

Jan. 7, 1936.

J. P. LAICO

2,027,180

ELECTRON DISCHARGE DEVICE

Filed Nov. 17, 1934

FIG. 1

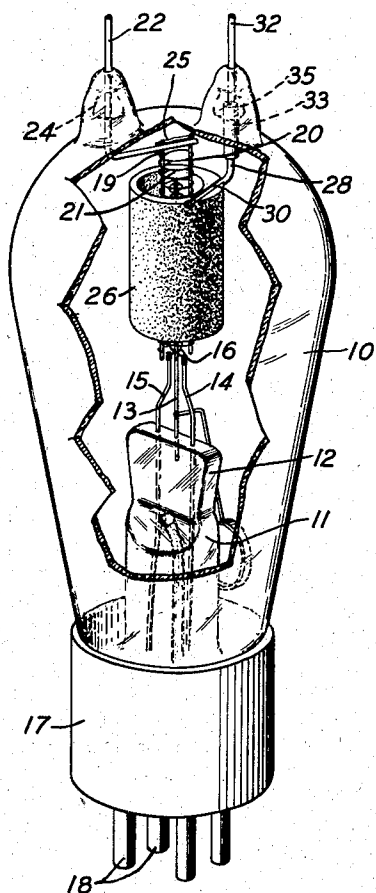


FIG. 3

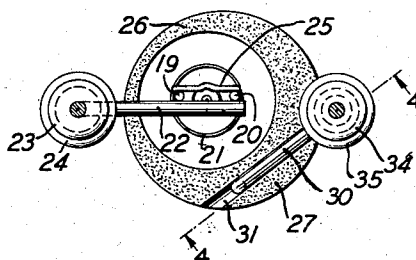


FIG. 2

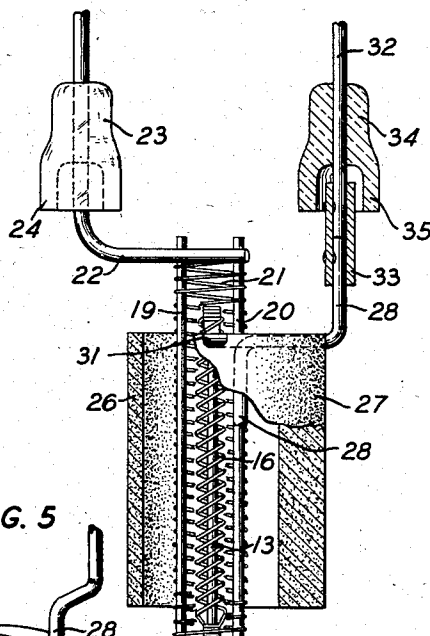


FIG. 5

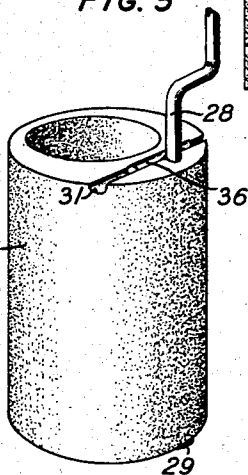
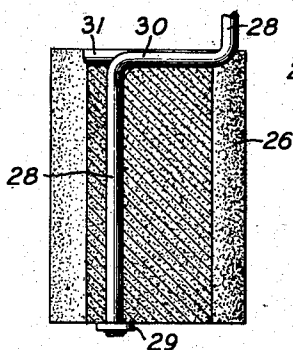


FIG. 4



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2,027,180

ELECTRON DISCHARGE DEVICE

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Application November 17, 1934, Serial No. 753,447

10 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices and more particularly to such devices for use in ultra-high frequency radio transmission systems.

One object of this invention is to obtain low inductance and low resistance connections between the electrodes for efficient operation at ultra-high frequencies.

Another object of the invention is to insure low inter-electrode capacitances and short electron transit time while maintaining the transconductance and energy dissipation at high values.

In accordance with this invention, the device comprises an enclosing vessel in which an electron emitter or cathode is supported axially on a stem and is surrounded by a control electrode or grid and an anode. In order to insure adequate insulating paths between the electrodes for efficient ultra-high frequency operation, the grid and the anode leading-in wires are segregated from the cathode and brought out through the top of the enclosing vessel. These wires are made relatively short and heavy to insure low inductance and resistance and to accurately maintain the electrodes in proper spacial relation with respect to the central electron emitter.

