Dec. 18, 1934. V. L. RONCI ET AL 1,984,992

ELECTRON DISCHARGE DEVICE

Filed April 15, 1931

FIG. 1

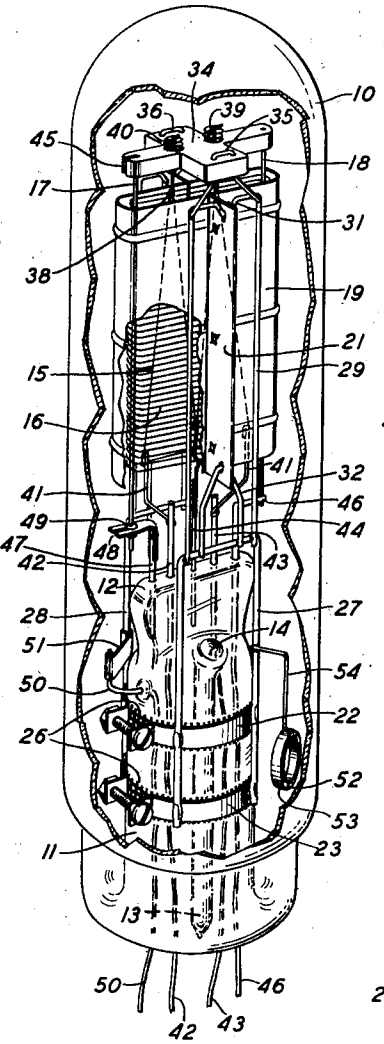


FIG. 3

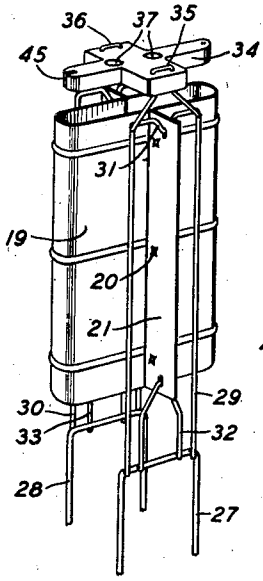
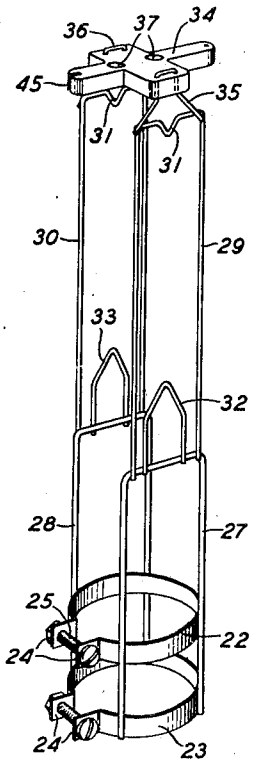


FIG. 2



INVENTORS: V. L. RONCI
J. E. CLARK

BY

Walter C. Kiesel

ATTORNEY

Patented Dec. 18, 1934 1,984,992

UNITED STATES PATENT OFFICE

1,984,992

ELECTRON DISCHARGE DEVICE

Victor L. Ronci, Brooklyn, N. Y., and James E. Clark, Newark, N. J., assignors to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application April 15, 1931, Serial No. 530,198

17 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices and especially to such devices employed in short wave transmission systems.

An object of the invention is to accurately maintain the interspace relation of the electrodes constant during the operating life of the device.

Another object of the invention is to permit longitudinal and lateral expansion and contraction of the control electrode during operation.

In accordance with this invention the electrode assembly of an electron discharge device employed in short wave transmission comprises a substantially closed metallic anode having oppositely disposed heat radiating flange portions and a wire-wound grid and a filament located within the metallic anode. The metallic anode is supported in the device from a collar surrounding the stem, the support consisting of two U-shaped frames projecting from the collar and connected to wire frame members threaded through opposite ends of the extending flange portions of the anode. This supporting structure applies a straining tension to the anode surface whereby the anode efficiently resists shocks which may impair the spacing between the various electrodes. An insulating member carried at one end of the supporting frame supports the grid and filament in spaced relation with respect to the surface of the anode.

One feature of the invention relates to the support of the grid or control electrode to permit lateral expansion thereof during operation of the device. In this arrangement one of the grid supporting wires is located in a slot in the insulating member and at the other end is positioned in a slotted metallic arm carried by the stem of the vessel. Suitable projections on the grid supporting wire on opposite sides of the slotted arm prevent displacement of the grid from the supporting structure. The electrode assembly of the device forms a rugged construction which substantially eliminates failure from mechanical defects, maintains the separate electrodes in accurate spaced relation for highly efficient operation, reduces the cost of production, and substantially reinforces the electrode structure against sudden impacts or shocks which may materially shorten the operating life of the device.

