Dec. 24, 1946. C. V. LITTON 2,412,997

ELECTRON DISCHARGE DEVICE

Filed Jan. 31, 1942

FIG. 1.

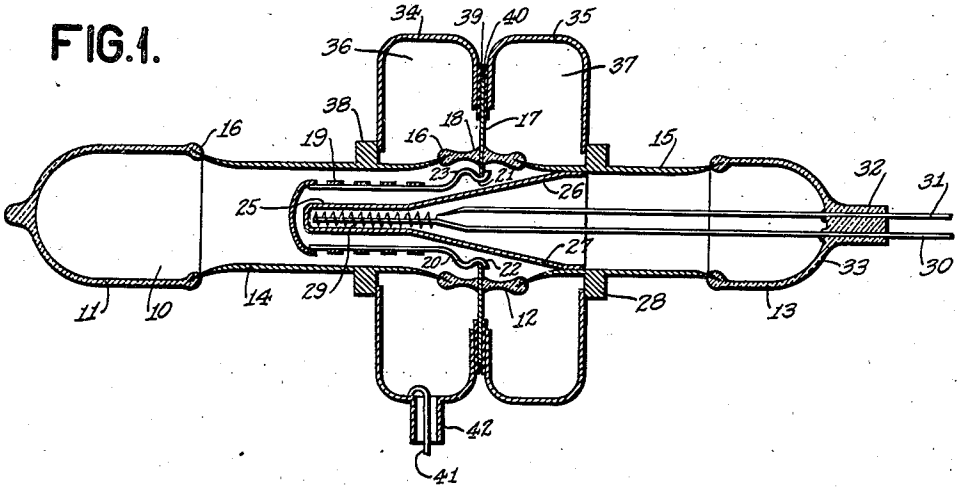


FIG. 1a.

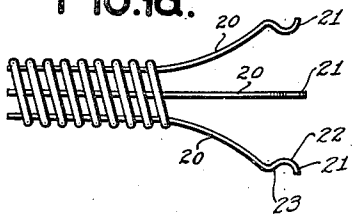


FIG. 2.

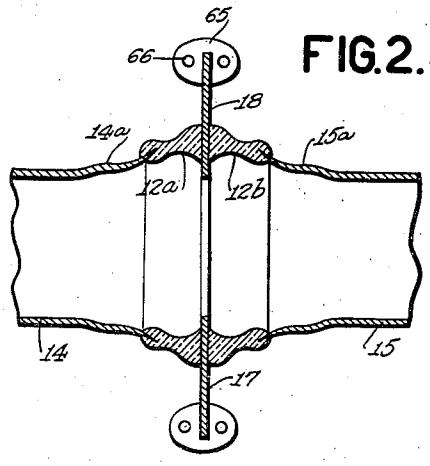
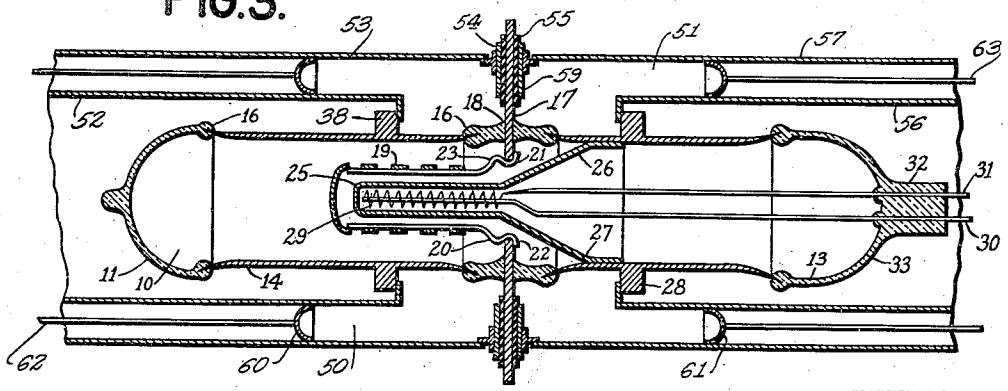


FIG. 3.



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ELECTRON DISCHARGE DEVICE

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6 Claims. (Cl. 315—6)

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This invention relates to electron discharge devices of the type adapted to operate at ultra high frequencies.

The object is to provide a vacuum tube of small size and element dimensions adapted to handle relatively small amounts of power at ultra high frequencies.

In order to provide vacuum tubes capable of efficiently operating at ultra high frequencies, it is important to make the tube electrodes and all dimensions of the tube as small as practical, and it is further important to make the metallic portions of the tube effectively small so as to reduce the capacity between them, which if too large, would tend to prevent the device from being tuned to the desired ultra high frequencies.

