Feb. 7, 1933. V. L. RONCI 1,896,464

ELECTRON DISCHARGE DEVICE

Filed April 30, 1930

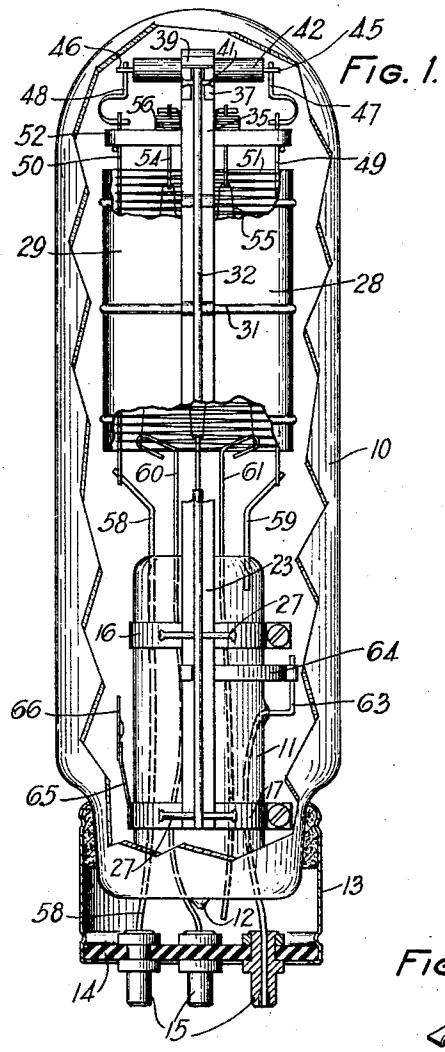

FIG. 1.

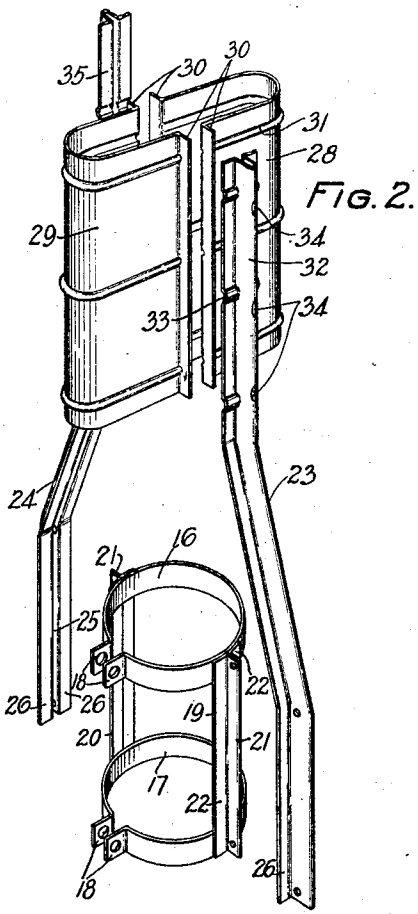

FIG. 2.

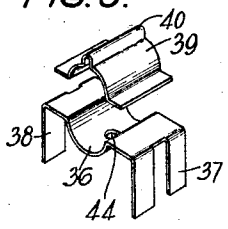

FIG. 6.

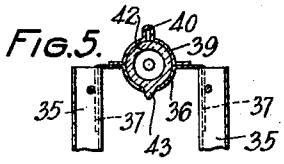

FIG. 5.

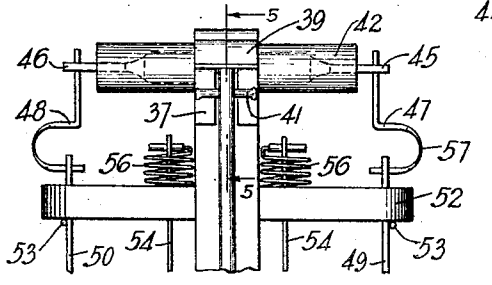

FIG. 3.

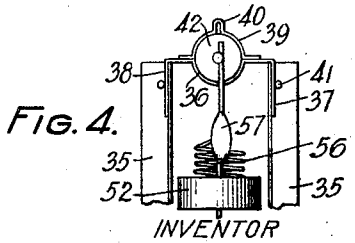

FIG. 4.

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UNITED STATES PATENT OFFICE

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ELECTRON DISCHARGE DEVICE

Application filed April 30, 1930. Serial No. 448,498.

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

An object of the invention is to prevent current leakage or arcing discharge between the control electrode or grid and the high potential anode.