The invention will be more clearly understood from the following detailed description in connection with the accompanying drawing:

Fig. 1 is a perspective view of an electron discharge device made in accordance with this invention with a portion of the enclosing vessel and the anode broken away to clearly show the assembly of the electrodes;

Fig. 2 is a perspective view of the frame assembly only, to show the symmetrical arrangement of the parts; and

Fig. 3 is a perspective view showing the anode supported by the frame assembly of Fig. 2.

Referring to the drawing, the electrode structure of this invention is enclosed in a glass vessel 10 having an inwardly projecting stem 11 terminating in a glass press 12 and provided with an outwardly extending exhaust tube 13 which communicates with the interior of the vessel through an orifice 14 in the side of the glass stem 11, in order that the interior of the vessel may be highly evacuated to create a high vacuum. The electrodes in the device consist of an M-shaped thoriated tungsten filament or cathode 15 extending lengthwise of the vessel above the press 12, a helical grid 16 preferably formed of molybdenum wire wound continuously around two spaced wire supports 17 and 18 with the flat sides of the helix arranged in parallel relation on opposite sides of the filament 15, and a surrounding anode or plate electrode 19, preferably formed of molybdenum, to withstand high temperatures and formed of two symmetrical U-shaped sections having outwardly extending angular flange portions. These flange portions are juxtaposed in face-to-face relation and held together by eyelets 20 punched through the adjacent faces of the flanges 21 to rigidly form the anode into a surrounding body, the large parallel surfaces of the anode 19 lying in parallel planes with the adjacent surfaces of the grid 16 and the filament 15.

The filament, grid and anode are usually mounted in the enclosing vessel in a certain definite space relation to obtain the desired dynamic and static characteristics for efficient operation. Any defect in the structural assembly of the electrodes, or of the material of the electrodes, or causes exterior to the enclosing vessel, may alter or change the inter-electrode spacing and thereby materially decrease the effectiveness of the device, or render the device unsuitable for its purpose. For instance, the electrodes may be supported by single wires which cannot withstand severe shocks or the electrodes may be so arranged as to provide insufficient insulation therebetween and these defects result in arcing between the electrodes at very high frequencies, such as are used in short wave transmission systems.

When an electron discharge device is employed in portable receiving and transmitting sets, such as are used in aircraft high frequency radio signaling, the electrodes in the device should be supported so that sudden jars or shocks, such as

may be experienced by the aircraft carrier leaving the ground, or alighting thereon, will not cause alteration of the electrode spacing or fracture the enclosing vessel by the electrode assembly striking the glass vessel. Furthermore, the electrodes should be highly insulated with respect to each other to prevent arcing at the high frequencies at which aircraft transmission is carried on.

In accordance with this invention, the electrodes are maintained in accurate space relation by a frame assembly which can withstand severe shocks without affecting the spacing between the cooperating electrodes supported in the vessel. The supporting frame assembly comprises two spaced metallic bands 22 and 23 surrounding the glass stem 11 in the vessel 10 which are provided with perforated angular extensions 24 through which bolts 25 may be threaded to securely clamp the bands to the stem 11. A strip of wire mesh cloth 26 is located between the adjacent surfaces of the glass stem 11 and the bands 22 and 23 to insure a positive gripping action for the metallic bands and thereby prevent slippage of the bands on the glass stem. A heavy gauge U-shaped metallic rod-like member 27, preferably of nickel, is arranged parallel to the stem 11, with the U-shaped portion extending above the plane of the top of the glass press 12 and the free leg portions being joined to the metallic bands 22 and 23, for instance, by welding. A similar U-shaped member 28 is attached to the metallic bands 22 and 23 in parallel relation with the U-shaped member 27, the two U-shaped members forming a substantially rigid frame or base for the electrodes. The heavy gauge frames 27 and 28 extending from the glass stem are arranged in parallel planes which bisect the planes of the flanges 21 extending from the hollow plate electrode 19. An elongated U-shaped metallic frame 29, formed of highly refractory wire, such as molybdenum, arises from the frame member 27 and a similar member 30 arises from the frame member 28. Both of these members are provided with a downwardly extending V-shaped bend 31 in the center of the closed end of the U-shaped members while the free legs of the members are attached to the horizontal portion of the frame members 27 and 28, respectively. The frame members 29 and 30 are threaded through elongated small apertures or eyes in the end of the flanges remote from the stem 11, and the anode is centrally located in the vessel by the V-shaped bend 31 in the frame members 29 and 30. The end of the anode 19 adjacent the stem is maintained in alignment with the opposite end of the anode by gable-shaped frame members or connectors 32 and 33 which are threaded through other elongated apertures in the end of the flanges adjacent the press. In the assembly of the anode structure in the vessel the frame members 29 and 30 are threaded through one end of the flanges 21 on the anode 19 and welded or otherwise attached at their lower ends to the frame members 27 and 28. After this operation is completed and the flanges are positioned midway between the legs of the frame members 29 and 30, the gable-shaped connecting members 32 and 33 are threaded through the lower ends of the flanges on the anode with the apex of the gable-shaped connectors centering the flanges 21 in alignment with the V-shaped bend 31 in the frame members 29 and 30. Then a straining force is applied to the gable connectors 32 and 33 so that the flanges of the anode cannot move from their central position determined by the bights of the V-shaped bend 31 in both of the frame members 29 and 30 and the connecting members 32 and 33. When the anode is accurately centered, the connecting members 32 and 33 are welded to the horizontal arm of the frame members 27 and 28.

