May 27, 1941. A. H. RYAN 2,243,537

RESONATOR GRID STRUCTURE

Filed July 31, 1940

Fig. 1.

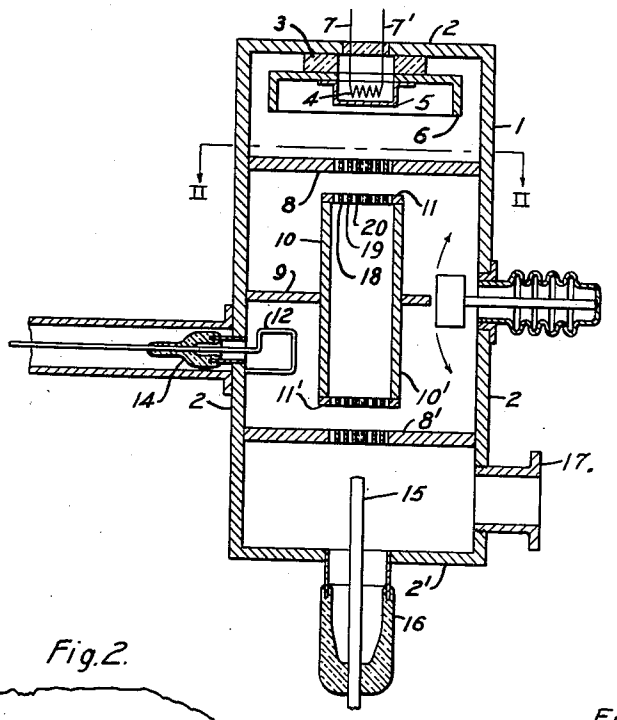


Fig. 2.

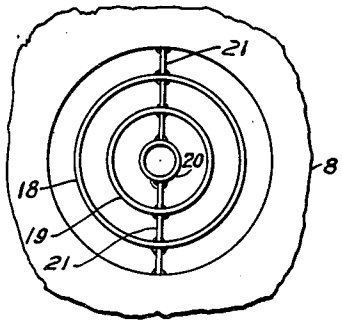
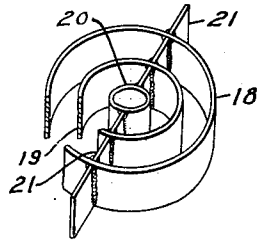


Fig. 3.



WITNESSES:

H. F. Lussier

B. E. Barthold

INVENTOR

Alden H. Ryan.

BY

F. W. Lyle

ATTORNEY

Patented May 27, 1941

2,243,537

UNITED STATES PATENT OFFICE

2,243,537

RESONATOR GRID STRUCTURE

Alden H. Ryan, Wilkinsburg, Pa., assignor to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application July 31, 1940, Serial No. 348,731

6 Claims. (Cl. 250—27.5)

This invention relates to electric discharge devices, particularly to discharge devices of the type incorporating hollow cavity resonators.

Electric discharge devices or vacuum tubes of the above type find extensive use for the generation of ultra high frequency oscillations and operate on the principle of resonant electrical circuits formed by a dielectric space which is completely enclosed by a conducting material. The space so formed is referred to as a resonating chamber of the hollow cavity type. The resonators so formed are built into the tube structure and act as one electrode of the tube and also as the frequency determining elements by virtue of their physical size and characteristic. A beam of electrons is arranged to enter the resonators through an opening. The physical configuration of this opening and the form of grid structure which is usually placed therein determines to a great extent the efficiency of the operation of the discharge device as a high frequency oscillator.

Various forms of grid structures have been devised in the past in order to simplify or improve the mechanical as well as the electrical characteristics of the tube. Because of the substantial energy of the electron beam the grid structures should be so opened that few electrons in the beam impinge thereon. However, one of the important properties of the resonators used in the discharge devices is that they are self shielding. Since the grid constitutes an interruption in the shielding surface of the resonator, it materially affects its performance and should be so constructed as to modify the self shielding property of the resonator as little as possible. A problem of considerable magnitude is thus involved on the construction of the grid. Of late hose manufacturing machinery has been used to form the grids but this procedure is necessarily cumbersome and expensive. The present invention is directed toward improving the overall efficiency and operation of such discharge devices by a novel grid structure which forms a simple mechanical assembly and improves the electrical performance of such devices.

