 10, as shown. Alternatively, the width of the end portions 13 and 14 may be made larger than the width of the resonator sections 10 as illustrated in the form of the invention shown in Figs. 4, 5, and 6. Further, both the width and the depth of the end portions can be increased, if required.

It may be desirable to avoid any abrupt changes in the configuration of the resonator where the end portions 13 and 14 join the resonator sections 10 and in order to avoid such abrupt changes, the junction between the end portions and the resonator sections may be inclined as indicated at 17 in Fig. 7.

The use of the resonator shown in Figs. 1, 2, and 3 in an electron discharge device is illustrated in Figs. 8 and 9. In the evacuated envelope 20, which may be glass or metal, there is

suitably supported on one side of the resonator a cathode 21 so constructed as to produce a ribbon-shaped beam of electrons having approximately the width and the length of the central space between the resonator sections. On the other side of the resonator and aligned with the cathode 21 and said central space is an anode 22 for collecting the electrons from the cathode after they travel past the grid wires 12 and the apertures 11. An output electrode 23 may be provided in the form of a loop entering one end portion through a suitable insulating bead 24. Terminals for the various electrodes may be brought out through seals in the envelope 20 as shown.

In one example of the invention a resonator of the form shown in Figs. 1 to 3 designed for operation at 10,000 megacycles may have a width of 13 mms., a distance between the grids of 2 mms., and a depth of 4.8 mms. The width of the apertures in the resonator may be 6 mms., and the outer diameter of the end portions 13 and 14, 18 mms. The length of the resonator may be as long as desired.

I claim:

1. A resonator of the cavity type comprising an elongated conducting body enclosing a cavity and resonant at a predetermined frequency, enlarged resonator end portions terminating the ends of said body, each of said portions having conducting walls enclosing an enlarged cavity opening into the cavity of said body, said enlarged portions combined being resonant substantially at said predetermined frequency.

2. A resonator of the cavity type comprising an elongated hollow tubular member enclosing a cavity and resonant at a predetermined frequency, one side of said member having an elongated aperture extending along its entire length, a resonator portion terminating each end of said tubular member and having conducting walls enclosing a space into which said cavity extends, said end portions combined being resonant substantially at said predetermined frequency.

3. A resonator of the cavity type comprising a pair of elongated resonator sections resonant at a predetermined frequency disposed parallel to each other and forming a space therebetween adapted to pass an electron beam, longitudinal apertures in the opposed walls of said sections forming gaps opening into the cavities of said resonator sections, said resonator sections being adapted to be excited by electrons crossing said gaps, there being developed an alternating potential along the length of said apertures, a resonator end portion closing and connecting said sections at each end thereof, said end portions being parts of a resonator resonant substantially to said predetermined frequency, whereby said potential is maintained more constant along said apertures.

4. A resonator of the cavity type comprising a pair of elongated resonator sections resonant at a predetermined frequency disposed parallel to each other and forming a space therebetween adapted to pass an electron beam, longitudinal apertures in the opposed walls of said sections forming gaps opening into the cavities of said resonator sections, said resonator sections being adapted to be excited by electrons crossing said gaps, there being developed an alternating potential along the length of said apertures, an end portion closing and connecting said sections at each end thereof, said portions having a substantially larger cross-sectional area than said sections and being parts of a resonator resonant substantially at said predetermined frequency, whereby said potential difference is maintained more constant along said aperture.

5. A resonator of the cavity type comprising a pair of elongated resonator sections resonant at a predetermined frequency disposed parallel to each other and forming a space therebetween adapted to pass an electron beam, longitudinal apertures in the opposed walls of said sections opening into the cavities of said resonator sections, a semi-circular resonator portion closing and connecting said sections at each end thereof, each of said semi-circular portions having a larger cross-sectional area than said sections and forming one-half of a toroidal resonator resonant substantially at said predetermined frequency.

6. A resonator of the cavity type comprising a pair of elongated resonator sections resonant at a predetermined frequency disposed parallel to each other and forming a space therebetween adapted to pass an electron beam, longitudinal apertures in the opposed walls of said sections opening into the cavities of said resonator sections, a resonator portion of rectangular section closing and connecting said sections at each end thereof, each of said portions having a larger cross-sectional area than said sections and forming one-half of a resonator resonant substantially at said predetermined frequency.

7. An electron discharge device including a resonator of the cavity type comprising a pair of elongated resonator sections resonant at a predetermined frequency disposed parallel to each other and forming a space therebetween, cathode means for generating an electron beam, anode means for collecting the electrons of said beam, longitudinal apertures in the opposed walls of said sections forming opposed gaps opening into the cavities of said resonator sections whereby said sections may be excited by electrons of said beam crossing said gaps, there being developed an alternating potential along said apertures, a resonator end portion closing and connecting said sections at each end thereof, each end portion having a longitudinal slot in its inner wall forming a continuation of said apertures, said end portions being parts of a resonator resonant substantially at said predetermined frequency, whereby said potential is maintained more constant along the length of said apertures.

8. An electron discharge device according to claim 7, wherein the cross-sectional area of said resonator end portions is substantially larger than that of said elongated resonator sections.

9. A resonator according to claim 3, wherein the opposite longitudinal edges of each of said apertures are joined by grid wires.

10. An electron discharge device according to claim 7, wherein the opposite longitudinal edges of said apertures are joined by grid wires.

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