June 6, 1939. C. A. BIELING 2,161,005

ELECTRON DISCHARGE DEVICE

Filed Sept. 4, 1937

FIG. 1

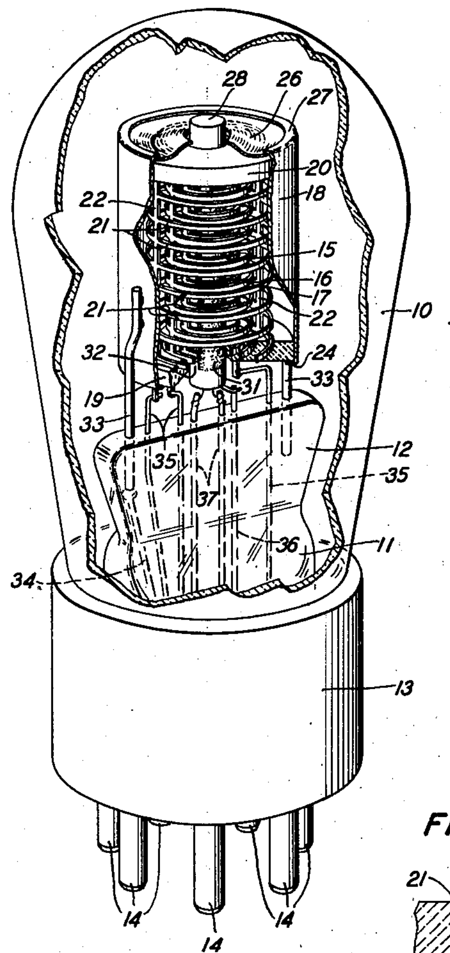


FIG. 2

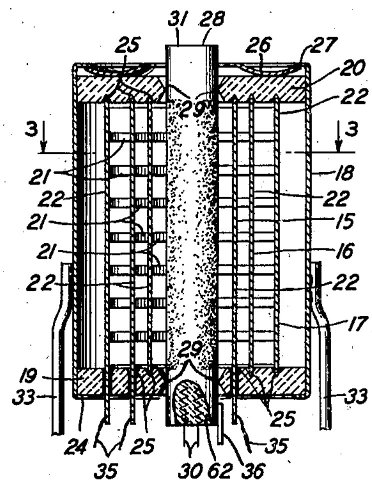


FIG. 3

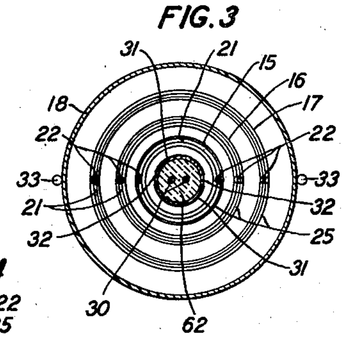


FIG. 4

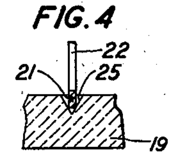


FIG. 5

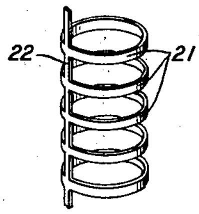
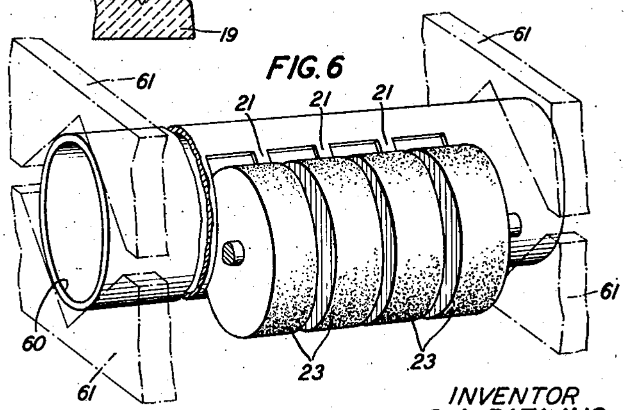


FIG. 6



INVENTOR
C. A. BIELING
BY
Walter C. Kiesel
ATTORNEY

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UNITED STATES PATENT OFFICE

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ELECTRON DISCHARGE DEVICE

Carl A. Bieling, Westfield, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

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7 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices and more particularly to such devices especially suitable for the generation and amplification of ultra-high frequency impulses.

One object of this invention is to expedite the fabrication of electron discharge devices and especially such devices having a plurality of grid electrodes.

Another object of this invention is to maintain accurately the desired form and geometrical disposition of the electrodes in electron discharge devices.

A further object of this invention is to obtain substantially uniform electron distribution from the cathode of electron discharge devices.

