Nov. 6, 1945. V. L. RONCI 2,388,289

ELECTRON DISCHARGE DEVICE

Filed Aug. 8, 1941

FIG. 1

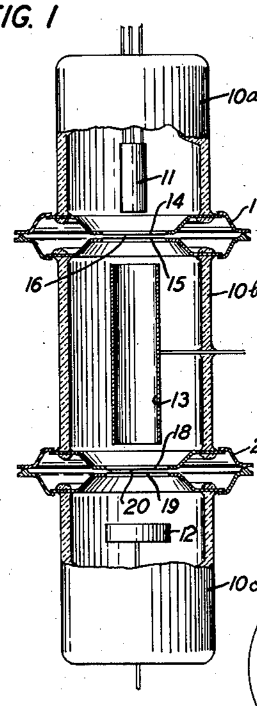


FIG. 2

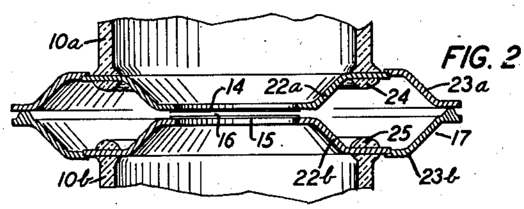


FIG. 3

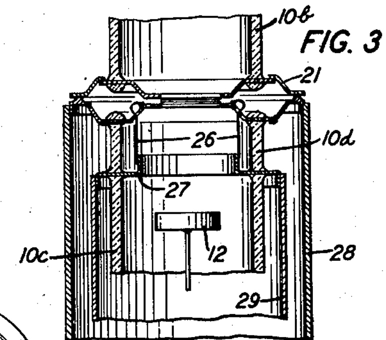


FIG. 5

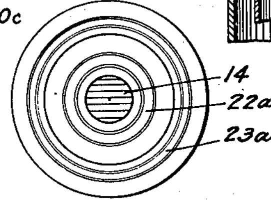


FIG. 4A

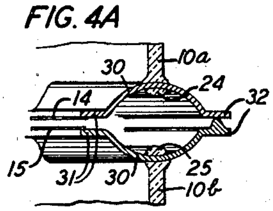


FIG. 4C

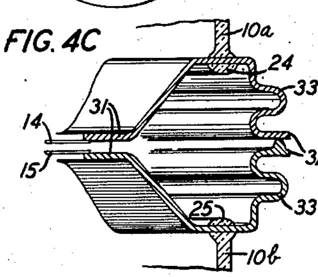


FIG. 4E

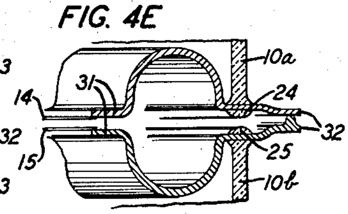


FIG. 4B

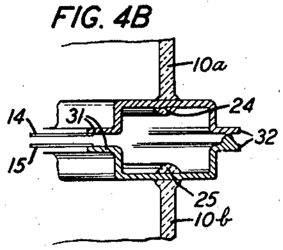


FIG. 4D

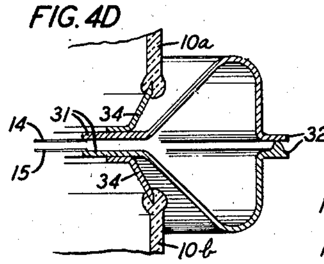
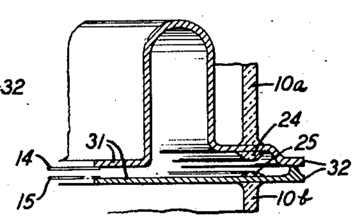


FIG. 4F



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ELECTRON DISCHARGE DEVICE

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Application August 8, 1941, Serial No. 405,938

7 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices and more particularly to such devices operable at ultra-high frequencies and having cavity resonators associated with electrodes thereof.