A feature of the invention relates to the arrangement of electrodes in such a manner that the electron transit time is relatively short between the source or cathode and the anode and adequate heat dissipation is insured in the anode regardless of the small areas of the electrodes and the high operating potentials employed in ultra-high frequency transmission systems. These results are attained by forming the anode of high heat dissipating material, such as graphite.

Since the mass of the anode is quite large in comparison with the other electrodes, it is essential to form and mount the anode so that a high operating efficiency may be attained. In accordance with this invention, the graphite anode is machined to a cylindrical form with an inner cylindrical surface arranged eccentric with respect to the circumference, and the thickened portion of the anode forms an anchoring body for the support or leading-in wire. The anode is prevented from changing its space relation with respect to the other electrodes by locking the support in a groove to prevent twisting or misalignment of the anode.

Another feature of the invention relates to the supporting assembly of the grid and anode in which a portion of the grid support and

an auxiliary member form an electrostatic shield at the top of the electrode unit to prevent spreading of stray electron fields. The anode support is formed of two sections surrounded by a sleeve to form a rigid joint between the sections.

These and other features of the invention will be more clearly understood from the following detail description taken in connection with the accompanying drawing.

Fig. 1 illustrates one embodiment of the invention in a perspective view with a portion of the enclosing vessel broken away to illustrate the internal electrode assembly;

Fig. 2 is an enlarged view of the cooperating elements shown in the device of Fig. 1 prior to their incorporation in the vessel with portions of the assembly shown in cross-section;

Fig. 3 is a plan view of the electrodes to illustrate the relationship of the supporting leading-in wires for the grid and anode as viewed from the top of Fig. 1;

Fig. 4 is an enlarged view in cross-section of the anode and its support taken on the line 4—4 of Fig. 3; and

Fig. 5 is a perspective view of the anode with a modified arrangement of the supporting member.

The utility of electronic discharge devices in the ultra-high frequency range of the radio spectrum is materially enhanced, particularly at the upper limits of the range, when the device is capable of oscillating with normal values of applied potential. This is due to two factors, namely, that the period of oscillations is comparable with the time required for the electrons to traverse the region between the cathode and anode and that circuit requirements do not impose a limiting frequency on the device.

The stable static characteristics and constants of the device attained in generating frequencies above 100 megacycles, under operating conditions, are realized by following certain features of construction which are as follows. The spacing between the elements, particularly the grid and cathode, should be close to obtain a high mutual conductance and short electron paths. The supports of the grid and the anode should be short and heavy to obtain low conductance and resistance and a minimum value of stray inter-electrode capacitance. The importance of low resistance conductors is evident when it is realized that the charging currents at even very small inter-electrode capacitances may reach large values at very high frequencies. The elimination of auxiliary supporting members, either metal or

insulating material, with their attending losses. The use of a high dielectric glass vessel and a graphite anode to permit high energy dissipation from a small electrode area.

5 The device of this invention which is a triode of the low power type particularly for use in the frequency range from 15 megacycles to 300 megacycles, is designed to meet the above requirements, and one embodiment of the device is shown in 10 Fig. 1 in which a high dielectric enclosing vessel 10, preferably of a boro-silicate glass, is provided with an inwardly projecting stem 11 terminating in a press 12. The press carries a central standard or arbor 13 and two leading-in wires 14 and 15, which are sealed in the press on opposite sides 15 of the central standard 13. A spiral filament or cathode 16, preferably in the form of a double helix, coaxially surrounds the standard and has its mid-point secured to the standard while the 20 ends are attached to the leading-in wires 14 and 15. The cathode is a thoriated tungsten filament which supplies a copious emission of electrons within a small area. The vessel is supplied with a mounting base 17 carrying the usual number 25 of terminal prongs 18 to fit a standard socket, although only two of the prongs may be employed for connection to the leading-in wires 14 and 15 of the cathode.