Another object is to fabricate the electrode structure so that the various parts may be salvaged when the device is unfit for further service.

In accordance with this invention, the electrode assembly of a discharge device employed for short wave transmission comprises a metallic anode having two centrally disposed upright members, one end of each member being rigidly attached to a glass stem and the other ends joined together by a spacing member which supports an insulating rod. A helical wire grid or control electrode is positioned within the metallic anode and is supported from the insulating rod by normally rigid suspension members which also support an insulating bridging member carrying resilient supporting hooks to which the filament is attached. Since the helical wire grid expands during operation and expansion is liable to distort the grid structure, the rigid supports extending from the insulating rod are provided with bent portions of reduced cross-section so that they will serve as yielding members when pressure is exerted on them by the expanding grid, to compensate for the expansion of the grid. This arrangement forms a rugged construction of the electrode assembly which substantially eliminates failure from mechanical defects, maintains the separate electrodes in accurate spaced relation for highly efficient operation, increases the insulating paths between the high and low potential electrodes, simplifies the electrode assembly, and reduces the cost of production.

A feature of the invention relates to the fabrication of the electrodes so that if the device fails in service a large number of parts may be reclaimed to be used in rebuilding the discharge device. The metallic anode is formed of two similar shaped portions having flanges which fit into and are secured together by parallel T-shaped members which support the anode. The members are connected together at one end by a bridging member which maintains the parallel relation between the flat surfaces of the anode and which has a collar portion embracing the insulating rod. The bridging member also has split extensions which fit over the T-shaped members and these extensions are fastened to the supporting members by welded links or pins. The other ends of the supporting members slide over tongued spacers attached to parallel bands clamped to the glass stem and are rigidly fastened thereto by links or pins threaded through the spacers and members and welded to the bands. This arrangement facilitates the removal of defective parts and replacement with perfect parts, and in the event of the anode buckling due to high temperature, the supporting structure may be salvaged and used in another assembly. The initial cost of the discharge device will, therefore, be reduced due to the reclamation value of the defective device.

These and other features of the invention will be apparent from the following detailed description when considered in connection with the accompanying drawing.

Fig. 1 is a view in elevation of a discharge device embodying all the features of this invention with the enclosing vessel broken away to show the detail structure,

Fig. 2 shows in perspective the various detail parts of the anode structure and support and their assembly relation,

Fig. 3 is an enlarged front view of the superstructure shown at the top of Fig. 1 showing the high insulating path between the anode and other electrodes and the expansion suspension members supporting the internal electrodes,

Fig. 4 is a side view of the superstructure shown in Fig. 3,

Fig. 5 is a view in cross section of the superstructure on the line 5—5 of Fig. 3, and

Fig. 6 shows in perspective an enlarged view of the bridging member shown in Figs. 4 and 5.

Referring to the drawing, the electron discharge device of this invention comprises an

enclosing vessel 10 of glass having an inwardly projecting stem 11 at one end, the inner end of which is pressed around the leading-in wires for the electrodes. An internal glass tube extends from the inner end of the glass stem 11 and projects from the vessel 10 at 12. The glass tube 12 serves as a means for evacuating the vessel 10 after which it is sealed off. The terminal end of the glass vessel 10 is enclosed in a protective base having a metal collar portion 13 which is attached to the end of the glass vessel 10 for instance, by cement, and an insulating disc portion 14 carrying terminals 15 for providing external connections for the electrodes in the vessel.

The glass stem 11 is surrounded by a clamping assembly from which the various electrodes in the device are supported. This clamping assembly consists of two parallel split metallic bands 16 and 17 having angular lips 18 through which a clamping screw may be passed to fasten the clamping assembly on the glass stem 11. The clamping bands 16 and 17 are formed into a unitary structure and equally spaced apart by parallel metallic ribs, or tongued spacing members, 19 and 20, formed by sheet material and folded as shown in Fig. 2 with an outwardly projecting flanged portion 21 and flat portions 22 which are welded to the bands 16 and 17. The flanged portions 21 extend out from the boundary of the bands 16 and 17 and are arranged in a plane through one diameter of the cylindrical structure formed by the clamping assembly. A pair of upright supporting members or standards 23 and 24 are formed of sheet metal and folded or fluted at their lower ends to provide a central groove 25, to slide over the flange 21 of the clamping assembly, and flat parallel surfaces 26, to lie against the flat portions 22 of the spacing members 19. It will be seen from Fig. 2 that the flanged portion 21 and the upright support 23, are pierced with holes in the vicinity of the clamping bands and a wire 27 shown in Fig. 1 is threaded through the pierced portions of the spacing member 19 and the upright supports 23 and 24, to securely fasten the supports to the clamping assembly. The ends of the wire are welded to the bands 16 and 17 on opposite sides of the upright supports 23 and 24.

