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2,402,601

ELECTRON DISCHARGE DEVICE

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FIG. 1.

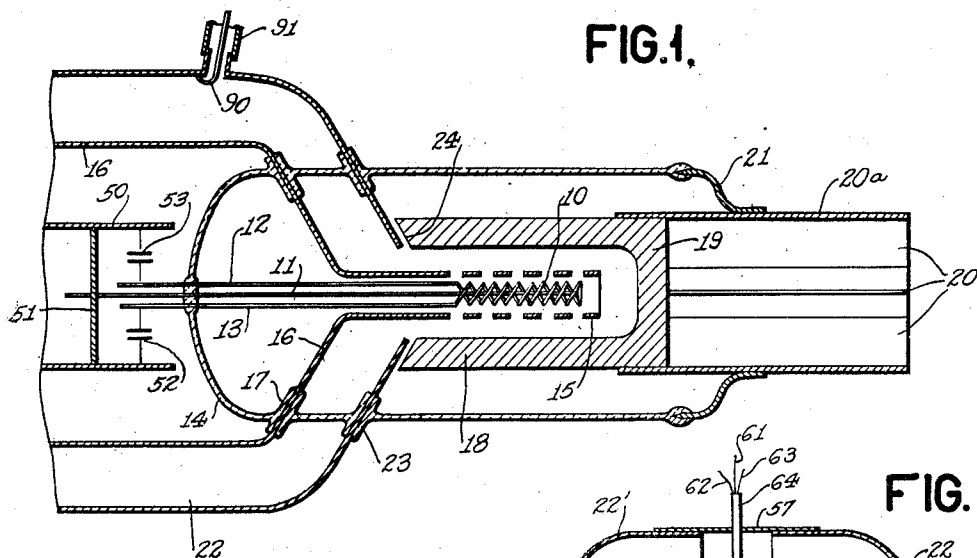


FIG. 2.

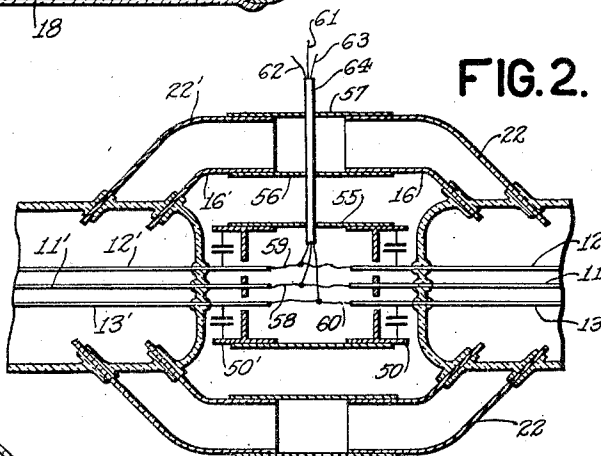
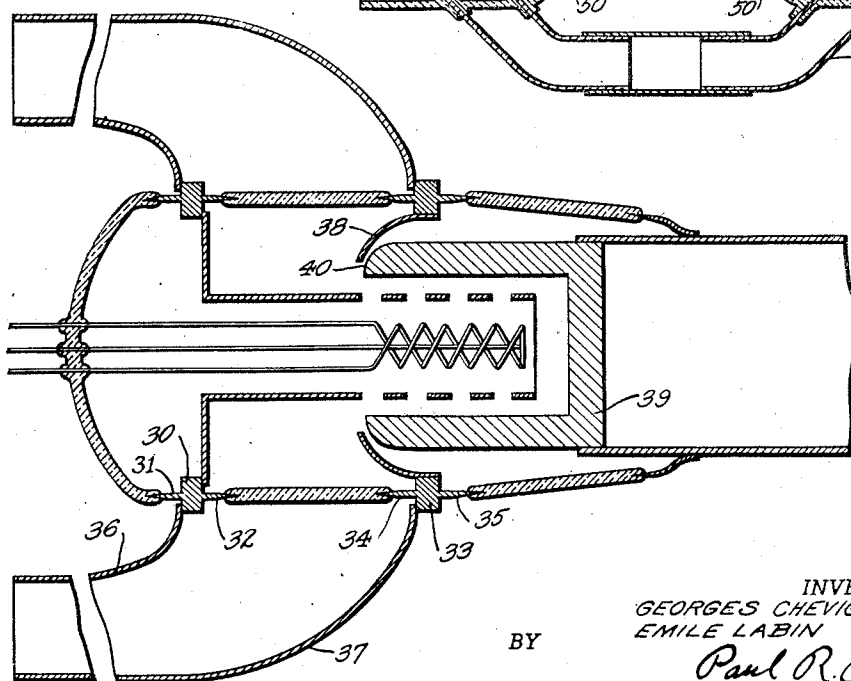


FIG. 3.



