April 28, 1942. E. LABIN 2,281,041

HIGH FREQUENCY ELECTRON DISCHARGE TUBE

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FIG.1.

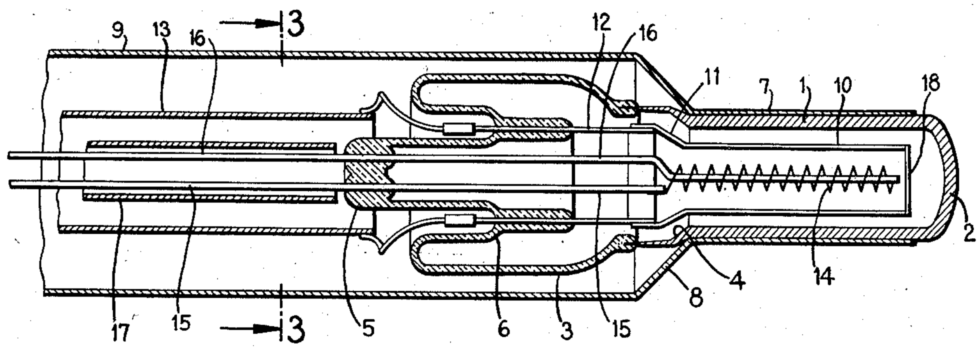

FIG.2.

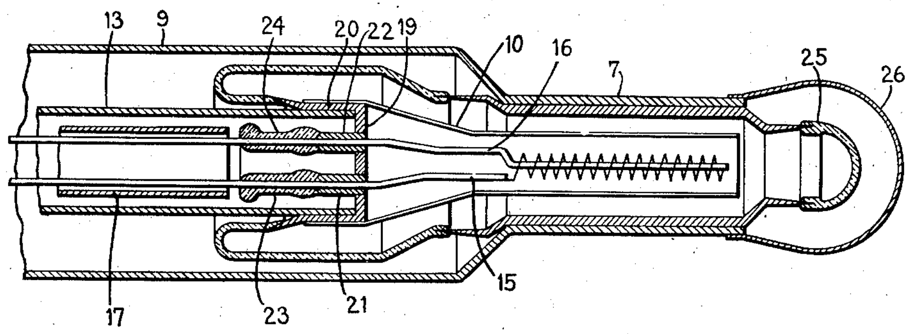

FIG. 3.

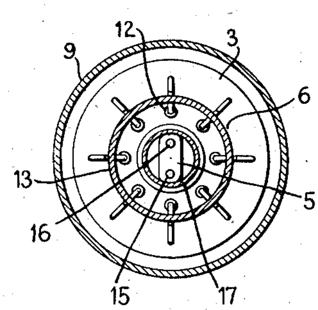

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FIG. 4.

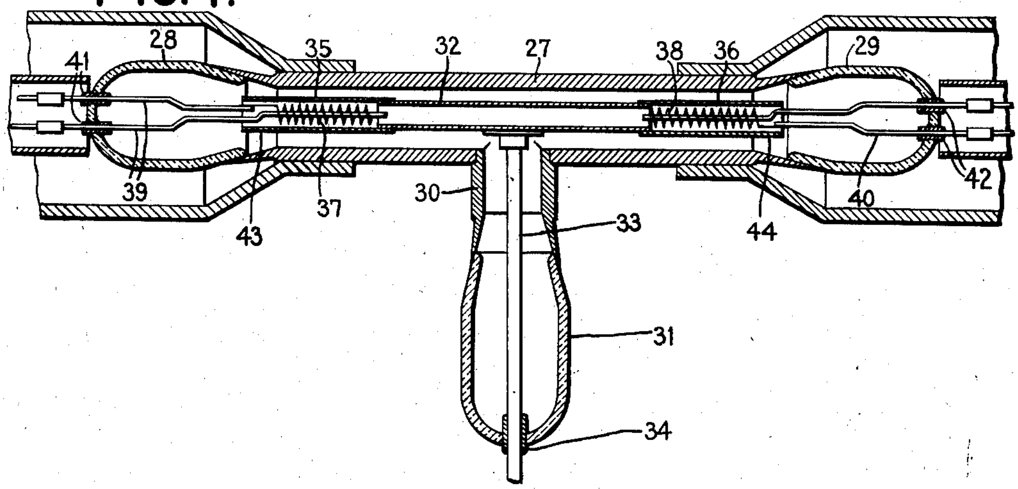

FIG. 5.