The highly refractory frame members 29 and 30 and the connecting members 32 and 33 of similar material, while formed of relatively small gauge wire, are sufficiently rigid to withstand the high temperatures generated in the region of the electrode surfaces. Another advantage of this frame assembly is the comparatively large supporting area of the frame with a minimum of material so that the frame support may be easily deprived of gases. Since the heat generated in the region of the electrodes does not seriously affect the supporting structure adjacent the stem, the base frame members 27 and 28 are preferably made of nickel. This construction materially decreases the cost of the assembly of the electrodes without detracting from the efficiency of the structure. Furthermore, the tension or straining force utilized in supporting the anode eliminates solid joints between the support and the anode, such as would be caused by welding. Therefore, the assembly is free from mechanical defects which might occur due to improper welding. While the anode is in contact with the supporting structure only at minute points, nevertheless, the large area of the supporting frame contributes toward a rigid assembly which substantially eliminates distortion or movement of the anode when subject to shocks either along the axis of the vessel or at right angles thereto.

In order to insure accurate space alignment of the filament and grid with respect to the anode surface, an insulating member is supported from the anode structure and the grid and filament are supported from the insulating member within the anode. The insulating member in accordance with this invention comprises a cross-shaped member 34, preferably of "lavite", or other high heat-resistant material, having oppositely disposed arms bridging or extending across the top of the frames 29 and 30. The insulating cross-member 34 is connected to the frame by straddling tie members 35 and 36 which are formed with a central loop portion threaded through parallel apertures in the end of the opposed arms of the insulating member 34 and beneath the insulating member are spread out and the ends welded or attached to the corners of the U-shaped frame members 29 and 30 respectively. In this position the transverse opposed arms of the cross-shaped insulating member 34 are aligned with the rectangular space above the hollow anode 19. The cross-shaped insulating member 34 is provided with two large diameter apertures 37 on opposite sides of the center of the member and these apertures permit the suspension of hook members 38 which extend toward the glass press 12 and are resiliently centered in the apertures 37 by wire helices or springs 39 and 40 which are seated within the boundary of the apertures and are connected to the ends of the hooks 38. The hooks 38 support the bights of the filament 15 which is in the form of an M-shaped wire attached at its lower ends to connecting wires 41 which are joined to the leading-in wires 42 and 43 sealed in the glass press 12. The center point of the filament is connected to a hook 44 projecting from the mid-portion of the press 12.

The molybdenum wire-wound grid carried by the upright wires 17 and 18 is situated between

the filament 15 and the anode 19 and is supported in accurate space relation with respect to the other electrodes by slidably supporting the ends of the upright wires 17 and 18 in the transverse arms of the insulating member 34. This is accomplished by supporting the upright wire 18 in an aperture, of slightly larger diameter than the wire, of the transverse arm and locating the upright wire 17 in an open slot 45 in the extremity of the arm opposite to the arm supporting the wire 18. The other end of the upright wire 18 is attached to a bent wire 46 which is sealed through the glass press 12 and serves as the leading-in wire for the grid electrode. The end of the supporting wire 17 opposite the insulator 34 is positioned by a rigid angular metallic member 47 which is attached to a wire embedded in the press 12 and extends outwardly from the axis of the vessel. This member is provided with a fork or bifurcated portion 48 and the upright wire 17 adjacent the fork 48 is provided with limiting metallic buttons 49 on opposite sides of the fork member 48.