In one class of electron discharge devices commonly designated as velocity variation devices, the input or output systems or both include cavity resonators associated with gaps within an enclosing vessel and defined by a pair of electrodes. The enclosing vessel is usually of a vitreous material and parts at least thereof are within the high frequency fields between the electrodes or gaps and the resonators so that these parts absorb energy from the fields and thereby provide an energy or power loss resulting in a decrease in the operating efficiency of the device. Also, the resonant frequency of such resonators is dependent upon the form and dimensions thereof so that when a change in the operating frequency is desired replacement of the resonator often is required or the introduction of some form of tuning means is necessitated.

One object of this invention is to reduce losses due to insulating or vitreous material within the high frequency fields of cavity resonators associated with ultra-high frequency electron discharge devices and thereby to increase the operating efficiency of such devices.

Another object of this invention is to facilitate the tuning of cavity resonators associated with electron discharge devices.

In one illustrative embodiment of this invention, an electron discharge device of the velocity variation type comprises an enclosing vessel having walls of vitreous or insulating material, an electron gun for producing an electron beam, pairs of electrodes defining gaps traversed by the electron beam, and cavity resonators associated with the gap defining electrodes and in energy transferring relation therewith.

In accordance with one feature of this invention, the cavity resonators constitute wall portions of the enclosing vessel, are conductively associated with the gap defining electrodes, and together with the electrodes define a continuous electrical enclosure the interior of which is substantially free of vitreous or insulating material.

In accordance with another feature of this invention, the cavity resonators are provided with flexible portions allowing alteration of the form of the resonators and, hence, adjustment of the resonant frequency thereof.

The invention and the above-noted and other features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawing, in which:

Fig. 1 is an elevational view partly in section of a velocity variation electron discharge device illustrative of one embodiment of this invention;

Fig. 2 is an enlarged detail view in section showing the construction of one of the cavity resonators included in the device illustrated in Fig. 1 and showing also the association of the resonator with two gap defining electrodes in the device;

Fig. 3 is a detail view in section of a modification of the construction illustrated in Figs. 1 and 2 particularly suitable for association with a coaxial transmission line;

Figs. 4A to 4F are detail sectional views of several cavity resonator structures made in accordance with this invention; and

Fig. 5 is a plan view of one of the grid electrodes and a portion of the cavity resonator associated therewith.

Referring now to the drawing, the electron discharge device shown in Fig. 1 comprises an enclosing vessel having three cylindrical vitreous portions **10**_a_, **10**_b_ and **10**_c_ and housing an electron gun **11**, which may be of the construction disclosed in Patent 2,303,166 granted November 24, 1942, to Joseph P. Laico, for projecting an electron beam axially of the enclosing vessel, a collector electrode **12**, and a cylindrical drift space electrode **13**. Mounted between the electron gun **11** and electrode **13** are a pair of grid electrodes **14** and **15** defining an input gap **16** and having associated therewith a toroidal cavity resonator designated generally as **17**. A second pair of grid electrodes **18** and **19** are mounted between the drift space and collector electrodes, define an output gap **20** and have associated therewith a toroidal cavity resonator designated generally at **21** similar in construction to the resonator **17**.

During operation of the device, the electron stream produced by the electron gun **11** crosses the gap **16** and, when the resonator **17** is energized, undergoes a velocity variation. The stream then flows through the drift space and is thus converted into a density varied beam which traverses the gap **20** and delivers energy to the resonator **21**. Energy may be supplied to the resonator **17** and taken from the resonator **21** in known ways.

As shown more clearly in Fig. 2, the cavity resonator **17** includes two similar, dished annular members each of which comprises an inner annular portion **22**_a_ or **22**_b_ to which the grids **14** or **15** are secured and an outer annular portion

23*a* or 23*b*. The portions 22 and 23 may be of copper or other metal copper coated or plated and corresponding portions may be brazed or welded together. The outer portions 23*a* and 23*b* may be welded together adjacent their peripheries. The joints, whether welded, brazed or otherwise formed, are made in such manner that the parts joined are sealed hermetically to one another.

