

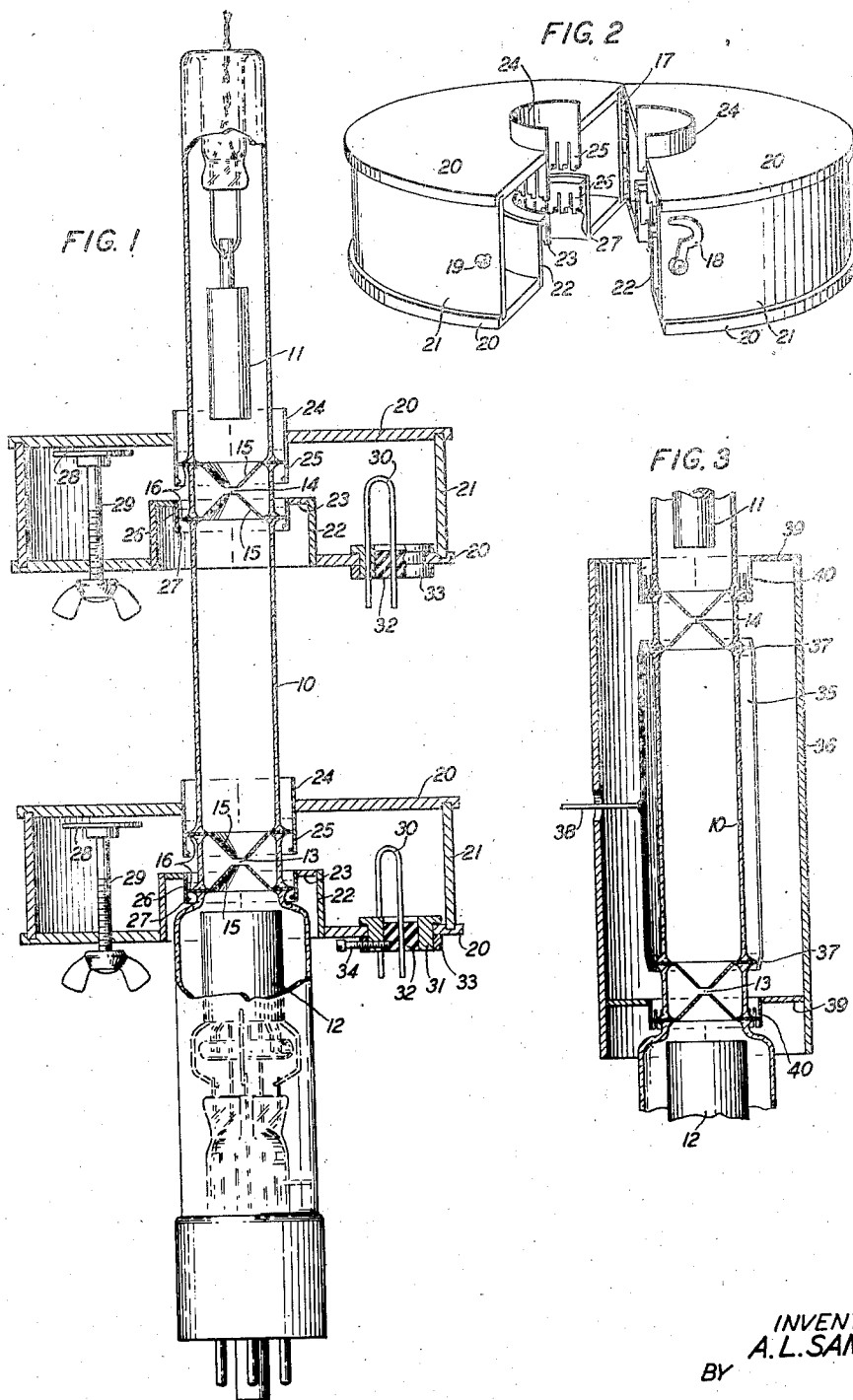
May 5, 1942.

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2,281,717

ELECTRON DISCHARGE APPARATUS

Filed Jan. 21, 1941



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2,281,717

ELECTRON DISCHARGE APPARATUS

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Application January 21, 1941, Serial No. 375,114

5 Claims. (Cl. 250—27.5)

This invention relates to electron discharge apparatus and more particularly to such apparatus including electron beam discharge devices of the velocity variation type.