Still another object of this invention is to increase the power capacity of electron discharge devices having closely spaced electrodes.

In one illustrative embodiment of this invention, an electron discharge device comprises a cathode, an anode encompassing the cathode, one or more cylindrical grids disposed between the cathode and the anode, and insulating members at opposite ends of and spacing the several electrodes.

The grids may be formed of sheet metal tubing, for example tubing of tungsten, tantalum or molybdenum, portions of the tubing being removed, as by abrasive wheels, to form a plurality of parallel circular grid elements integral with one or more supporting or upright portions. The insulating spacer members are provided with concentric annular grooves for receiving the ends of the grids.

In accordance with one feature of this invention, the insulating spacer members are positioned by the anode and means are provided for resiliently holding one of the insulating members against the grid or grids so that the grid or grids may expand and contract freely in a longitudinal direction.

In accordance with another feature of this invention, the annular grooves in the insulating spacers are V-shaped in section so that lateral shifting of the grid or grids is prevented and accurate spacing and alignment of the electrodes is thereby maintained.

In accordance with still another feature of this invention, only those portions of the cathode opposite the reticulated portions of the grid nearest the cathode are coated with thermionic material whereby a uniform electron distribution through the reticulated portions of the grid is obtained.

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 in perspective of an electron discharge device constructed in accordance with this invention, portions of the enclosing vessel and of the electrode structure being broken away to show details of construction more clearly;

Fig. 2 is a longitudinal sectional view of the electrode assembly embodied in the device shown in Fig. 1;

Fig. 3 is a lateral sectional view of the electrodes in the device shown in Fig. 1 along lines 3—3 of Fig. 2, illustrating the form and disposition thereof and showing the extent of the thermionic coating upon the cathode;

Fig. 4 is an enlarged detail view in section illustrating the association of a grid and an insulating spacer in the device illustrated in Fig. 1;

Fig. 5 is a perspective view illustrating a modified grid constructed in accordance with this invention; and

Fig. 6 illustrates a method of fabricating grids in accordance with this invention.

Referring now to the drawing, the electron discharge device shown in Fig. 1 comprises an enclosing vessel 10 having an inwardly extending stem 11 that terminates in a press 12 from which the electrodes are supported. A suitable base 13, for example of insulating material, is secured to the enclosing vessel and carries a plurality of terminal prongs or pins 14 through which electrical connection to the electrodes may be established.

A unitary electrode assembly is supported from the press 12 and comprises a central cathode, a plurality of grids 15, 16 and 17, a cylindrical anode 18, and insulating spacer members or discs 19 and 20 at opposite ends of the electrodes. As illustrated in Fig. 3, the several electrodes preferably are arranged concentric with one another. The innermost grid 15 may be utilized as the control electrode, the next grid 16 as a screen or shield electrode and the outermost grid 17 as a suppressor electrode.

Each of the grids is a rigid, self-sustaining unit comprising a plurality of parallel circular elements 21 joined by and integral with diametrically opposite supporting or upright portions 22. As illustrated in Fig. 6, the grids may be formed of sheet metal tubing 60 held in suitable clamps 61, portions of the tubing being removed by parallel abrasive wheels 23, the width of which determines the spacing of the circular elements 21 and the spacing of which determines the size of the elements 21. Any burrs formed by the abrasive grinding may be removed by a buffing operation. Grids thus constructed, it will be apparent, may be manufactured expeditiously in quantity and at low cost. Such grids, furthermore, obviate the use of welds in the grid structure and thereby allow the use of materials such as tungsten, tantalum and molybdenum having high melting points. Consequently, grids constructed as above described may be operated at high temperatures and the devices of which they form a part are capable of handling large powers.

As shown clearly in Fig. 2, the anode is provided at one end with an inwardly extending flange 24 upon which the insulating spacer member or disc 19 is seated. This insulating spacer 19 is provided with concentric annular grooves 25 in each of which a corresponding one of the grids 15, 16 and 17 is seated. The other insulating spacer member or disc 20 is slidably fitted within the anode 18 and, similarly to the member 19, is provided with concentric annular grooves 25 for receiving the grids. It is held in intimate engagement with the several grids by a resilient, annular, dished metallic member or spring 26 which is held in position by an inwardly extending flange 27 on the anode. The spring member 26, it will be seen, allows longitudinal expansion and contraction of the grids, occasioned by temperature variations therein during operation of the device, so that the cylindrical form of the several grids is preserved. By its action, however, the spring member 26 holds the insulating disc 20 in contact with the several grids so that the grids are held in spaced relation.