The leakage paths between the high frequency 30 and high voltage terminals of the electrodes and the low voltage terminals of the filament or cathode should be exceedingly long in order to maintain a high insulation path between the respective electrodes. In the device shown in Fig. 1, 35 the conductors for the grid and anode are sealed through the top of the enclosing vessel and therefore are, as far as possible, away from the stem and press which support the leading-in conductors for the cathode. The grid or control electrode is formed of two parallel wires 19 and 20 40 which form supports for a continuous helical wire grid 21 which surrounds the double helical cathode 16. The grid is supported by a wire 22 which is bent in the form of an L so that one end extends across the two grid support wires 19 and 45 20 and is welded thereto while adjacent the other end a glass bead 23 is fused on the support wire 22 and carries a skirt portion 24 as shown in Fig. 2. The bead is formed of the same material as 50 the glass vessel 10 and is sealed thereto in the manner as shown in Fig. 1, with the terminal 22 extending vertically from the vessel in an offset position with respect to the axis of the vessel. A short heavy wire 25 having a central nodal portion 55 is welded to the grid support wires 19 and 20 on the side opposite the angular extension of the grid conductor 22 to prevent the escape of stray electron fields through the top of the grid structure. The inter-electrode capacitance between 60 the cathode and grid is maintained relatively low due to the small dimensions of these elements and the inductance and resistance of the conductor 22 is relatively low due to its short length. Furthermore, this conductor is sufficiently rigid to 65 adequately support the grid structure in proper alignment and spacial relation with respect to the central cathode.

A cylindrical anode 26 surrounds the cathode and grid and due to its small area, it is preferably 70 made of a high heat dissipating material, such as graphite, since approximately 55 watts of energy may be dissipated during operation. The anode 26 is supported independently by a leading-in conductor sealed through the top of the vessel in 75 the same manner as the conductor of the grid.

In order to efficiently support the anode in special relation with respect to the other electrodes and also to prevent the large mass of the electrode varying the characteristics of the device 5 due to vibration or shock, it is essential that the electrode be rigidly held in proper relation to the other electrodes.

In accordance with this invention, the cylindrical anode is formed with an eccentric cylindrical large inner bore or hollow portion to provide 10 a relatively thick wall portion 27 on one side of the anode while the remaining wall portion gradually decreases to a minimum thickness on the other side so that the axis of the bore is offset with respect to the normal axis of the circumference. The thick wall portion 27 is provided 15 with a small diameter longitudinal bore through which extends a support rod 28 which is rigidly held in the wall portion by an enlargement or metallic button 29 welded on the end of the support 20 rod 28, as shown in Fig. 4. The upper end of the rod is bent at an angle, as shown at 30, and is seated in a chordal slot or groove 31 to rigidly anchor the support rod in the body of the anode and prevent twisting or shifting of the position 25 of the anode with respect to the other electrodes. The support rod 28 is preferably formed of molybdenum to reduce the cost of the device and this support rod is connected to a tungsten leading-in conductor 32 by a nickel sleeve 33 which surrounds 30 the butt joint of the two wires, the sleeve being welded to the abutting ends of the wires. The conductor 32 carries a glass bead 34 having a skirt portion 35 similar to the bead on the grid conductor and this bead is sealed through the top 35 of the vessel, as shown in Fig. 1, with the grid and anode leading-in conductors lying in a plane at right angles to the plane of the press 12 within the vessel.

A modified supporting arrangement of the anode 26 is shown in Fig. 5 in which the support 40 rod 28 extends vertically from the central portion of the thickened wall of the anode and a short anchor wire 36 is located in the slot 31 and welded to the support rod 28 at a central point. 45

The fabrication of the electrode assembly and particularly the alignment of the grid and anode in their proper relation while sealing their supports in the vessel may be facilitated by following the methods and employing the machine sealing heads which are disclosed in my companion 50 application, Serial No. 755,555, filed December 1, 1934 now Patent 2,027,181 of January 7, 1936.