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ELECTRON DISCHARGE DEVICE

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12 Claims. (Cl. 250—27.5)

1

This invention relates to electron discharge devices and circuits, and particularly to such apparatus adapted to operate at ultra high frequencies.

The object of the invention is to provide a device of this type capable of a high power output at ultra high frequencies, arranged in an efficient and compact form so that it may operate efficiently with high applied voltages, and also be readily connectable with other tubes of the same type.

According to this invention, a cavity resonator is arranged with its walls passing through the envelope of the evacuated vessel and into electrical relation with the respective electrodes inside the envelope. A feature is an arrangement of a wall of the resonator, or a surface connected with it, in close proximity with a wall of the tube anode, or a surface connected with it, inside the envelope, to provide a capacity coupling within the vessel between the anode and cavity resonator. Such an arrangement permits tuning or adjustment of the cavity resonator outside the evacuated envelope while providing the advantage of capacitive coupling inside the envelope where it can be placed most efficiently. This enables the high D. C. voltage of the anode to be kept off the cavity resonator which minimizes insulation problems and enables the cavity resonator to be made small for high frequency operation. Another feature of this invention is an arrangement whereby a cavity resonator is built out from the respective terminals of the tube electrodes and formed into a resonant line ending near the filament or cathode terminals of the vessel so that these terminals and cavity resonator walls of one tube can readily be connected with those of a similar tube.

The invention will be understood from the following detailed description taken in connection with the accompanying drawing of which

Fig. 1 shows in longitudinal section a device embodying the invention;

Fig. 2 shows a manner of connecting together two of the devices of Fig. 1; and

Fig. 3 shows a modification of the arrangement of Fig. 1.

The construction shown in Fig. 1 comprises a centrally located filament 10 constituting the cathode, connected in a usual manner with a filament midpoint lead 11 and filament terminal leads 12 and 13, which are brought out of the tube through the end of the insulating tube wall 14, composed of a vitreous substance through which the leads are sealed. The grid 15 is of the cylin-

2

drical type which may be formed in a well-known manner and placed concentrically around the filament where it is held in place by the conical supporting member 16 which passes through an annular oblique seal 17, in the tube wall. The anode 18 is of a cylindrical construction concentrically surrounding the grid and filament, and is closed at its outer end 19. There are extended outwardly from the top of this head 19, heat radiating fins 20, arranged radially with respect to the longitudinal axis. A cylinder 20a may surround the fins to confine the flow of cooling air. The wall of the vacuum tube is sealed to the circumference of cylinder 20a by means of the annular seal member 21 sealed to the glass wall of the vessel.

The conical member 16 from the grid forms the inner wall of a concentric type of resonant line (or cavity resonator) or circuit, the outer wall of which is formed by a similar member 22 which passes into the tube through seal 23. The walls of the resonant line are preferably bent at a place just outside of the vessel as shown, so that the walls become substantially cylindrical in shape toward the end of the line. The end of this concentric line may be made either open-ended or closed-ended, as desired, and it serves to tune the anode circuit, in a well-known manner, to a frequency determined by its dimensions.

To provide a suitable capacity coupling between the wall 22 and the anode, the inner rim of this wall is brought in close proximity to the open end of the anode, which is beveled at 24 to provide a substantial surface parallel to the adjacent conical end of wall 22. These parallel surfaces constitute the plates of the coupling condenser, within the vacuum space.

It is ordinarily desirable to tune also the grid-cathode circuit, and this may be done by connecting to the filament midpoint lead 11 a coaxial cylinder 50, which may be attached to the midpoint lead by suitable connecting pieces 51. The cylinders 50 and 16 form a coaxial line which, by its dimensions, will serve to tune the grid-filament circuit. It may be desirable to place by-pass condensers 52 and 53 between the respective filament leads 12 and 13, and the cylinder 50 in order to enhance the operation. This may be done by any well-known type of high frequency condenser.