A particular feature of the invention is that the simplified form of grid structure permits an easy mechanical assembly of several resonators in such coaxial alignment as to permit the positioning of the grid elements in a manner which will offer the least obstruction to the passage of electrons.

Another feature of the invention is that in the manufacture of resonators considerable time can be saved in installing the grid structure in the opening, making the manufacturing process suitable for mass production.

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

Figure 1 is a cross sectional view of an ultra high frequency discharge device incorporating resonators,

Fig. 2 is a sectional view taken along the lines II—II of Fig. 1 showing the grid opening of the resonator, and

Fig. 3 is a perspective view of the grid structure in accordance with this invention.

Referring to Fig. 1, a discharge device incorporating cavity resonators is shown in cross section. The electrical connections necessary for completing the circuits in order to place the tube in operation have been omitted since this invention resides in the physical structure of parts of the resonating chambers forming an element of the discharge device. In order to obtain a better understanding of the improvement resulting from this invention, a brief description will be given of the various tube elements and their cooperative function.

The discharge device comprises a cylindrical metallic container 1 of a suitable vacuum tight material such as copper or steel which is closed by end plates 2 and 2'. An electron emissive cathode assembly is supported from an insulating ring 3 secured to the inner surface of the end wall 2. The cathode assembly includes a heater 4 enclosed within an emissive cap 5, the outer surface of which is covered by suitable electron emissive material such as alkaline earth oxides. A disk shaped flange 6 surrounds the cathode 5 and serves as a focusing reflector plate for the electrons. The terminals 7 and 7' of the heater 4 are sealed within and electrically insulated from the body of the discharge device. The inside of the cylinder 1 is subdivided by partitions 8, 8' and 9 and these partitions with the wall 1 form chambers each having a reentrant portion 10 and 10' in the form of a coaxial cylinder having end plates 11 and 11'. The space bounded by the partitions 8 and 9 and the inner wall 10 and end plate 11 forms a cavity which by its physical dimensions acts as an electrical resonator.

Similarly, the space bounded by the wall 1, the partitions 9 and 8', the inner cylindrical surface 10' and end plate 11 forms another electrical resonator. Both of these resonating cham-

bers are identical in physical size and may be regarded as being placed face to face with respect to their reentrant cylindrical portion formed by walls 10, 10' and end plates 11 and 11'. In the hollow space a second resonator which is below the first one is placed, a loop 12, one terminal of which is in electrical contact with the wall 1 whereas the other is sealed in and insulated therefrom by the seal 14 and brought out from the chamber. A collector electrode 15 is placed within the end wall 2' and is brought out through an insulating bushing 16 which also forms a hermetic as well as an electrical seal. An opening is provided to the inside of the discharge device by the flanged fitting 17 for connection to a suitable vacuum pump whereby during operation a vacuum is maintained within the device.

The electrical circuits which are to be associated with the tube will maintain the entire assembly at a higher positive potential than the cathode producing thereby an electron flow therefrom toward the collector electrode 15. The electron flow through the resonating chambers is restricted by the opening in the partitions 8 and 8' and in the end plates 11 and 11'. The physical configuration of these openings is extremely important in the operation of the discharge device as an oscillator and must include a grid structure in order to provide electrical shielding between adjacent resonators yet must offer the lowest possible obstruction for the electrons passing therethrough.

The operation of the discharge tube as an oscillator of ultra high frequency energy is due to the electrical field produced by the flow of electrons penetrating the resonators. The stream of electrons passing through the first resonator is subjected to a field tending to accelerate certain of the electrons and decelerate others. The space between the two resonators forms a neutral field and the accelerated electrons overtake the decelerated ones whereby at certain points in the space they become bunched. The second resonator is so disposed that it intercepts the electrons at the point where they are bunched. The spacing of the electron bunches or crowds is such that when the field of the second resonator is of improper polarity to absorb energy, the second resonator is traversed by relatively few electrons.