Electron beam discharge devices of the velocity variation type include, in general, an enclosing vessel of insulating material housing a cathode or electron gun for producing an electron beam, a target electrode upon which the beam is directed, and a plurality of electrodes defining one or more gaps traversed by the beam at which a signal is impressed for controlling the beam or at which energy is taken from the beam. Heretofore, external circuits have been associated with the beam by mounting elements of the circuit externally of the vessel and in the vicinity of the gap or gaps mentioned, the coupling path between the circuit and gap including the insulating material of the enclosing vessel. Such association of the external circuits with the gaps, it has been found, does not provide an efficient coupling between these circuits and gaps due in part to the physical and conductive segregation thereof and to losses, particularly at ultra-high frequencies, in the insulating material of the enclosing vessel. In addition, such association renders difficult, at best, the attainment of electrical symmetry between the beam and the electrical circuits and the exact tuning of the circuits.

One object of this invention is to achieve close, efficient and symmetrical coupling between the circuits and the gaps in electron beam discharge apparatus.

Another object of this invention is to expedite the association of external circuits with the gaps in electron beam discharge apparatus.

A further object of this invention is to facilitate the exact tuning of external circuits associated with electron beam discharge devices.

In accordance with one feature of this invention, the electrodes defining the gaps are provided with annular metallic portions sealed in the wall of the enclosing vessel and extending therethrough, and the external circuits comprise chamber resonators contacting with the annular metallic portions.

In accordance with another feature of this invention the chamber resonators comprise separable halves adapted when joined to encompass the enclosing vessel of the device and to make good mechanical and electrical contact with the annular portions of the gap defining electrodes.

The invention and the foregoing 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 mainly in section of electron beam discharge apparatus illustrative of one embodiment of this invention;

Fig. 2 is a perspective view of one of the chamber resonators included in the apparatus shown in Fig. 1; and

Fig. 3 is a fragmentary view mainly in section of electron beam discharge apparatus illustrative of another embodiment of this invention and particularly suitable for the generation of ultra-high frequency oscillations.

Referring now to the drawing, the electron discharge apparatus illustrated in Fig. 1 comprises a highly evacuated enclosing vessel of vitreous material having an elongated tubular portion 10, a target electrode 11 mounted within the enclosing vessel at one end thereof, and an electron gun 12, which may be of the construction disclosed in the application Serial No. 327,826, filed April 4, 1940, of Arthur L. Samuel and Carlyle V. Parker, mounted within the vessel at the other end thereof, the target electrode and electron gun being coaxial with the tubular portion 10 of the enclosing vessel. Mounted between the target electrode and electron gun and coaxial therewith are a plurality of electrodes arranged in pairs as shown to define a pair of gaps 13 and 14. Each of these electrodes includes a central frusto-conical portion 15 and an outer annular portion 16 hermetically sealed to and extending through the wall of the tubular portion 10 of the enclosing vessel.

The electron gun 12 when energized produces a concentrated electron beam which flows along the axis of the device to the target electrode 11 and in so doing traverses the gaps 13 and 14. The beam may be controlled, by velocity variation, by potentials impressed upon or between the electrodes defining the gap 13 and energy may be taken from the device by a circuit coupled to the electrodes defining the gap 14.

In the apparatus shown in Fig. 1, the input and output circuits comprise chamber resonators each of which, as shown more clearly in Fig. 2, includes two complementary semicircular metallic halves hinged together as shown at 17 and adapted to be locked together by a hook 18 and catch 19. Each of the metallic halves includes semicircular end walls 20 joined to a semicylindrical outer wall 21, and an inner semicylindrical wall 22 having thereon a flange 23. All of these walls may be of a suitable metal, such as copper. Secured to the upper wall 20 is a semicylindrical

metallic member 24, for example of tinned sheet copper, having a flexible slotted edge portion 25. Similarly, semicylindrical metallic members 26, for example of tinned copper, having a slotted flexible edge portion 27 are secured to the flanges 23.

The two halves of each chamber resonator when joined define an axially symmetrical structure which may be mounted readily on the tubular portion 10 of the enclosing vessel, with the flexible portions 25 and 27 making a good electrical contact with the annular portions 16 of one pair of the gap defining electrodes, as shown in Fig. 1. Hence, it will be appreciated that a low resistance, close and highly efficient coupling free from discontinuities is established between the gaps and the resonating chambers.

The resonating chambers in a particularly advantageous form are so constructed as to be substantially resonant to the frequency at which the device with which they are associated is to be operated. Exact tuning of each chamber to a desired frequency may be effected by a metallic plate 28 mounted in adjustable parallel relation to one of the end walls 20 of the chamber by a wing bolt 29 threaded into the opposite end wall 20.

An input or output circuit may be coupled to each chamber resonator through a metallic loop 30 one end of which is fitted in an aperture in a metallic eyelet 31 fitted in one wall 20 of the chamber and the other end of which extends through an insulating member 32 within the eyelet 31, the eyelet being secured to the wall 20 by a locking ring 33 and set screw 34. The loops 30 are constructed to provide the desired impedance and coupling for any particular application or use and, as will be understood, loops of different impedances may be used interchangeably to meet particular requirements.