The construction permits two devices of the type of Fig. 1 to be readily connected together in the manner shown in Fig. 2, wherein the end of the tuning line of one tube, having walls 16 and 22, is shown arranged end-to-end with the end of a similarly tuned line, having walls 16' and

22', of a second tube. The coaxial cylinders 50 and 50' of the two tubes are likewise aligned. These respective aligned cylinders may be joined together by overlapping cylinders 55, 56 and 57, respectively, so that the respective tubes may be moved toward or away from each other to shorten or lengthen the length of the coaxial lines which now extend from one tube to the other. The filament leads 11, 12 and 13 of the first tube may be connected in parallel with the corresponding filament leads 11', 12' and 13' of the second tube by flexible leads 58, 59 and 60, and filament supply leads 61, 62 and 63 may be brought into these flexible leads through a suitable conduit 64 passing through the cylinders 55, 56 and 57. If this conduit be made of insulating material, it may be made to fit snugly through the conducting cylinders.

Fig. 3 shows a modification of the arrangement for attaching the resonant line to the tube and coupling it with the anode. In this modification, the grid is connected with a collar 30 sealed between the vitreous portions of the tube by flanges 31 and 32; and there is provided a second collar 33, similarly sealed between the vitreous portions of the tube by flanges 34 and 35. The resonant line walls 36 and 37 are connected respectively with these two collars 30 and 33. The coupling capacity connecting wall 37 with the anode 39 is formed by the generally conical or curved member 38 protruding from collar 33 within the tube and adjacent the end of the anode 39 which is beveled at 40 to correspond with the closely adjacent surface of member 38.

It will be understood that in any of the embodiments the part of the cavity resonator outside the envelope may be made as a separate part and attached to the part protruding through the envelope as by brazing, and need not necessarily be of the same unitary sheet of metal as the part inside of the envelope.

The insertion of the coupling capacity between the resonant line or cavity resonator and tube electrode is required in order to allow different D. C. voltages to be applied to the electrodes. The use of the anode itself as one of the plates of the coupling capacity between the anode and tuning cavity resonator, as used in the embodiments herein, constitutes a very effective means for obtaining the capacity coupling, as the anode offers a relatively large surface near the vessel wall near which the tank member or connection can easily be brought. The location of the plates of the coupling condenser within the evacuated vessel has the further advantage that the condenser plates can be brought closer together without the occurrence of sparking between them than would be possible in the atmosphere; and this enables the coupling capacity to be made larger with a consequent desired decrease in the voltage drop across it.

The constructions according to this invention, in which the resonant line is brought through the glass to the outside of the vessel while the coupling capacity is placed inside the vessel, is of special advantage, as the portion outside the vessel can be tuned either by varying the length of the line in the case of a line, and at the same time the effectiveness of the coupling capacity within the vessel is retained. The use of the coupling capacity between the cavity resonator and the anode is of especial advantage because it enables the high D. C. voltage ordinarily placed on the anode to be kept off the resonant line;

and this greatly simplifies problems of insulation and results in enabling small cavity resonators to be used, which is a requirement for high frequency operation. By keeping the high D. C. anode voltage off the cavity resonator, the cavity resonator can be placed nearer to the cathode, that is with a shorter section of glass between the cathode and cavity resonator, than otherwise, and as the high D. C. voltage is between the anode and cavity wall the required insulation there-between can be provided by a sufficiently long section of the glass envelope wall between the cavity resonator and anode. This keeps the large D. C. voltage stress away from the glass section between the two walls of the cavity resonator which protrude through the glass, so that the only voltage across the glass extending between the walls is the oscillating or signal voltage between the anode and grid. This enables the two walls of the cavity resonator to be brought quite close together which correspondingly permits the use of a small cavity resonator, tunable to high frequencies.

The tube may be used in any well-known manner, for example, as an amplifier or an oscillator. As is well known, to make the tube oscillate, it is only necessary to proportion the elements so that a sufficient feed back of energy from the anode circuit to the grid-cathode circuit shall occur to sustain the oscillations. Energy output may be taken from the devices in a convenient, practical manner. For example, a loop may be placed in the cavity and taken out through a concentric line. Such an arrangement is illustrated in Fig. 1, wherein the looped conductor 90 is attached inside the wall 22, and taken out through the concentric tubing 91.

What is claimed is:

1. Electron discharge apparatus adapted for ultra high frequency operation comprising an evacuated vessel having insulating walls, cathode, control grid, and anode electrodes within said vessel, and a resonant circuit coupled between said anode and grid electrodes, said resonant circuit comprising a pair of conducting walls extending through the insulating walls of said vessel from the inside to the outside and forming outside said vessel a concentric line which is coaxial with said cathode, one of said conducting walls connecting to the grid electrode and the other conducting wall coupled to the anode electrode by capacity within the vessel.