In a high voltage power amplier used in short wave transmission systems the high potential applied to the plate electrode causes excessive heating and, therefore, it is necessary to construct the plate electrode of material which will withstand this high degree of heat. Furthermore, the material of the plate electrode should be relatively thin so that it will dissipate the heat more readily. In accordance with this invention the plate electrode or anode is formed of thin sheet molybdenum and is formed of two similar U-shaped sections 28 and 29 having the edges of each section bent outwardly to form a flange 30. The two sections are arranged in opposed relation to form a closed flat cylinder with the flanges of opposite sections in face-to-face relation. In order to strengthen the thin sheet material against buckling under excessive heat conditions a plurality of corrugations 31 are formed at spaced intervals along the cylindrical boundary of the anode. Due to the small thickness of the flanges 30, it is impossible to weld the two sections of the anode together since the excessive heat generated in the welding arc melts the thin metal when a weld is being made. To overcome this difficulty, the upright supports 23 and 24 are provided with a grooved or folded portion 32 in which the flanges 30 of the sections 28 and 29 may be inserted and held therein by crimping the folded portion 32 until the welding operation can be performed. The flat portions 26 of the upright supports 23 and 24 adjacent the plate surface are provided with corrugations 33 coinciding with the corrugations 31 on the anode surface. Due to the contact surface of the anode of this invention being increased by the folded portion 32 of the upright supports 23 and 24 and the double edge of the flanges 30 within the groove of the folded portion, a satisfactory weld can be secured between these parts when welding the metal of the thin material. This weld may take place as shown at spaced intervals 34 along the curved edge of the portion 32 of the upright members. The upright supporting members 23 and 24 are provided with T-shaped ends 35 preferably formed continuous with the anode portion 32 which project above the upper edge of the anode and are arranged in opposed relation across the short diameter thereof. This assembly provides a rigid structure for the anode which will withstand the high temperatures prevailing in its use and the fabrication of the anode may be considerably speeded up due to the simplicity of forming the various parts which enter the anode assembly. Furthermore, the removable linkage of the anode supports to the clamping assembly facilitates removal of a defective anode and replacement with a perfect anode when such a condition warrants the substitution for the assembly of the device.

In order to maintain accurate space relation between the parallel walls of the anode formed by the U-shaped sections 28 and 29, a bridging member is attached to the top of the extensions 35 of the upright supports. This bridging member comprises a metallic strip shown in Fig. 6 having a central curved portion 36 and downwardly extending slotted portions 37 and 38. A top piece 39 having an outwardly curved portion provided with a rib or corrugation 40 is welded to the

top of the bridging member to form a tubular sleeve. As shown in Fig. 4, the tubular sleeve is located between the extensions 35 of the upright supports and the downwardly bent slotted portions 37 and 38 fit over the curved portion of the extensions 35. The bridging member is rigidly attached to the extensions 35 by inserting a short length of wire 41 through perforations in the curved portion of the extension and welding the ends thereof to the slotted portions 37 and 38. A cross rod 42, of quartz, extends through the sleeve portion of the bridging member and is rigidly held therein by crimping the rib 40, to frictionally maintain the rod in the sleeve and prevent rotation thereof. In order to prevent longitudinal displacement of the quartz rod within the sleeve of the bridging member a bead 43 is formed on the lower surface of the rod intermediate its ends and this bead is seated in a pocket or aperture 44 in the sleeve portion 36 of the bridging member. The quartz rod insures a high degree of insulation between the high potential which is applied to the anode and the low potentials applied to the other electrodes which will be described hereinafter.

The quartz rod is preferably tubular in form in order to seal short stubs of metal wire 45 and 46 in the ends thereof by fusing the ends of the rod around the wires. Attached to the stub wires 45 and 46 are outwardly curved suspension members or wires 47 and 48 respectively which are attached to supporting wires 49 and 50 extending longitudinally of the anode and within the same. These supporting wires are encircled by a continuous helix 51 having a configuration similar to the flat cylindrical form of the anode and coaxially spaced with respect thereto. The wires and helix form the grid or control electrode of the device. An insulating plate 52 parallel to the insulating quartz rod 42 is interposed between the rod and the upper edge of the anode and centered in space relation between the extensions 35 of the upright supports as shown in Fig. 4. This plate is carried by the grid supporting wires 49 and 50 and is held against downward displacement by cross rods 53 welded to the wires 49 and 50 adjacent the lower surface of the plate 52. The plate 52 is provided with apertures equally spaced from the center thereof through which hooks 54 extend to support the bight of the filamentary cathode 55. These hooks are resiliently supported on the plate 52 by coiled springs 56. This assembly insures a high degree of insulation between electrodes having a large difference of potential and the multiple support between the anode and the filament prevents leakage of the high voltage to the electrodes.