In accordance with this invention, there is provided a compact construction of an elongated tube having small cross section. A feature is the provision of several metallic sections separated by insulating sections forming part of the elongated vessel wall, one of the metallic sections being used as the anode, with the grid and cathode electrodes placed concentrically within it. The construction facilitates the assembling, and enables the electrodes to be easily guided into place within the relatively small vessel.

A related feature is the provision of a conducting member sealed through the vitreous wall of the vessel mechanically connecting the sheaths, and extending into the vessel to act as an electrode connection. A related feature is an arrangement for connecting tuning cavities between the electrodes.

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 vacuum tube together with resonant tuning capacities in accordance with the invention;

Fig. 1*a* shows a detail used in the construction of Fig. 1;

Fig. 2 illustrates a means for sealing a metallic element through the vitreous wall of the tube; and

Fig. 3 illustrates a tube construction according to the invention, and a variation of the tuning circuits.

The device of Fig. 1 comprises an elongated evacuated vessel 10, comprising insulating vessel walls 11, 12 and 13, which may be of glass, and a pair of metal sections 14 and 15 of a general cylindrical form. The metal sections are tapered at their ends which are preferably flared outwardly, as shown, so that they may be sealed in a well-known manner to the respective insulating walls by seals 16. At approximately the central section of the tube, there is placed a metal member 17, preferably in the shape of an annular disc, extending through the vitreous wall 12, and sealed thereto at 18. This seal 18 may be made in a manner illustrated in Fig. 2. The cylinders 14 and 15 are provided with sharpened ends 14*a* and 15*a*, which may conveniently be flared outwardly, as shown. A glass bead, or rim 12*a* is sealed to the tapered end 14*a* of section 14 in a well-known manner, and a similar glass bead, or rim, is sealed to edge 15*a* of section 15. The glass rims are then brought together with the annular disc 17 therebetween. A suitable heating element 65, which may be provided by suitable electrical coils 66, is applied to the outer rim of member 17, heating it sufficiently to fuse the glass at 18 to create a seal with member 17.

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The cylinder 14 is used as an anode. A control grid 19, which may be made in any desired manner, such as from a coil of wire, is attached to the inner circumference of the disc 17. A convenient means for making this attachment is by prongs 20 (see Fig. 1*a*) extending from the grid supports, and provided at their outer edge with a hook 21. The portion of the hook, just back of the flange, is grooved at 22 and raised slightly at 23. Prongs 20 are made resilient with a tendency to spring outwardly, so that with this arrangement, the grid and its supporting prongs 20, may be inserted within the right end of the elongated tube and moved back toward the anode 14 until member 23 snaps over the inner rim of disc 17 to which it may be fastened in a suitable manner. In this way the placing of the extremely small grid and its secure attachment concentrically within the anode, can be readily affected.

The cathode 25 is located concentrically within the grid 19. The cathode may be of any desired form, the one shown in the figure being of the uni-potential type in the form of a small diameter cylinder provided on its outer surface with an active substance for inducing electron emission. The cathode is supported by a plurality of relatively long small diameter prongs 26 of a resilient character which makes them tend to spring outwardly. This facilitates the setting of the cathode within the grid in assembling, as the cathode can be inserted into the vessel from the right end and moved to the left to its proper position concentrically within the grid and the anode. The resilient prongs 26 have cylindrical end portions 27, which contact and slide along the inner circumference of cylinder 15. When the cathode reaches its proper position, the portions 27 may

be brazed to cylinder 15. This can be accomplished by first applying brazing substance to the portions 27, and then heating the annular collar 28 of cylinder 15 to the desired brazing temperature.

The cathode heater element 29, ordinarily required for this type of cathode, may be formed in an appropriate manner as by a coiled filament, the electrical terminal leads 30 and 31 of which are carried through the glass stem 32 through which they are sealed. Stem 32, together with its associated dish-shaped rim 33 may be formed of pressed glass in a mold.

The tube as thus constructed can be made of very small dimensions and is especially useful for small amounts of power, as in stations for receiving radio signals.

Suitable tuned circuits may be connected to provide tuning to the desired high frequency. These circuits may be of the cavity type provided by the metallic convolutions 34 and 35, forming toroidal cavities 36 and 37, respectively, around the vessel. One edge of wall 34 is connected with the flange 38 on cylinder 14, to which it may be brazed; and the corresponding edge of the other cavity wall 35 may likewise be attached to flange 28 of the other cylinder 15. The remaining two edges of these cavity walls are carried to the central disc 17. To permit different D. C. voltages to be applied to the tube electrodes, the cavity walls should be insulated from disc 17, but should be coupled by an impedance which is relatively low at the ultra high frequencies. A suitable coupling arrangement is provided by inserting annular insulating discs 39 and 40 between the disc surface and the cavity wall surfaces, as shown. These annular discs may be of mica, which has a good dielectric value and provides capacity coupling between the central disc 17 and the respective cavity walls.