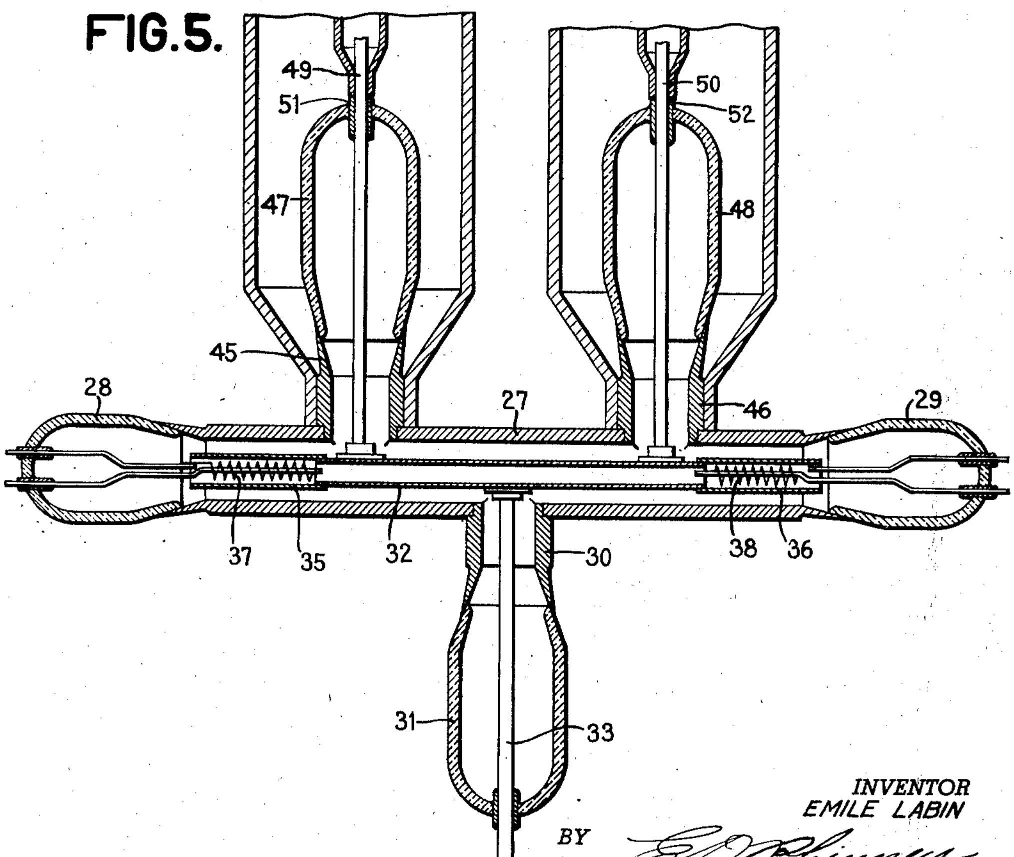

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FIG. 6.