During operation of the device the high temperature causes expansion of the grid and if no means were provided for compensating for this expansion, the grid electrode would be distorted and cause irregularities in the characteristic of the device in operation. Another advantage which is obtained by this invention is the ability of the structure to compensate for expansion of the grid electrode and at the same time maintain the axial relation of the grid and filament with respect to the anode. This is accomplished in accordance with this invention by flattening the curved portion of the suspension members 47 and 48 as shown at 57 in Fig. 4 so that this portion of the suspension member is weaker that the rest of the suspension member and as the grid expands with increasing temperature it will exert pressure on the suspension members and the flattened portions 57 yield in a longitudinal direction, to compensate for expansion without deflecting the axial position of the grid with respect to the anode. The flattened portions of the suspension members return to their normal position as shown in Figs. 1 and 3 when the grid contracts. The lower ends of the grid are attached to wires 58 and 59 projecting from the stem and the wire 58 is continued through the stem to serve as a connector to the terminal 15 on the base. Two similar wires 60 and 61 are attached to the filament and extend through the stem 11 to be attached to the terminals 15. The plate leading-in wire 63 is sealed in the side of the stem 11 and extends to the terminal 15 and a band 64 welded to the upright 23 is clamped around the leading-in wire 63 and welded thereto. The clamping assembly band 17 supports a wire 65 to the upper end of which is attached a dished plate 66 which serves as a pocket for a pellet of magnesium which is vaporized in the final evacuation of the device to fix occluded gases.

While the invention has been described as embodying all the features of this invention in a single tube of a specific structure, it is, of course, understood that any of the features may be embodied in devices differing in structure than that here described and, therefore, the invention is only to be limited within the scope of the appended claims.

What is claimed is:

1. In a discharge device, an electrode comprising similar U-shaped portions having flanged ends arranged in opposed relation with the flanges in the same plane, and a grooved member embracing adjacent flanges of said portions.

2. In a discharge device, a plate electrode comprising thin sheet metal U-shaped portions having angular ends arranged parallel to the axis of said device, and a longitudinal folded metallic member enveloping walls of said angular ends and rigidly holding said ends together.

3. In a discharge device, a plate electrode comprising similar U-shaped portions having angular ends projecting outside the boundary

of the U-shaped portions, and a folded T-shaped metallic member engaging said angular ends exterior to the boundary formed by the closed wall of said plate electrode.

4. In a discharge device, an anode comprising a pair of U-shaped sections of thin sheet molybdenum having outward bent extensions arranged in face-to-face relation to form a closed flat cylinder, the material of said sections being too thin to be welded, and a supporting member for said anode having a grooved portion engaging said extensions so that a weld may be made between the grooved portion and the edges of the extensions.

5. An electron discharge device comprising a vessel having a stem, a band surrounding said stem, an anode, a support extending from said anode to said band, and means extending transverse to said support and affixed to the surface of said band for removably attaching said support to said band.

6. An electron discharge device comprising a vessel having a stem, a band surrounding said stem, an anode, a support extending from said anode to said band, and a pin member passing through said support and said band.

7. An electron discharge device comprising a vessel having a stem, a band having a longitudinal ridge parallel to said stem, an anode, a fluted support spacing said anode from said stem and a wire extending through said fluted support and ridge and attached to said band on either side of said support.

8. In an electron discharge device, an anode assembly comprising an embracing member formed of two circular bands, spacing members of T-shaped cross-section attached to said bands, an anode, upright members attached to said anode, said upright members having a groove engaging said spacing members, and means fastening said upright members to said spacing members.

9. In an electron discharge device, an anode assembly comprising an embracing member formed of two flattened circular bands, spacing members of T-shaped cross-section attached to said bands, an anode of flattened cylindrical formation, upright members attached to said anode on the flattened sides thereof, said upright members having a groove engaging said spacing members, means fastening said upright members to said spacing members, and a bridging member joining said upright members across the smaller diameter of said anode.