While the invention is disclosed as applied to a triode of a particular construction, it is of 55 course understood that the invention may be applied to other combinations of electrodes either for use at low or high frequencies and, therefore, the invention is only to be limited within the scope of the appended claims. 60

What is claimed is:

1. An electron discharge device comprising an enclosing vessel having a stem, a plurality of electrodes within said vessel including an electron emitting cathode supported from said stem, 65 a grid surrounding said cathode, an anode surrounding said grid, said anode having an eccentric thickened portion, a leading-in wire extending from said grid, and a leading-in wire anchored in the thickened portion of said anode, 70 both of said leading-in wires individually supporting the respective electrodes, said wires being sealed through the end of the vessel remote from said stem and arranged offset with respect to the axis of said vessel. 75

2. An electron discharge device comprising an enclosing vessel having a stem, a plurality of electrodes within said vessel including an electron emitting cathode supported from said stem, a cylindrical anode having a hollow portion eccentric with respect to the circumference, said hollow portion coaxially surrounding said cathode, and a support extending through said anode intermediate the circumference and hollow portion, said support having anchoring means engaging said anode to prevent rotation thereof with respect to the support and to prevent displacement thereof with respect to said cathode.

3. An electron discharge device comprising an enclosing vessel having a stem, an electron emitting cathode supported from said stem, a grid surrounding said cathode, a hollow cylindrical anode surrounding said grid, said anode having its axis offset with respect to the normal axis to provide a thick wall portion having a longitudinal bore, and a support extending through said bore for maintaining said anode in proper spaced relation to said grid and cathode, said support being sealed in the end of said vessel remote from said stem.

4. An electron discharge device comprising an enclosing vessel having a stem, an electron emitting cathode supported from said stem, a grid surrounding said cathode, a cylindrical anode surrounding said grid, said anode having its axis offset with respect to the normal axis to provide a thick wall portion having a longitudinal bore and a chordal groove communicating with said bore, and a support extending through said bore and having a portion lying in said groove.

5. An electron discharge device comprising an enclosing vessel having a stem, an electron emitting cathode supported from said stem, a grid surrounding said cathode, a cylindrical anode surrounding said grid, said anode having its axis offset with respect to the normal axis to provide a thick wall portion having a longitudinal bore and a chordal groove communicating with said bore, a vertical support rod extending through said bore, and an anchor member within said groove connected to said rod.

6. In an electron discharge device, a graphite anode having a cylindrical circumference and a large eccentric circular bore to form a thick wall portion, said wall portion having a longitudinal bore and a communicating chordal slot, and a metallic support situated in said longitudinal bore and slot.

7. In an electron discharge device, a graphite anode having a cylindrical circumference and a large eccentric circular bore to form a thick wall

portion, said wall portion having a longitudinal bore and a communicating chordal slot, a metallic support extending through said longitudinal bore and slot, and an enlargement of said support at the opposite end of said wall portion.

8. An electron discharge device comprising an enclosing vessel having a press, a support extending from said press, a pair of leading-in wires in said press, a helical cathode surrounding said support and connected at its ends to said leading-in wires and at an intermediate point to said support, a pair of grid supports outside of said cathode and lying in a plane at right angles to the plane of said press, a helical grid attached to said grid supports and coaxially surrounding said cathode, an angular leading-in wire attached to said grid supports, a hollow cylindrical anode surrounding said grid, the circumference thereof being eccentric with respect to said grid to form a comparatively thick wall on one side, said wall having a longitudinal bore and a transverse slot at one end, a leading-in wire for said anode having a portion extending through said bore and another portion seated in said slot, the grid and anode leading-in wires being sealed in the top of said vessel in a line transverse to the plane of said press.

9. An electron discharge device comprising an enclosing vessel having a stem, an electron emitting cathode supported from said stem, a helical grid coaxially surrounding said cathode and including a pair of parallel supports, a cylindrical anode surrounding said grid having an eccentric thickened portion, a leading-in wire for said anode extending through said thickened portion, a leading-in wire for said grid connected across said parallel supports on one side, and a short wire having a central nodal portion connected across said parallel supports on the opposite side.

10. An electron discharge device comprising an enclosing vessel having a stem, a helical electron emitting cathode supported from said stem, a grid coaxially surrounding said cathode and including a pair of parallel support wires, a cylindrical graphite anode surrounding said grid, said anode having an eccentric thickened portion, a refractory leading-in wire for said grid sealed through the top of said vessel, a refractory leading-in wire for said anode sealed through the top of said vessel, a support wire extending through said anode thickened portion, and a metallic sleeve surrounding the butt joint of said leading-in and support wires of said anode and secured thereto.

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