In the fabrication of the device, the annular portions 22*a* and 23*a* are joined hermetically and the annuli 22*b* and 23*b* are similarly joined. The annulus 22*a* is then hermetically sealed to and between the vitreous cylinder 10*a* and a glass ring 24 and the annulus 22*b* is sealed similarly to the vitreous cylinder 10*b* and a glass ring 25. The grids 14 and 15 are then secured suitably to the respective annuli 22*a* and 22*b* and the outer annuli 23*a* and 23*b* are subsequently joined adjacent their peripheries. If the glass and metal employed for the cylinders 10*a* or 10*b* and the annuli 22*a* or 22*b* have substantially the same coefficients of expansion, the glass rings 24 or 25 may be omitted.

The grids 14 and 15 may be composed of parallel wires and in the assembly of the device or the manner described above, it will be appreciated that, if desired, the wires of the two grids may be aligned with facility.

The annular portions 23*a* and 23*b* are made of sufficient thickness to prevent contact between the two grids 14 and 15 and yet sufficiently thin so that they may be flexed by the application of pressure thereto to alter the form of the resonator and thereby tune it to a desired frequency. The flexing action is restricted to the portions 23*a* and 23*b* due to the sealing of the portions 22*a* and 22*b* adjacent their peripheries so that when the resonator is tuned the grids 14 and 15 are maintained in parallel relation.

It will be noted that the resonator and grids constitute an electrically continuous enclosure so that very close and efficient coupling between the electron stream and the resonator is realized. The interior of this enclosure is devoid of insulating material except for the glass rings 24 and 25, which are of small volume, so that losses due to absorption of energy from the high frequency fields are very small and a correspondingly high operating efficiency is obtained.

The pressure for flexing the portions 23*a* and 23*b* may be applied through any suitable instrumentalities as, for example, through a pair of annular members threaded to one another and each bearing against one of the annular portions 23*a* and 23*b*, or through a pair of clamping members engaging these annular portions and adjustably spaced by a suitable micrometer drive.

In the construction illustrated in Fig. 3, the cavity resonator 21 is provided with a plurality of small apertures through each of which a wire pick-up conductor 26 extends, the several conductors 26 being mounted on a flanged metallic support 27 extending between and sealed hermetically to cylindrical vitreous portions 10*c* and 10*d* of the enclosing vessel. Coaxial conductors 28 and 29 are connected to the resonator 21 and support 27 as shown and couple the resonator and pick-up conductors to a suitable load or circuit. A similar coaxial line may be associated in the same manner with the resonator 17 associated with the input gap 16.

The cavity resonators 17 and 21 may be of a variety of forms and constructions, other than those shown in Figs. 1, 2 and 3, a number of which are illustrated in Figs. 4A to 4F, inclusive. In the construction illustrated in Fig. 4A, the cavity is formed by two annular metallic members having intermediate dished portions 30 and inner and outer parallel flanges 31 and 32 respectively, the grids 14 and 15 being secured in parallel relation to the flanges 31 and the flanges 32 being joined hermetically to each other. The metallic members may be of copper or other metal copper plated, are hermetically sealed to the vitreous cylinders 10*a* and 10*b*, and may be sufficiently thin to allow tuning of the resonator by the application of pressure between the portions of these members outside of the cylinders, as by application of pressure between the flanges 32.

The construction illustrated in Fig. 4B is similar to that shown in Fig. 4A except that the metallic members are of such form that the intermediate portion of the resonator is rectangular in radial section.

In the construction shown in Fig. 4C, the metallic members forming the cavity resonator are provided with flexible corrugated portions 33 which facilitate tuning of the resonator by flexure of wall portions thereof.

In the construction shown in Fig. 4D, the intermediate portion of the resonator is substantially entirely outside of the vitreous cylinders 10*a* and 10*b* and the inner flanges 31 are hermetically joined to metallic annuli 34 in turn hermetically sealed to the vitreous cylinders 10*a* and 10*b*.

