Nov. 5, 1935. D. A. S. HALE ET AL 2,019,492

ELECTRON DISCHARGE DEVICE

Filed Oct. 6, 1934

FIG. 1

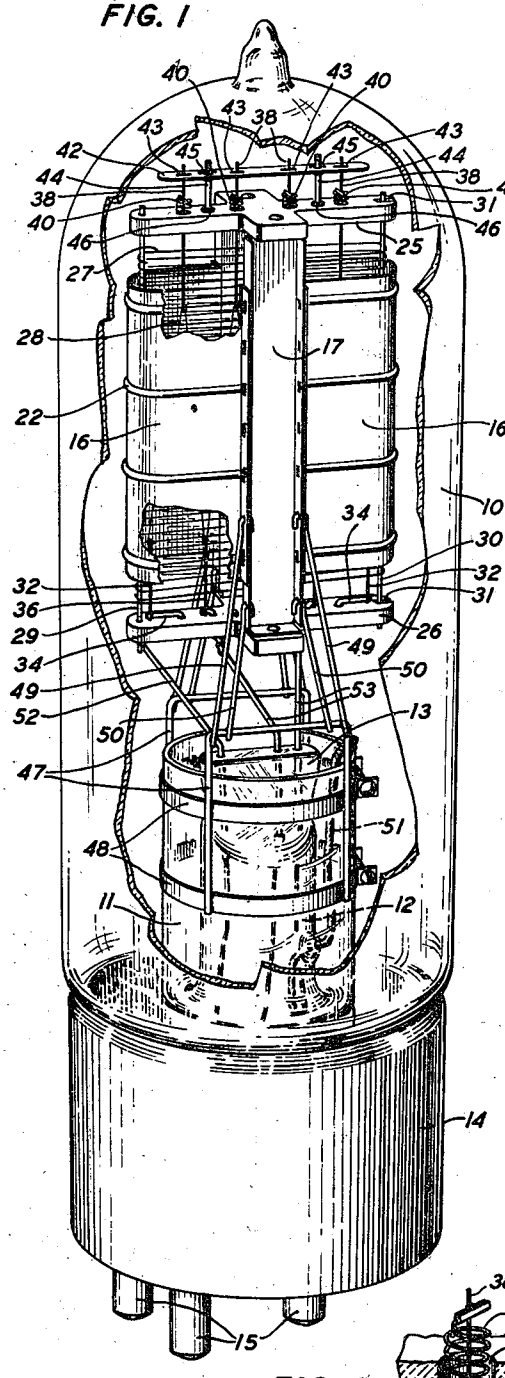


FIG. 2

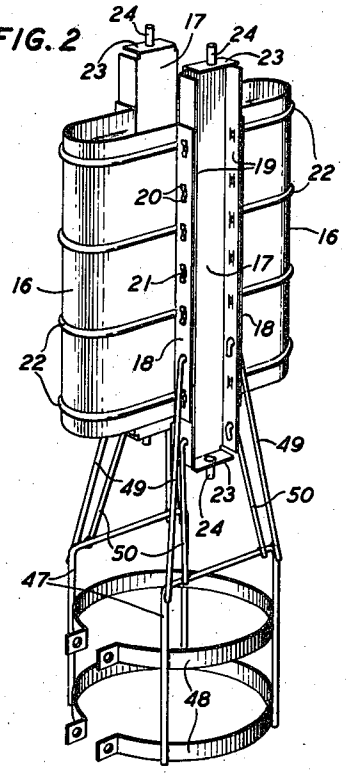


FIG. 3

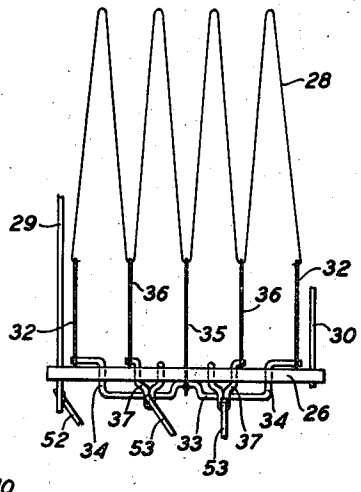
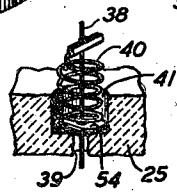


FIG. 4



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ELECTRON DISCHARGE DEVICE

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10 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices and more particularly to an electrode assembly for such devices of the power type.