10. An electron discharge device comprising a vessel having a stem, a hollow electrode, parallel supports attached to said stem and electrode, a bent metallic member bridging said supports at the free ends thereof adjacent said hollow electrode, and pins engaging said supports and bridging member.

11. An electron discharge device comprising a vessel having a stem, upright members extending from said stem, a metallic spacing member joined to said upright members having a tubular portion between said members, a grid and filament insulatingly supported from said spacing member, and an anode attached to said upright members surrounding said grid and filament.

12. An electron discharge device comprising a vessel having a stem, a plate electrode having parallel supports, a spacing member having a tubular portion between said supports and bent extensions exterior to said supports, an insulating support extending through said tubular portion at right angles to said parallel supports, and an electrode within said plate electrode yieldingly supported by said insulating support.

13. An electron discharge device comprising an enclosing vessel, a plate electrode having parallel supports attached to one end of said vessel, a spacing member having a tubular portion between said supports and bent extensions exterior to said supports, an insulating rod extending through said tubular portion at right angles to said parallel supports, and a plurality of inner electrodes surrounded by said plate electrode suspended from said insulating rod.

14. An electron discharge device comprising an enclosing vessel having a stem, a plate electrode having parallel supports carried by said stem, a spacing member attached to said supports having a tubular portion between said supports, an insulating rod extending through said tubular portion at right angles to said parallel supports, an electrode yieldingly supported by said insulating rod within said plate electrode, and cooperating means on said tubular portion and insulating rod to prevent slipping of said insulating rod.

15. An electron discharge device comprising an enclosing vessel having a stem, a metallic anode, metallic support members attached to said stem and anode, an insulating member carried by said support members at the free ends thereof, an electrode within said anode, and a second insulating member suspended from said first insulating member, said second insulating member supporting said electrode.

16. An electron discharge device comprising an enclosing vessel having a stem, a pair of upright members secured to said stem, an anode supported by said members, an insulating rod arranged at right angles to the axis of said stem, a collar supported by said members and embracing said rod intermediate its ends, a grid within said anode supported by said rod, an insulator extending across one end of said grid and a cathode supported at one end from said insulator and at the other end from said stem.

17. An electron discharge device comprising an enclosing vessel having a stem, a

metallic anode, metallic support members attached to said stem and anode, an insulating member carried by said support members at the free ends thereof, a suspension member extending from each end of said insulating member having a flattened loop portion, a flat plate carried by said suspension members and lying parallel to said insulating member, and a plurality of electrodes extending from said plate and enclosed by said anode.

18. An electron discharge device comprising a vessel having a stem, a hollow anode having parallel flat walls supported from said stem, parallel projections on said anode, a metallic sleeve member bridging said projections to maintain the space relation of the walls of said anode, a cross insulating member held in said metallic sleeve, a second insulating member interposed between said cross member and anode, a plurality of electrodes within said anode supported by said second insulating member, and a pair of oppositely disposed looped expansion members supporting said electrodes and second insulating member from said cross member.

19. An electron discharge device comprising a vessel having a stem, a hollow anode having parallel flat walls supported from said stem, parallel projections on said anode, a metallic sleeve member bridging said projections to maintain the space relation of the walls of said anode, a cross insulating member held in said metallic sleeve, a second insulating member interposed between said cross member and anode, a plurality of electrodes supported by said second insulating member within said anode, and a pair of wire hook members located between said cross member and second insulating member and having a portion flattened in the hook area to allow longitudinal expansion only.

20. An electron discharge device comprising an enclosing vessel having a stem, a clamping assembly on said stem having a pair of ring members spaced apart by oppositely disposed connectors of T-shaped cross-section, a pair of metallic uprights having a grooved portion to engage said connectors, a hollow two part anode of flattened cylindrical form having flanged portions held together by other grooved portions of said uprights, a metallic spacing and supporting member having a tubular portion and downwardly extending portions engaging the free ends of said uprights, an insulating rod held in the tubular portion of said spacing member and extending across the hollow portion of said anode, a flat insulator located between said rod and anode and parallel thereto, a pair of longitudinal supporting wires extending from said flat insulator and located within said anode, a helical wire grid carried by said wires and spaced coaxially from the anode surface, a resiliently mounted hook extending through said flat insulator, a filament supported from said hook and arranged in the axial plane of said anode and grid, and a pair of outwardly curved metallic members located between the ends of both insulators to maintain the axial space relation of said filament and grid with respect to said anode surface and allow expansion of said grid in a longitudinal direction only.

In witness whereof, I hereunto subscribe my name this 28th day of April, 1930.

VICTOR L. RONCI.