In the operation of the device, the high temperature generated in the region encompassed by the plate electrode necessarily is communicated to the wire grid structure and this electrode due to its fragile construction may easily be distorted. However, the grid structure, in accordance with this invention, is permitted to expand and contract in a longitudal direction due to the sliding contact with the arms of the cross-shaped insulating member 34 and the sliding contacts of the grid upright wire 17 in the slot 45 of the insulating member and the fork member 48 permit lateral expansion and contraction. Therefore, the grid is never constrained to such limits as would warp or distort the shape of the grid and the spacing of the grid with respect to the filament and plate electrodes is substantially constant. A leading-in wire 50 sealed through the side of the glass stem 11 between the press 12 and the upper metallic band 22 is attached to a metallic strap 51 which is connected to the U-shaped base frame member 28, to impress a voltage on the plate electrode 19. In order to create a high vacuum in the vessel 10, a getter material, such as magnesium, is vaporized in the final evacuating stages of the device to clean up residual gases and absorb them in a film deposit on the surface of the glass vessel. This is usually accomplished by vaporizing the magnesium either by bombardment or by high frequency methods, which are well known, whereupon the vapor is condensed in a film on the glass vessel. The magnesium which is usually in the form of a strip or ribbon, such as shown at 52, is held in a grooved ring 53 by pinching the sides of the groove together to hold the magnesium in place. The grooved ring 53 is mounted toward the lower end of the vessel with the open groove facing the wall of the vessel so that the vapor will be projected toward the glass wall and deposit thereon.

The invention has been disclosed in a specific three-electrode thermionic discharge device although it is conceivable that the invention may also be applied to a two-electrode device such as a rectifier or to other devices having more than three electrodes such as a screen grid device. Furthermore, the invention may also be adapted for gaseous discharge devices where the requirements of shock-proof mounting of electrodes is essential. Therefore, the invention is not to be confined to the specific construction illustrated and described, but is intended to cover all modifications which may come within the scope of the appended claims.

What is claimed is:

1. An electron discharge device comprising an enclosing vessel having a stem, a hollow anode having flanged portions projecting above said stem, frame members supported from said stem on opposite sides of said flanged portions and extending therethrough, a grid and a cathode within said anode, and insulating means extending across said frame members and anode for supporting said grid and cathode in interspace relation with respect to said anode.

2. An electron discharge device comprising an enclosing vessel having a stem, a hollow anode of highly refractory material supported beyond said stem, wire frame members of refractory material having loop portions extending through said anode, an insulator member extending across said frame members, a cathode and a grid within said anode supported by said insulator member, and other frame members of less refractory material supported from said stem and connected to said first mentioned frame members.

3. An electron discharge device comprising an enclosing vessel, an anode supported within said vessel, a cathode and a grid insulatingly supported adjacent said anode, and a forked member engaging said grid to allow expansion of said grid transverse to the longitudinal axis thereof.

4. In a discharge device, a glass stem, an electrode beyond said stem, frame members on opposite sides of said stem and extending toward and exterior to said electrode, clamping means on said stem connected to said frame members, and rigid means carried by said frame members projecting through opposite ends of said electrode and adapted to exert straining forces on said electrode parallel to the surface of said electrode.

5. An electron discharge device comprising an enclosing vessel having a stem, a metallic band encircling said stem, a plurality of similar shaped metallic frames extending from said band, a cathode and a grid supported at one end from said stem, a metallic anode surrounding said cathode and grid, auxiliary frame members in contact with said anode and superimposed on said similar shaped frame members, and an insulating member connected to the ends of said auxiliary frame members, said member supporting the said cathode and grid at the other end.

6. An electron discharge device comprising an enclosing vessel having a tubular stem terminating in a press, a hollow anode supported beyond said press, an insulating member having a grooved end portion extending across said anode, a cathode within said anode supported by said insulating member, a pair of upright metallic members within said anode, a continuous helical grid surrounding said cathode and supported by said upright members, one of said upright members being located within the grooved end portion of said insulating member, and a forked metallic angular member extending from said press and engaging the opposite end of said upright member.

7. An electron discharge device comprising an enclosing vessel having a tubular stem terminating in a press, a hollow anode supported beyond said press, an insulating member having a grooved end portion extending across said anode, a cathode within said anode supported by said insulating member, a pair of upright metallic members within said anode, a continuous helical grid surrounding said cathode and supported by

said upright members, one of said upright members being located within the grooved end portion of said insulating member, a forked metallic angular member extending from said press and engaging the opposite end of said upright wire, and metallic buttons on said upright member on opposite sides of said forked member to prevent longitudinal displacement of said member in said forked member.