One object of this invention is to efficiently dissipate the heat generated in the output electrode or anode of the device during the evacuation treatment and operation thereof so that distortion of the electrode is prevented.

Another object of this invention is to maintain accurately the relative positions of electrodes in an electron discharge device so that contact between the electrodes is prevented and uniform operating characteristics of the device are attained.

A further object of this invention is to reduce vibration of the electrodes in electron discharge devices.

In one embodiment of this invention an electron discharge device comprises a unitary electrode assembly including a cylindrical anode, insulating members extending across the ends of the anode and affixed thereto, a control electrode or grid within the anode and supported between the insulating members, and a multi-section filamentary cathode disposed within the control electrode or grid and resiliently suspended from one of the insulating members.

In accordance with a feature of this invention, the anode is formed of a plurality of flanged sections to increase the rigidity and area thereof. More specifically, the anode may comprise substantially U-shaped end sections having oppositely extending longitudinal flanges, and intermediate channel-shaped sections having cooperating portions secured to corresponding flanges on the end sections. The channel-shaped sections are provided with end flanges to which the insulating members are secured.

In accordance with another feature of this invention means are provided for accurately positioning and maintaining the position of the suspension members for the cathode. In a specific illustration, the apices or bights of a double M-shaped filamentary cathode, which is disposed in a medial plane of a flattened helical grid, are engaged by hook members resiliently supported from the upper insulating member. The hook members have elongated shanks which are held in alignment by slots in an auxiliary insulating guiding member. The slots in the guiding member are arranged in the plane of the cathode to allow shifting of the hook members in the cathode plane to compensate for unequal expansion and contraction of the several cathode sections. However, the guiding member prevents movement of the hook members at an angle to the plane of the cathode.

In accordance with a further feature of this invention, the electrode assembly is rigidly supported as a unit from a stem of the enclosing vessel by rigid braces which are locked in the joined flanges of the anode sections.

The invention and the 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 a perspective view of an electron discharge device constructed in accordance with this invention with portions of the enclosing vessel and the anode broken away to show details of the electrode assembly more clearly;

Fig. 2 is a perspective view of the anode assembly and support incorporated in the device shown in Fig. 1;

Fig. 3 is a detail view in elevation of the cathode and lower insulator assembly showing the electrical connections of the several sections of the cathode; and

Fig. 4 is an enlarged fragmentary detail view of the suspension spring assembly for the filamentary cathode.

Referring now to the drawing, an electron discharge device illustrative of one embodiment of this invention comprises an enclosing vessel 10 having coextensive coaxial stems 11 and 12, the inner stem terminating in a press 13. The stems 11 and 12, and also the enclosing vessel 10, preferably are formed of a boro-silicate glass having a high mechanical and dielectric strength and low coefficient of expansion, such as "Nonex". A base 14 is suitably secured to the end of the enclosing vessel adjacent the stems and carries a plurality of terminal prongs 15.

An anode assembly is supported from the stem 11 and comprises an electrode including opposed U-shaped end sections 16 and intermediate channel-shaped sections 17. The end sections 16 are provided with integral longitudinal flanges 18 of relatively large area extending outwardly and at substantially right angles to the flat portions of the end sections. The channel-shaped sections are provided with similar large area flanges 19 each of which is secured to a corresponding one of the flanges 18 as by tabs 20, integral with the flanges 19, extending through apertures 21 in the flanges 18 and crimped against the flanges 18. The end sections 16 also may be provided with a plurality of parallel corrugations or ribs 22 for increasing the rigidity thereof.

This construction provides an anode of high

rigidity and relatively large surface and heat radiating capacity which will maintain its form despite the high temperatures to which it becomes heated during the evacuation treatment and operation of the device in which it is incorporated.