In the particular tube herein shown by way of example, the time of passage of an electron through the second resonator should be small compared to a period of the resonant frequency. Therefore, the second resonator should be provided with an attenuated section where it is to be traversed by the electrons. It is also necessary that it should be tuned to the same frequency as the first resonator. Consequently, it must have the same structure. The attenuated section is provided by the grid openings and the grid structure placed therein. This structure must offer a small cross section of metal to prevent intercepting the electron beam. It also must have as low resistance as possible to the current circulating in the resonator wall. Furthermore, it must be of such material as to dissipate a considerable amount of heat. The first requirement necessitates that the grids be very thin edgewise and also that they be all exactly the same shape and size in suitable alignment between the two resonators.

Several forms were tried in the past, some forming a honeycomb structure by means of drilling holes in the end plates 11 and 11' and filing out the edges of these holes to form a honeycomb pattern. Another method employed was to use wedge shaped prongs radially extending with their apexes toward the center of the grid opening. These methods have the disadvantage of being mechanically weak, and difficult to make and cannot easily be inserted in the opening so that every element forming the structure will be lined up in exact superposition with the other elements throughout the openings of the two resonators. In order to make the mechanical assembly easier, fine wires were knitted in machines similar to those which produce stockings in a closely woven pattern and this was used to cover the openings. Although the mechanical assembly was considerably simplified, the alignment of these grids could not be effected and despite the small surface which they offer to the electrons the obstruction was considerable.

In accordance with the present invention, the grid structure comprises simple metal ribbons which are concentric with the grid opening. This can be seen in Fig. 2 in which the grid is held by supporting bars 21 which may be welded to the inner surface of the plate 8. These bars support metal rings 18, 19 and 20 placed with their thin edges perpendicular to the axes of the opening.

In Fig. 3 the perspective illustration shows the ribbons 18, 19 and 20 and the supporting bar which may be welded or otherwise secured to the outer and inner surface of each ribbon.

The simple structure herein shown can be easily made and placed into the opening by rapid welding process. The edges present small obstruction to the flow of electrons while the width of the ribbon provides satisfactorily strong and rigid mechanical assembly as well as good electrical and thermal conductivity. Their symmetrical circular configuration permits also an easy alignment between corresponding ribbons of the axially aligned openings. This symmetry and mechanical strength provides good heat dissipation, each ribbon being fairly wide, and more efficient operation due to the exact alignment which can be obtained without undue complexity in the mechanical assembly. For the material of the annular grid elements any metal having a high product of thermal conductivity and melting temperature may be used. For example, tungsten, tantalum, molybdenum or copper.

I claim as my invention:

1. In an electric discharge device of the type incorporating hollow cavity resonators, a grid structure for said resonators comprising a plurality of concentrically supported annular members in the opening of said resonator.

2. In an electric discharge device of the type incorporating hollow cavity resonators, a grid structure for said resonators comprising a plurality of concentrically supported annular members in the form of ribbons of electrically conductive material in the opening of said resonator.

3. In an electric discharge device of the type incorporating hollow cavity resonators, a grid structure for said resonators in the openings thereof comprising metal ribbons concentrically spaced having their flat surfaces parallel with the longitudinal axis of said resonators.

4. In an electric discharge device of the type incorporating hollow cavity resonators, a grid structure for said resonators in the openings thereof comprising metal ribbons concentrically

spaced having their flat surfaces parallel with the longitudinal axis of said resonators, the edge of each of said ribbons being substantially perpendicular to said axis.

5. In an electrical discharge device, a plurality of cylindrical resonating chambers of the hollow cavity type having a reentrant coaxial cylindrical portion, a circular opening in the plane end of said chamber and a similar opening in the plane end of said reentrant portion, both of said openings being perpendicular to the axis of said chamber and substantially of equal radius, a grid structure in each of said openings comprising concentrically arranged annular members in the form of metal ribbons affixed to a supporting bar diametrically dividing said opening, the narrow edges of said ribbons being substantially perpendicular to the axis of said chamber, whereby the flat surfaces of said ribbons are in parallel therewith, both said openings and individual ribbons of said two grid structures being in concentric alignment respectively.

6. In an electrical discharge device according to claim 5, two cylindrical resonators coaxially placed with their reentrant portion face to face, each of said resonators having two openings in which identical grid structures permit open passage through said resonators, every corresponding ribbon element of each of said structures being in substantially exact alignment equi-distantly from the common axis of said resonators.

ALDEN H. RYAN.