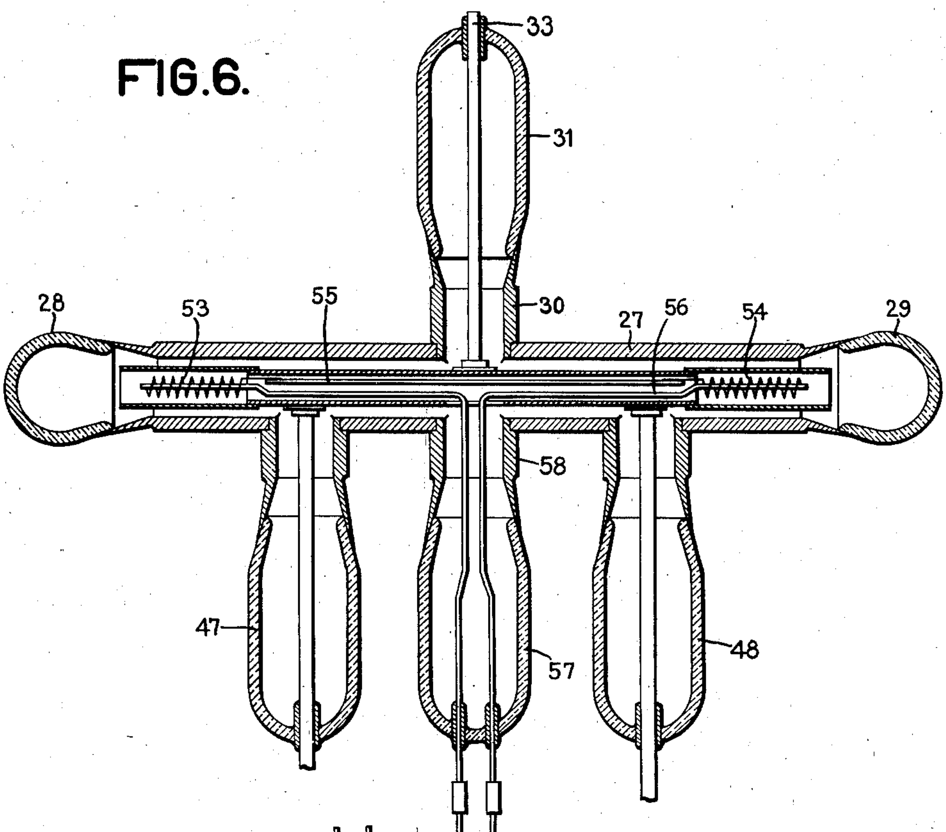
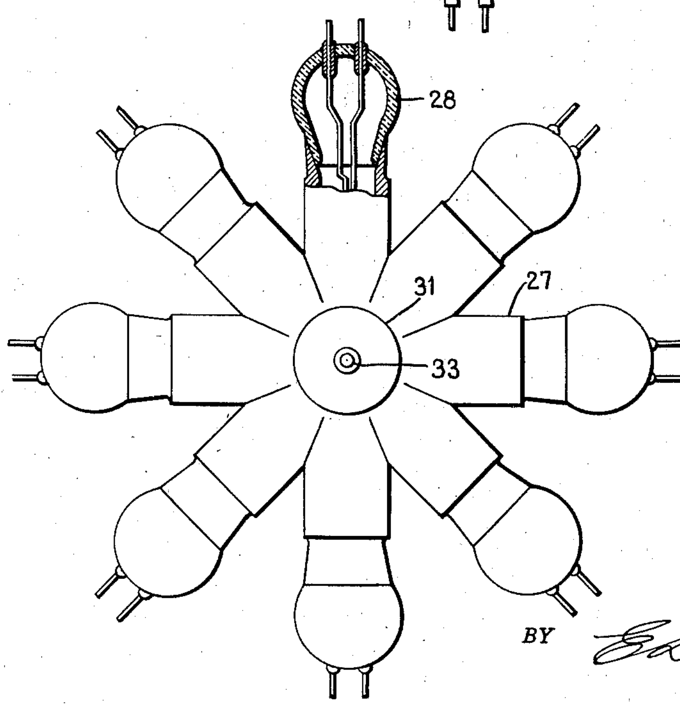


FIG. 7.



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HIGH FREQUENCY ELECTRON DISCHARGE TUBE

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Application February 19, 1941, Serial No. 379,559

6 Claims. (Cl. 250—27.5)

The present invention concerns structure of electron discharge tubes especially designed for operation at high frequencies. In particular the invention provides, according to certain characteristics thereof, arrangements and electrode structures for simple or multiple electron discharge tubes which permit the convenient application of feed connections or output connections in the forward transmission lines of the several electrodes. In addition the invention also provides arrangements for such connections.