As clearly shown in Fig. 2, the intermediate sections 17 extend beyond the ends of the sections 16 and are provided with integral parallel end flanges or extensions 23 each of which carries a pin 24. Seated upon the flanges 23 are cross-shaped insulating members 25 and 26 which are fixed to the flanges by spinning over the pins 24, the insulating members serving as spacers and supporting members for a helical wire control electrode or grid 27 and a double M-shaped filamentary cathode 28.

The helical grid 27 is carried by parallel uprights or rods 29 and 30 extending between the insulating members 25 and 26. The upright or rod 29 may extend loosely through slightly oversized apertures in the insulating members 25 and 26. The upright or rod 30 may be fitted loosely in slots 31 in corresponding arms of the insulators 25 and 26. This construction allows lateral and longitudinal expansion and contraction of the helical grid 27 so that distortion of the grid is prevented and the proper form and position thereof is maintained.

The ends of the preformed filamentary cathode 28 are secured to hook members 32 carried by a rigid tie wire 33 having arms 34 extending through the lower insulator 26, and the midpoint of the cathode is engaged by a hook member 35 extending through the insulator 26 and affixed to the tie wire 33. The centers of the two M-shaped sections of the cathode 28 are engaged by hook members 36 individually secured to rigid U-shaped wires 37 carried by the lower insulator 26.

The filamentary cathode 28 preferably is disposed in a medial plane of the flattened helical grid 27. As is known in the art, it is desirable that the variation in the spacing between the cathode and the grid be very small. However, when the electrodes are thus closely spaced, there is danger, due to the fact that the cathode may expand and contract non-uniformly during operation, of causing a short-circuit between the cathode and grid wires. In accordance with a feature of this invention, this is overcome by supporting the cathode so that the apices or bights of the cathode may shift in the plane of the filament but cannot shift at other angles to this plane. The apices or bights of the cathode are engaged individually by hook members 38 which have elongated shanks extending through slightly oversized apertures 39 in the upper insulating member 25. The hook members 38 are supported individually by helical compression springs 40 seated in recesses or pockets 41 in the insulator 25. An insulating guiding strip 42, for example of mica, having a plurality of spaced elongated slots 43, is supported above the insulating member 25 and substantially parallel thereto by a pair of pins or posts 44, to which it is secured by eyelets 45. The pins or posts 44 are provided with integral flanges or collars 46 seated upon the insulating member 25 and the lower ends of the posts are staked to secure them to the insulating member 25. The slots 43 are disposed coplanar with the filamentary cathode 28 and in alignment with the apertures in the insulating member 25 and allow shifting of the hooks 38 in this plane to compensate for unequal expansion and contraction of the several filament sections. However, the strip 42 prevents movement of the hook members 38 at any angle to this plane so that the cathode cannot make contact with the control electrode or grid 27.

It will be apparent from the foregoing that the several electrodes may be fabricated in a unitary assembly. This assembly may be supported rigidly from the stem 11 by a pair of inverted U-shaped frames 47 which are affixed to parallel collars or bands 48 clamped about the stem 11. Each of the frames 47 carries two pairs of converging braces 49 and 50 which are suitably secured, as by welding, to the frames at one end, and are mechanically locked to the joined flanges 18 and 19 at the other end by hook terminations. This construction provides a rigid support which will not allow excessive vibration of the electrode assembly.

A leading-in connection for the anode may be established through a conductor 51 which is sealed in the side of the stem 12 and secured to one of the frames 47, or to another suitable portion of the anode assembly, and to one of the terminal prongs 15. This disposition of the conductor 51 provides a long insulation path between the leading-in conductor for the anode and the conductors for the other electrodes. Although the conductor 51 has been shown as sealed in the stem 12, it may be sealed in the stem 11 at a point below the lower collar or band 48. A conductor 52 embedded in the press 13 is connected to the upright or rod 29 and to one of the terminal prongs 15 and serves as a support and as a leading-in wire for the control electrode or grid 27. The heating current for the filamentary cathode 28 may be supplied through conductors 53 extending from the press 13 and connected to the U-shaped bent wires 37 and to two of the prongs 15.