2. Electron discharge apparatus adapted for ultra high frequency operation, comprising an evacuated vessel having vitreous walls, a cathode located centrally within said vessel, a control electrode within the vessel and concentrically surrounding the cathode, and an anode electrode concentrically surrounding the control electrode, a resonant circuit coupled between said anode and grid electrodes, said resonant circuit comprising a pair of generally conical conducting walls extending through the vitreous vessel walls, and forming outside said vessel a concentric line which is coaxial with said cathode, one of said walls being connected with the control electrode inside the vessel, and the other of said walls being coupled capacitively with the anode inside said vessel.

3. An electron discharge device adapted for ultra high frequency operation, comprising an evacuated vessel, a cathode, a control grid, and an anode within the vessel, a cavity resonator coupled between the grid and anode electrodes, one of the walls of the cavity resonator extending

5

within the vessel in close proximity to a surface of the anode and forming a capacity coupling between said wall and the anode.

4. An electron discharge device adapted for ultra high frequency operation comprising an evacuated vessel, a control grid, and an anode within the vessel, a cavity resonator having a wall connected to the grid and another wall in the vessel in close proximity to a surface of the anode and forming a capacity coupling between the latter wall and the anode, said anode surface being substantially parallel with said latter wall.

5. An electron discharge device adapted for ultra high frequency operation, comprising an evacuated vessel having glass wall sections, a cathode, a control grid, and an anode within the vessel, a cavity resonator having walls passing through the glass of the vessel and extending outside the vessel, one of the walls of the cavity resonator inside the vessel being directly connected to the control grid, and the other wall inside the vessel being capacitively coupled to the anode.

6. An electron discharge apparatus adapted for ultra high frequency operation comprising a pair of evacuated vessels having insulating walls, cathode, control grid and anode electrodes within each vessel, a resonant coaxial line coupled between the anode and grid electrodes of one vessel, and the anode and grid electrodes of the other vessel, said line extending through the walls of each vessel and physically interconnecting them, and means included in said line for adjusting the length thereof.

7. Electron discharge apparatus adapted for ultra high frequency operation, comprising an evacuated vessel having insulated walls, a cathode, an anode and a grid within said vessel, and cathode leads protruding from said vessel, a resonant circuit coupled between said anode and grid electrodes, said resonant circuit including a pair of conducting walls extending through the insulating walls of said vessel from the inside to the outside and forming outside said vessel a concentric line coaxial with said cathode leads, one of said conducting walls being directly connected to said grid and the other being spaced from said anode to form a capacitive coupling therewith.

8. An electron discharge device adapted for ultra high frequency operation, comprising an evacuated vessel having insulated walls, a cathode, a grid and an anode within said vessel, a pair of longitudinally spaced-apart rings sealed in the

6

walls of and forming part of said evacuated vessel, conductive means attached to one of said rings and supporting said grid, conductive means attached to the other of said rings and extending inwardly into capacitive relationship with said anode, and a coaxial line outside of said vessel, having one conductor attached to one of said rings and the other conductor to the other ring.

9. An electron discharge apparatus adapted for ultra high frequency operation comprising a pair of evacuated vessels having insulating walls, cathode, control grid and anode electrodes within each vessel, a resonant coaxial line coupled between the anode and grid electrodes of one vessel, and the anode and grid electrodes of the other vessel, said line extending through the walls of each vessel and physically interconnecting them, and a cylindrical wall coupled to the two cathodes in said vessels and located within the walls of said coaxial line connecting said vessels.

10. Apparatus according to claim 6 wherein said means for adjusting the length of said line comprises a section of said line in which the parts thereof have telescopic relation.

11. An electron discharge apparatus adapted for ultra high frequency operation comprising a pair of evacuated vessels having insulating walls, cathode, control grid and anode electrodes within each vessel, a resonant coaxial line coupled between the anode and grid electrodes of one vessel, and the anode and grid electrodes of the other vessel, said line extending through the walls of each vessel and physically interconnecting them, and an insulating tube extending through said line, and through which leads are taken to the cathodes of said two vessels.

12. Electron discharge apparatus adapted for ultra high frequency operation comprising an evacuated vessel having an insulating wall section, a tubular grid positioned within said vessel, a tubular anode surrounding said grid and disposed coaxially therewith, a coaxial line disposed in axial alignment with said grid and anode elements and having an inner conductor which extends through said insulating wall section and is connected with said grid, said coaxial line having a tubular outer conductor with a portion thereof disposed in overlapping relation with a portion of said tubular anode providing a capacitive coupling between said anode and said tubular outer conductor.

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