8. An electron discharge device comprising an enclosing vessel having a glass stem, a clamping bend encircling said stem, a hollow anode having flanged portions extending beyond said stem, said flanged portions having perforations at opposite ends, parallel inverted U-shaped base members extending toward said flanged portions from said clamping band, an elongated U-shaped wire frame member extending vertically from each of said base members and having a portion in contact with the perforated flanged portions at one end of said anode, a looped connector extending from each of said base members and engaging the perforated flanged portions on the opposite ends of said anode, an insulating member extending across said elongated frame members, and an electron emitting electrode within said anode and supported by said insulating member.

9. An electron discharge device comprising an enclosing vessel having a glass stem, a metallic band clamped about said stem, a hollow rectangular anode having flanged portions extending beyond said stem, said flanged portions having perforations at opposite ends, parallel U-shaped wire members attached to said band, wire formed supports extending from each of said members, said supports having a short portion extending through said flanged portions of the anode and longitudinal portions extending parallel to said flanged portions, a looped connector extending from each of said U-shaped members and engaging the flanged portions of said anode, a cross-shaped insulator adjacent one end of said anode having arms extending toward said supports and transverse arms within the boundary defined by said anode, a wire-wound grid supported within said anode by said transverse arms, a cathode resiliently supported within said grid by said insulator, and means extending through said insulator engaging said supports.

10. An electron discharge device comprising an enclosing vessel having a glass stem, a hollow rectangular anode projecting beyond said stem, a plurality of spaced clamping bands on said stem, said anode having flanged portions extending outwardly therefrom perpendicular to the axis of said anode, U-shaped frame members extending from said bands and engaging the flanged portions of said anode remote from said stem, connector members extending from said bands engaging the flanged portions of said anode adjacent said stem, a cross-shaped insulator adjacent one end of said anode having bridging arms extending toward said frame members and transverse arms within the boundary defined by said anode, a wire-wound grid supported within said anode by said transverse arms, a cathode resiliently supported within said grid by said insulator, said bridging arms having parallel perforations in the ends thereof, and a wire loop member extending through said parallel perforations, the ends of said loop member being spread outwardly at one side of said insulator and connected to the angular bends of said frame members.

11. An electron discharge device comprising an enclosing vessel having a glass stem, a hollow metallic anode having flanged portions extending above said stem, a pair of metallic bands encircling said stem and clamped thereto, a U-shaped frame member extending from each side of said stem towards said anode in alignment with said flanged portions, a U-shaped support member extending from each of said frame members and formed with a short horizontal section having a central V-shaped bend extending through said flanged portions remote from said stem, a V-shaped support member extending from each of said frame members and threaded through the flanged portions of said anode adjacent said stem, an insulating member extending across the end of said anode remote from said stem, a filament and grid within said anode supported at one end by said insulator, and wire loop members extending through said insulator, and connected to said support members.

12. An electron discharge device comprising an enclosing vessel, an anode within said vessel having flanges, a cathode insulatingly supported adjacent said anode, and supporting frame members extending on opposite sides of said anode having bent portions in contact with the flanges at opposite ends of said anode for applying a pulling force to said anode in opposite directions from a central longitudinal point.

13. In a discharge device, a hollow electrode having flanges on opposite sides thereof, the ends of each flange being provided with an aperture, and a support for said electrode including frame members, portions of which extend on opposite sides of each flange and loop portions which pass through said apertures.

14. In a discharge device, a hollow electrode having oppositely disposed flanges on the outer side thereof, and means for supporting said electrode comprising frame members having portions extending on opposite sides of the flanges and loop portions engaging the ends of the flanges, the centers of the loop portions being in longitudinal alignment.

15. An electron discharge device comprising an enclosing vessel having a cathode, an anode and a grid electrode supported therein, and guiding means engaging the bottom and top ends of said grid for longitudinal and transverse movement of said grid with respect to said cathode and anode.

16. An electron discharge device comprising a vessel having a plurality of electrodes mounted therein, means engaging one of said electrodes for longitudinal movement thereof, and slotted means engaging the bottom and top ends of another of said electrodes for longitudinal and transverse movement with respect to said other electrodes.

17. An electron discharge device comprising an enclosing vessel having a stem, frame members extending from said stem including two pairs of rods and two pairs of loop members, an insulating member supported from said rods, a cathode and a grid supported by said insulating member, and an anode supported by said loop members.

VICTOR L. RONCI.
JAMES E. CLARK.