In order to prevent excessive heating of the helical springs 40 during the outgassing treatment of the electrodes, an insulating disc 54 may be provided between the lower end turns of each of the springs, as described more fully and claimed in the copending application of James E. Clark, Serial No. 747,174, filed Oct. 6, 1934.

Although a specific embodiment of the invention has been shown and described, it will be understood, of course, that 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 electrode assembly comprising a rectangular anode formed of opposed U-shaped end sections having flanges, parallel central channel sections joined to the respective flanges of the end sections and having end flanges projecting outwardly to form supporting surfaces, a spacing member secured to said end flanges, and another electrode located within said anode and carried by said spacing member.

2. An electrode assembly for an electron discharge device comprising an electrode including oppositely directed U-shaped end sections having longitudinal flanges and intermediate sections having longitudinal flanges, corresponding flanges on said end and intermediate sections being joined together, a collar adapted to be fixed about a stem of said device, and means supporting said electrode from said collar including a plurality of pairs of brace members, each of said pairs being secured to corresponding joined flanges at spaced points.

3. In an electron discharge device, a stem, a

collar clamped about said stem, an electrode including oppositely directed U-shaped sections having longitudinal flanges and channel-shaped intermediate sections having flanges joined in face to face relation to corresponding flanges of said U-shaped sections, frame members carried by said collar, and a plurality of pairs of brace members carried by said frames, each pair of said brace members being locked to the corresponding joined flanges.

4. An electron discharge device comprising an electrode having opposed U-shaped end sections and intermediate channel-shaped sections joining said end sections, said intermediate sections having flanges at one end, an insulating member seated upon said flanges, and another electrode supported from said insulating member.

5. An electron discharge device comprising a hollow electrode including U-shaped end sections and intermediate channel-shaped sections joined to said end sections, said intermediate sections having flanges at opposite ends, insulating members extending across opposite ends of said electrode and secured to the end flanges, and another electrode supported between said insulating members.

6. An electron discharge device comprising a flattened cylindrical anode including U-shaped end sections having longitudinal flanges and parallel intermediate sections having flanges secured in face to face relation with the respective flanges of said U-shaped sections, said intermediate sections having parallel projecting portions at opposite ends, insulating members at opposite ends of said anode and rigidly affixed to said projecting portions, and a filamentary cathode extending between and supported by said insulating members.

7. In an electron discharge device, a multisection filamentary electrode, means supporting said electrode at one end, an insulating member adjacent the other end of said electrode, a guiding strip carried by said insulating member, said guiding strip and said insulating member having aligned apertures, and a plurality of hook members individually engaging the sections of said electrode and extending through said apertures, certain of said apertures being elongated to allow shifting of said hook members in one plane.

8. In an electron discharge device, a filamentary cathode having a plurality of sections disposed in a common plane, means rigidly positioning said sections at one end, a plurality of hook members individually engaging said sections at the other end, an insulating member having guide apertures through which said hook members extend, and an insulating strip carried by said insulating member and having elongated slots for receiving said hook members, said slots being disposed in said plane.

9. An electron discharge device comprising an enclosing vessel having a stem, an anode of flattened cylindrical form having parallel central projecting portions, an insulating member rigidly attached to said parallel projecting portions at each end of said anode, a supporting structure on said stem, a plurality of braces extending from said supporting structure to said anode, said braces having hook portions locked to said anode, a cathode including a plurality of filamentary sections within said anode, a plurality of suspension hooks engaging said filamentary sections, resilient means on one of said insulating members secured to said hooks, and common guiding means superimposed on said insulating member and having elongated slots through which said hooks extend beyond said resilient means.

10. An electron discharge device comprising an enclosing vessel having a stem, an anode of flattened cylindrical form having parallel central projecting portions, insulating members rigidly attached to said parallel projecting portions at opposite ends of said anode, a supporting structure on said stem, a plurality of rigid wires extending from said supporting structure to said anode and provided with hook portions engaging the central projecting portions of said anode, a cathode including a plurality of filamentary sections within said anode, a plurality of suspension hooks engaging said filamentary sections, resilient means on one of said insulating members secured to said hooks, and a guiding strip supported parallel to said one insulating member and having slots in which said hooks register to permit limited shifting movement thereof in a plane common to said filament sections.

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