The cavity resonators may be also substantially entirely within the vitreous portion of the enclosing vessel as shown in Figs. 4E and 4F. In these structures, the vitreous cylinders are sealed hermetically to the flanges 32 and the cavity resonator is tunable by the application of pressure between the flanges 32.

Although a number of specific embodiments of this invention have been shown and described, it will be understood that they are but illustrative and that various modifications may be made therein without departing from the scope and spirit of this invention as defined in the appended claims.

What is claimed is:

1. An electron discharge device comprising means for producing an electron stream, an electrode, a pair of electrode members between said means and said electrode defining a gap, means defining a cavity resonator including a pair of annular metallic members in juxtaposition and hermetically joined at their peripheries, each of said annular members having an inner substantially rigid portion mounting one of said electrode members and having also an outer flexible portion, and an enclosing vessel housing said first means, electrode members and electrode and constituted in part by spaced parts of the flexible portions of said annular metallic members.

2. An electron discharge device comprising an enclosing vessel including a pair of vitreous cylindrical members in spaced end-to-end relation, a pair of juxtaposed annular metallic members defining a cavity resonator and having parts constituting a portion of the enclosing vessel, said metallic members being joined hermetically at their peripheries and hermetically sealed to juxtaposed ends of said cylindrical members, the space bounded by said resonator being substantially free of insulating material, a pair of juxtaposed electrodes within said vessel, defining a gap in said resonator and each supported by one of

said annular members, an electron gun within said vessel and opposite one of said electrodes, and a collector electrode opposite the other of said members.

3. An electron discharge device in accordance with claim 2 wherein said annular metallic members include juxtaposed wall portions outside of said cylindrical members, deformable by pressure to tune the cavity resonator.

4. An electron discharge device comprising means defining a metallic toroidal cavity resonator the space within which is substantially free of insulating material, said means including a pair of juxtaposed annular metallic members each having inner and outer flanges and intermediate dished portions, the outer flanges of said members being joined hermetically, an electrode mounted on the inner flange of one of said members, a second electrode mounted on the inner flange of the other of said metallic members, an electron gun opposite one of said electrodes, a collector electrode opposite the other of said electrodes, and an enclosing vessel including a pair of aligned, cylindrical, insulating wall portions each joined hermetically to one of said annular metallic members.

5. An electron discharge device comprising a pair of annular metallic members defining a cavity resonator and having inner portions and flexible outer portions, the outer portions being joined hermetically adjacent their peripheries, a pair of electrodes secured to the inner portions of said metallic members, an enclosing vessel constituted in part by portions of said metallic members and having aligned cylindrical vitreous portions hermetically sealed to the inner portions of said metallic members, and a pair of electrodes within said vessel and in cooperative relation with said first electrodes.

6. An electron discharge device comprising an enclosing vessel including a pair of vitreous cylindrical members in spaced end-to-end relation, means defining a toroidal cavity resonator, said means including a pair of inner annular metallic members hermetically sealed to the juxtaposed ends of said cyindrical members and including also a pair of outer annular metallic members hermetically joined at their outer edges and each joined hermetically to a corresponding one of said inner metallic members, a pair of substantially parallel electrodes within said vessel and each secured to a corresponding one of said inner annular members, and electrode means within said vessel in cooperative relation with said electrodes.

7. An electron discharge device comprising an enclosing vessel including a pair of vitreous cylindrical members in spaced end-to-end relation, means defining a toroidal cavity resonator including a pair of annular metallic members between and hermetically sealed to the juxtaposed ends of said vitreous members, said metallic members being joined hermetically adjacent their peripheries, a pair of electrodes mounted by said metallic members, within said vessel and defining a gap, means for projecting an electron stream across said gap, a plurality of pick-up conductors within said vessel and extending within said resonator, a metallic support mounting said conductors, hermetically sealed to and projecting from said enclosing vessel, and coaxial conductors external to said vessel connected one to said support and the other to said resonator.

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