The invention will be described in detail in the following description in connection with several illustrative embodiments represented in the attached drawings, wherein

Figs. 1 and 2 represent two simple electron discharge tube structures incorporating certain features of the invention;

Fig. 3 shows an end view of these two structures;

Figs. 4, 5 and 6 represent three embodiments of double electron discharge tubes incorporating certain characteristics of the invention; and

Fig. 7 schematically represents an arrangement of a multiple tube according to the features of the invention.

The structure of the electron discharge tube represented in Fig. 1 comprises an envelope in which a vacuum is provided and which is constituted by tubular anode 1, closed at one end by a base 2, and an insulation portion 3 of glass, for example, sealed onto widened portion 4 of the anode and joined to a press 5 by a tubulation or inverted annular press 6. Anode 1, base 2, widened portion 4, on the one hand, and the portion 3, the presses 5 and 6, on the other hand, may clearly each be formed of a single piece or on the other hand may be independently sealed together.

The lead-in connection of the anode consists, as shown, of a cylinder 7 pressed upon it in intimate electrical and mechanical contact (for example, pressed on by force and brazed at its ends) which is joined by a conical portion 8 and a cylinder of larger diameter 9.

The grid of the tube consists of a grid of spiral wires or squirrel cage or other form around mounting bars such as represented at 10. These mounting bars 10 are fixed, for example, brazed, onto a piece 11 having the form of truncated cone terminated at each side in cylindrical portions. Conducting stems 12 extend to and join onto said piece on the opposite side from the active portion 10 of the grid, said conducting stems being disposed along the generatrixes of an imaginary cylinder and serving as supporting connections and lead-out connections which pass through the annular press 6. On the outside of the tube these stems 12 are fixed on the periphery of a real conductive cylinder 13 which is coaxial with cylinder 19 of the anode. The diameters of the cylinders 9 and 13 are the same ratio as the diameter of the anode 1 and the imaginary surface of grid 10. The joining surfaces 8 and 11, although shown as truncated cones, are, so far as possible, formed in such manner as to follow the imaginary curves of junction which are theoretically required to preserve the uniform gradient between the structures of the anode and the grid.

The cathode structure consists of a filament 14 spirally wound, for example, on an imaginary cylinder coaxial to the cylinders of the grid and anode and supported and fed in known manner by two stems 15 and 16 which pass through the press 5. On the outside of the envelope the two stems 15 and 16 are placed as shown within the inside of a conductive screen 17 in such manner as to form a shielded pair coaxial to the connecting cylinders 13 and 9 of the grid and anode. Here, also, the diameters of this screen 17 and of the grids cylinder 13 are in the same ratio as the diameter of the imaginary cylinders 10 and 14 of the active parts of the grid and filament. This ratio, as well as the previously mentioned one, is preferably provided in such a way as to have a value which is well known in the art of coaxial transmission lines. In this way the feeding of the electron discharge tube circuit is effected by means of a three conductor coaxial line 9, 13, 17, as seen in plan view in Fig. 3.

In the embodiment shown, an end cap 18 is provided on the grid to play the part of a screen between the grid cathode space of the base 2 of the anode. With respect to the assembly, the cathode and grid electrodes are first assembled in insulating portion 3 of the envelope, while said assembly is mounted. Then when the assembly is mounted in anode 1, one can thus determine with precision the value of the capacity between base 2 and the anode and screen 18 of the grid.

The structure represented in Fig. 2 is in general analogous to Fig. 1, especially in so far as the arrangement of the lead-out connections from the electrodes in the form of a three conductor coaxial line is concerned. In this figure, the same reference characters as shown in Fig. 1 are applied to the corresponding elements.

However, supports 10 of the grid are extended and bent in such a way as to extend to and join electrically and mechanically around a metal plate provided with peripheral brim 20 for sealing to insulation portion 3 of the envelope and for electrical and mechanical attachment of the feed cylinder 13. Also, conductors 15 and 16 supporting and feeding the filament pass through two sleeves 21 and 22 of larger diameter which form part of the plate 19 and are sealed in insulating sleeves 23 and 24, which themselves are sealed to the conductive sleeves 21 and 22 extended to such a point as to avoid discharge along the insulation between the connections of grid and cathode.