As shown clearly in Fig. 4, the grooves 25 preferably are V-shaped in section so that the two surfaces thereof engage opposite edges of the grids. Hence, lateral shifting of the grids is prevented and the requisite spacings between the grids and the cathode and anode are accurately maintained. This, it will be appreciated, is highly desirable in ultra-short wave devices, wherein the electrode spacings not only are very small but also must be accurately constant during operation of the device to assure uniform electron transit times and constant operating characteristics.

The cathode may be of the equipotential type and comprises a cylindrical metallic sleeve 28 extending through aligned central apertures in the insulating discs 19 and 20 and frictionally engaged by chamfered edges 29. Disposed within the cathode sleeve 28 and insulated therefrom by a ceramic body 62 is a suitable heater filament 30. The cathode sleeve 28 has thereon coatings 31 of a thermionic material, such for example as barium and strontium oxides. As shown clearly in Fig. 3, the portions 32 of the cathode sleeve 28 in the shadow of the supporting or upright portions 22 of the control grid 15 are not coated with thermionic material so that concentration of electrons adjacent the supporting or upright portions 22 is prevented and a uniform dispersion of electrons through the control grid 15 is obtained.

The unitary electrode assembly above described may be supported from the press 12 by a pair of rigid supports 33 embedded in the press and affixed, as by welding, to the anode 18, one of the supports being connected electrically to a corresponding one of the terminal prongs 14 by a conductor 34.

One of the supporting or upright portions 22 of each of the grids may be extended through and below the lower insulating spacer 19, as shown clearly in Fig. 2, and have affixed thereto a leading-in conductor 35, each of which is electrically connected to a corresponding one of the terminal prongs 14. Electrical connection to the cathode may be established by a suitable conductor 36 affixed to the cathode sleeve 28 and heating current for the filament 30 may be supplied through conductors 37.

It will be understood that each of the several grids may be utilized to perform one of a number of functions. If desired, the grid utilized as the control electrode may be provided with a leading-in conductor extending through a suitable aperture in the ring member 26 and sealed in the vessel 10 at the top thereof, to minimize the capacitance between this grid and the other electrodes.

As shown in the drawing, the circular portions 21 of the several grids may be in alignment and of the same thickness. For example, these portions may be of the order of 5 mils in thickness and may be spaced of the order of 10 mils. Of course, the portions 21 of the several grids need not be in alignment and, if desired, these portions of each grid may be spaced non-uniformly to provide variable mu characteristics.

As illustrated in Fig. 5, each of the grids 15, 16 and 17 may have but a single supporting or upright portion 22.

Although specific embodiments of the invention have been illustrated and described, it will be understood, of course, 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. An electron discharge device comprising a plurality of cooperatively disposed electrodes, an insulating member spacing said electrodes at one end, a second insulating member spacing said electrodes at the other end, and resilient means bearing against said second insulating member for urging it toward said first insulating member.

2. In an electron discharge device, an electrode assembly comprising an insulating spacer having a plurality of annular grooves therein, a plurality of rigid tubular electrodes each seated at one end in a corresponding one of said grooves, an insulating member engaging said electrodes at the other end thereof, and means including a resilient member for holding said spacer and insulating member in engagement with said electrodes.

3. In an electron discharge device, an electrode assembly in accordance with claim 2 wherein said annular grooves are V-shaped in section.

4. In an electron discharge device, an electrode assembly comprising a rigid electrode having a flange at one end thereof, a spacer member seated upon said flange, a second electrode seated at one end upon said spacer member, and means including a resilient member positioned by said first electrode and engaging the other end of said second electrode for holding said second electrode in engagement with said spacer member.

5. In an electron discharge device, an electrode assembly comprising a hollow anode having flanges at the ends thereof, an insulating spacer seated upon one of said flanges, an electrode within said anode and seated upon said insulating spacer, an insulating member slidably mounted within said anode and engaging said electrode, and resilient means engaging the other of said

flanges and said insulating member for maintaining said member in contact with said electrode.

6. In an electron discharge device, an electrode assembly in accordance with claim 5 wherein said resilient means comprises an annular dished member having its periphery engaging said other flange and an intermediate portion bearing against said insulating member.

7. In an electron discharge device, an electrode assembly comprising a cylindrical anode having inwardly extending flanges at its ends, an insulating disc within said anode and seated upon one of said flanges, said disc having a plurality of concentric annular V-shaped grooves therein, a plurality of coaxial tubular grids having one end seated in said grooves, a second insulating disc slidably fitted in said anode and engaging the other end of said grids, said second insulating disc having concentric, annular, V-shaped grooves for receiving the other end of said electrodes, and an annular resilient member between and engaging said second disc and the other flange on said anode.

CARL A. BIELING.