The dimensions of the cavities determine the frequency at which the system is tuned, the cavity 36 serving to tune the anode-grid circuit and the cavity 37 tunes the grid-cathode circuit. The device may be used in a well-known manner, as an amplifier, or if desired, as an oscillator. To make the tube oscillate, it is only necessary to provide sufficient feed-back of energy from the output to the input circuit to sustain the oscillations in a well-known manner. As the structural relations of the two tubes provide a sufficient feedback path, the two cavities may be connected together by passageway in a well-known manner to provide the feedback. Output energy may be taken from the tube in a well-known manner, the arrangement shown being the concentric output line composed of the looped conductor 41 connected inside the cavity wall 34, and extending outside through the concentric tube 42, forming a concentric line.

Fig. 3 shows a modification of the tube of Fig. 1, the like-numbered parts being corresponding parts in the two figures. Instead of toroidal shaped cavities there are provided a pair of concentric resonators 50 and 51. The resonator 50 is formed by an inner cylindrical wall 52 connected to flange 38, and an outer concentric cylindrical wall 53 attached to an annular member 54 which is separated from the disc 17 by the dielectric sheath 55. The other resonator 51 is similarly formed by concentric cylindrical members 56 and 57, the wall 57 similarly being coupled to member 17 by the capacity due to the mica annulus 58 between member 17 and annulus 59.

These resonators may be tuned to different frequencies by manipulation of the metallic plungers 60 and 61 respectively, which are in the form of partial toroids closing the concentric lines. These may be moved to different positions by manipulation of suitable handles 62 and 63; and the positions of the plungers establish the frequency to which the device is tuned.

What is claimed is:

1. An electron discharge tube adapted for ultra high frequency operation, comprising an elongated evacuated vessel, the elongated wall of which comprises a pair of metal sheaths separated by a vitreous section sealed to said sheaths, a cathode located concentrically within first of said sheaths and being supported only by, and electrically connected with, the second of said sheaths, a metal member protruding through, and sealed to, said insulating section, a grid located concentrically around the cathode and only within the first sheath, said grid being supported by, and electrically connected to said member.

2. An electron discharge device adapted for ultra high frequency operation comprising an elongated evacuated vessel, the elongated wall of which comprises a pair of metal cylinders separated by a vitreous cylindrical section sealed to said cylinders, a cathode located concentrically within the first of said cylinders, and being connected with the second of said cylinders, a metallic member sealed through said vitreous cylinder, and providing a rim within said vessel, a cylindrical shaped grid located concentrically around the cathode and within the first cylinder, said grid having resilient prong rings snapped on said rim.

3. An electron discharge device adapted for ultra high frequency operation, comprising an elongated evacuated vessel, the elongated walls of which comprise a pair of metal cylinders separated by a cylindrical vitreous section sealed to said cylinders, a cathode located concentrically within a first of said cylinders, and being connected with the second of said cylinders, a metallic disc in a plane transverse to said vessel and sealed through said vitreous section and having an inner rim within said vessel and an outer rim without said vessel, a cylindrical grid located concentrically around the cathode and within the first cylinder and connected to the inner rim of said disc, and a pair of toroidal cavity walls around the circumference of said vessel, one of said walls having an edge connected to the first cylinder and another edge joined to the outer rim of said disc through an insulating medium, and the other of said walls having an edge joined to the second cylinder and its other edge joined to the rim of said disc through an insulating medium.

4. An electron discharge device adapted for ultra high frequency operation comprising an evacuated vessel, the wall of which includes a pair of metallic sections separated by a vitreous section sealed to the metallic sections, a cathode within a first of said metallic sections, a metallic member sealed through said vitreous section, a control grid between the cathode and the first metallic section, and connected to said metallic member, a metallic convolution forming a cavity around the vessel, and extending from the first section to the metallic member, and separated from the metallic member by an insulating sheath forming a condenser dielectric, and a second metallic convolution extending from the second metallic section to said member, and separated

from said member by an insulating sheath also forming a condenser dielectric.

5. An electron discharge device adapted for ultra high frequency operation comprising an elongated evacuated vessel, the circumferential wall of which includes a pair of metallic sections separated by a vitreous section sealed to said metallic sections, a central conducting member sealed through said vitreous section, a cathode within one of said metallic sections and connected to the other metallic section, and a grid electrode surrounding the cathode and connected with said central member, a cylindrical wall connected to

each of the metallic sections outside the vessel and extending toward the respective ends of the vessel, and a second cylindrical wall concentrically surrounding the first-mentioned cylindrical walls and forming concentric lines therewith, the second-mentioned cylindrical wall being coupled to said central member.

6. Apparatus according to claim 5, in which the outer cylindrical walls are each connected with a metallic surface substantially parallel to, and insulated from, the surface of said central member to form a capacity coupling.

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