At the other end of the tube is shown an anode structure different from that of Fig. 1. In this tube anode 1 is open at both ends and is sealed onto a balloon 25 made of glass, for example, and the outside cylinder 7 is extended all around this balloon, as shown at 26, whether it be by an external metalization of the balloon or by a continuous metal envelope or by a metallic screen or trellis. Such an end structure has the advantage compared to that of Fig. 1, that the assembly of the tube is facilitated. For before sealing the balloon 25 tools may be passed through anode 1. The capacity between the screen of grid 18 and the base 26 of the anode is then not known, but is made very small in consequence of the relatively large spacing between said screen 18 and the metallic coating 26.

One sees that the section of Fig. 3 can again be considered as applicable to the structure of Fig. 2, aside from the fact that the press 5 must be replaced by two insulating sleeves 23 and 24. It is clear that the anode may be cooled if desired in any suitable manner, either by circulation of cooling fluid within a skirt which is provided for this purpose around this anode, or simply by providing on the surface of cylinder 7 little cooling wings. The anode 1, may, moreover, consist either of a metal plate which is beaten out or shaped in some other manner or a bar which is hollowed out so as to contain the other electrodes.

In addition, it is clear that in the structures, as well as in those hereafter to be described, additional electrodes, for example, grids, could be added to the tubes without departing from the scope of the invention.

A tube structure such as described, is clearly well suited for the operation at high frequencies especially in consequence of the lead-out arrangements which assure short range connections within the tube. However, in systems operating at high frequencies it is nearly always desirable to provide circuits capable of operating in push-pull manner and in consequence it is desirable to provide double tube structures for this purpose. Various ways of applying the invention to such double tubes will now be described.

In the case where anode 1 is formed by a solid bar, hollowed out to contain the other electrodes, there is no need for a drawing to explain the arrangement of such a double tube. It is sufficient to consider, for example, one of the Figs. 1 and 2, and to complete it by a structure which is symmetrical with respect to a plane perpendicular to the longitudinal axis passing near the end of the anode. However, such a structure will necessitate pumping operations unless a passage be established through the solid portion of the bar which serves as an anode.

A similar arrangement could clearly be adopted with a thin walled anode, such as represented in Figs. 1 and 2, the two end structures being sufficiently spaced from each other. However, it may be advantageous in certain cases to abandon the three-conductor coaxial output line and use in its place two or several transmission lines extending from the electrodes of the arrangement. Figs. 4, 5 and 6 show three examples of such structures.

In the structure of Fig. 4, the cylindrical anode 27 is open at its two ends and on these ends are sealed insulated balloons 28 and 29 which may, for example, be of glass. In cylinder 27 there is fixed, for instance by brazing, a short conductive tube 30 on the open end of which is sealed insulating balloon 31. On the inside of the air tight envelope thus formed, there is disposed a grid structure consisting of an elongated cylinder 32 coaxial to anode 27 and supported at its center by a stem 33 serving as a lead-in conductor. Stem 33 passes coaxially through sleeve 30 and passes out of balloon 31 through seal 34, for instance, a direct glass metal seal as shown. At each end of tube 33 there are fixed, for example by brazing, a certain number of posts 35, 36, parallel to the generatrixes of the cylinder 33 on which are wrapped the grid threads, not shown. On the inside of these grids and along their length are disposed filamentary cathodes 37 and 38, respectively, carried by supporting and lead-in stems 39 and 40 which pass through the balloons 28 and 29 through seals, such as shown for example at 41 and 42. Screens may, as shown at 43 and 44 be provided at the ends of the grids 37 and 38.

Two coaxial lines may then be provided at the two ends of the structure in the manner shown in Figs. 1 and 2 by means of cylinders attached to anode 27 and extending coaxially with respect to the axis of the complete structure, the other conductor of these coaxial lines being constituted by cylinders forming the screen for the lead-in conductors of the cathodes. A third coaxial line may, if desired, be provided between the anode sleeve 30 and the grid conductor 33 in the same way. A jacket for water or other cooling fluid may be provided around the anode. The continuity of the grid structure avoids all undesirable electron couplings between the ends of the filaments and the anode.