When the loop 30 in the resonating chamber nearest the gun 12 is energized by the application of a potential or signal thereto, this resonating chamber is excited accordingly and a corresponding controlling action is exerted on the electron beam, at the gap 13. The beam in passing through the gap 14 excites the resonating chamber associated with this gap and an output current corresponding to the input signal is obtained from the loop 30 associated with the output resonating cavity.

It will be noted that each resonating chamber together with the electrodes 15, 16 associated therewith defines a conductive structure electrically symmetrical with respect to the longitudinal axis of the electron beam and the gaps 13 and 14 so that uniform transmission of energy between the beam and the resonating chambers is realized and faithful translation is obtained. Furthermore, as noted heretofore, a low resistance, low loss coupling free from discontinuities is achieved between the electron beam and the chamber resonators.

A chamber resonator structure particularly suitable for use in apparatus for generating ultra-high frequency oscillations is illustrated in Fig. 3 and comprises coaxial cylindrical conductors 35 and 36. The inner conductor 35 may be in one piece and of tinned sheet copper and is provided at its ends with flexible slotted portions 37 for grasping the annular portions 16 of two of the gap forming electrodes. Electrical connection to the inner conductor 35 may be established through a conductor 38 secured to

the conductor 35 midway between the ends thereof.

The outer conductor 36 may be composed of two metallic, e. g., copper, halves hinged together as in the resonator illustrated in Fig. 2 and provided with inwardly extending flanges 39 to which metallic sleeves having flexible end portions 40 are secured, these end portions grasping the annular portions 16 of two of the gap defining electrodes as shown. The resonating chamber, therefore, provides a low impedance, low loss coupling between the gaps 13 and 14 and symmetrical with respect to the longitudinal axis of the electron beam.

Although specific embodiments of the invention have been shown and described, it will be understood, of course, 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. Electron discharge apparatus comprising an enclosing vessel having a tubular insulating portion, means opposite one end of said portion for producing an electron beam, a target electrode opposite the other end of said portion, a pair of electrodes between said means and said electrode defining a gap to be traversed by said beam and having portions sealed in and extending through said insulating portion, a second pair of electrodes between said means and said target electrode defining a gap to be traversed by said beam and having portions sealed in and extending through said insulating portion, and a chamber resonator outside of said vessel including a wall electrically connecting one of said first pair of electrodes and one of said second pair of electrodes and a second wall electrically connecting the other electrodes of said pairs.

2. Electron discharge apparatus comprising an enclosing vessel having a tubular insulating portion, an electron gun opposite one end of said portion for projecting an electron beam axially thereof, a target electrode opposite the other end of said portion, two pairs of axially aligned electrodes within said insulating portion and defining a pair of gaps to be traversed by the electron beam, each of said electrodes including an annular metallic member extending through said insulating portion and hermetically sealed thereto, and a cylindrical chamber resonator encompassing said tubular portion and including an inner cylindrical conductor contacting one of the annular members of the electrodes in each said pairs of electrodes and including also an outer cylindrical conductor electrically connected to the annular members of the other electrodes in said pairs of electrodes.

3. An electron beam discharge apparatus comprising an enclosing vessel having a tubular insulating portion, an electron gun opposite one end of said portion for projecting an electron beam therethrough, a target electrode opposite the other end of said portion, and means in energy transferring relation with said beam comprising a pair of spaced electrodes having portions defining a gap to be traversed by said beam and having also conductive members extending through said portion and hermetically sealed thereto and a chamber resonator encompassing said portion, said resonator including a pair of complementary halves each having resilient metallic portions contacting said conductive members.

4. Electron beam discharge apparatus including an enclosing vessel having a tubular insulating portion, means opposite one end of said portion for projecting an electron beam there-through, a target electrode opposite the other end of said portion, and means in energy translating relation with said beam comprising a pair of annular metallic discs extending through the wall of said insulating portion and hermetically sealed thereto, electrodes electrically integral with said discs and defining a gap to be traversed by said beam, and a cylindrical chamber resonator encompassing said insulating portion and including

two complementary separable halves each having spaced walls each of which has affixed thereto substantially semicylindrical flexible members grasping the periphery of one of said discs.

5. Electron beam discharge apparatus in accordance with claim 4 comprising means for tuning said chamber resonator including a metallic plate opposite and in parallel relation to one of said walls and means for varying the spacing between said plate and said one wall carried by the opposite wall.

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