In such a double structure, it may nevertheless be desirable to be able to withdraw energy from the grid. Consequently, as shown in Fig. 5, one may provide on the anode 27 two other cylindrical sleeves 45 and 46, schematically disposed on each side of the axis of the sleeve 30 and on the other side of the anode. These sleeves 45 and 46 carry sealed on to them insulating balloons 47 and 48 through which pass the lead-in conductors of grids 49 and 50, by means of seals 51 and 52, for example. These conductors 49 and 50 may constitute a parallel wire line. The rest of the structure being identical to Fig. 4 will not be described in detail and the same numerical references are assigned to corresponding elements, as is the case also in the structure of Fig. 6.

In this Fig. 6, however, the two balloons 28 and 29 at two ends of the anode 27 are no longer passed through by the lead-outs of the filaments of the two active structures. These structures operate in the case of this figure with filaments 53 and 54 in series, fed by conductors 55 and 56 which extend longitudinally on the inside of the grid cylinder and pass out at right angles, as shown through an insulating balloon 57 sealed to a fourth cylindrical sleeve 58 of the anode 27. This lead-out is effected in the middle of the tube between the lead-out conductors of the grid.

Still another utilization of the structures described in the invention may be visualized for tubes which are no longer double but multiple. In this case schematically represented in plan view in Fig. 7 a certain number of simple structures are schematically assembled around an axis. Such an arrangement requires no additional description, being self-explanatory in accordance with the descriptions of the preceding figures.

Although the invention has been described in the case of certain particular examples of embodiments, it is clear that it is not limited thereto in any respect, but is, on the contrary, susceptible of numerous modifications and adaptations without departing from the domain of the invention. In particular all of the appropriate structures of filaments and grids may be used in devices incorporating the characteristics of the invention.

What is claimed is:

1. A high frequency vacuum tube arrangement comprising a cylindrical anode forming a part of the envelope, a grid electrode assembly arranged on a cylindrical surface of a given diameter arranged concentrically of said anode, a concentric transmission line external of said envelope, means interconnecting said outer conductor and said anode, and means interconnecting said inner conductor and said grid, each of said interconnecting means comprising a generally conical tapering member, one of said conical members being disposed within the other of said conical members, whereby a substantially uniform gradient between the anode and the grid structures is obtained.

2. A high frequency tube arrangement according to claim 1 in which the respective radii of each of said members at any given point along the axis of said tube bears substantially the same ratio as the ratio of the respective radii of the conductors of said concentric transmission line.

3. A high frequency tube according to claim 1, further comprising a cathode having a cylindrical surface concentrically arranged within said grid electrode assembly and means for energizing said cathode, comprising a shielded conductor pair, the shield of said pair being arranged concentrically within said inner conductor and having substantially the same diametral ratio to said inner conductor as said cathode cylinder has to said cylindrical surface.

4. A vacuum tube structure comprising an anode of substantially cylindrical form, glass bulbs sealed at each end of said anode, a tubular grid support mounted concentrically within said anode, a set of grid wires at each end of said tube cooperating with said anode, cathode structures arranged concentrically of said grid wire set and supported by leads through said glass bulbs, a further glass seal substantially at a longitudinal midpoint on the periphery of said anode, and a rod fastened substantially at the center of said tubular support and extending generally radially of said anode and supported in said further glass seal to maintain said tubular support in position.

5. A vacuum tube structure according to claim 4, further comprising output leads comprising rods connected at one end to symmetrically spaced points on said tubular support, and lateral extensions in said anode concentrically arranged outside each of said leads.

6. A vacuum tube structure according to claim 4, further comprising cathode energizing leads arranged within said tubular support, said tubular support and said anode being provided with an opening substantially mid-way along their lengths, and means for supplying the filament heating current to said cathode energizing leads extending through said openings.

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