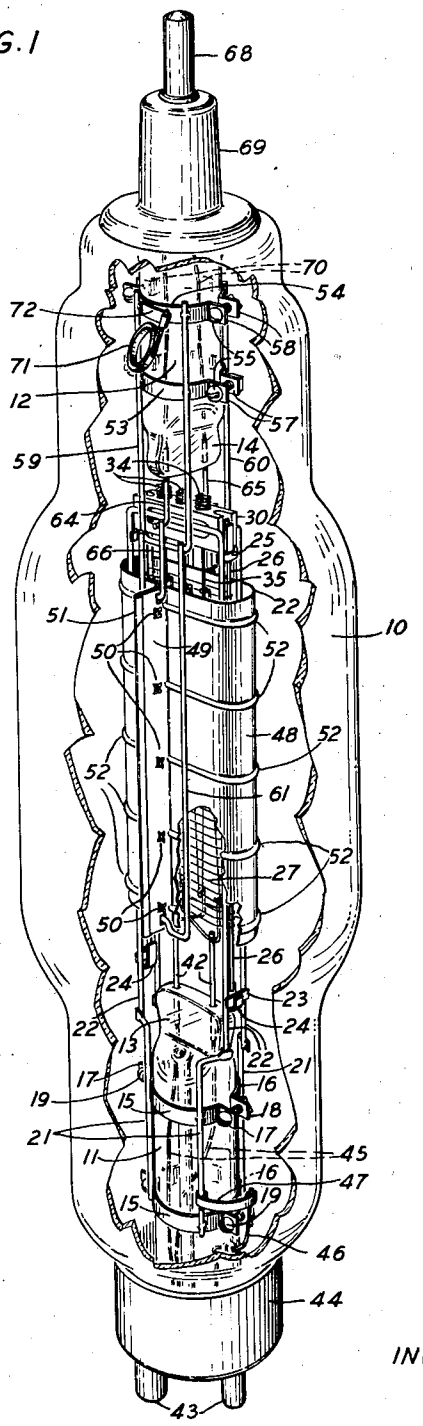
Dec. 18, 1934. V. L. RONCI ET AL 1,984,993

ELECTRON DISCHARGE DEVICE

Filed Dec. 17, 1931 2 Sheets-Sheet 1

FIG. 1



INVENTORS V. L. RONCI
J. P. LAICO

BY

Walter C. Kiesel

ATTORNEY

Dec. 18, 1934. V. L. RONCI ET AL 1,984,993

ELECTRON DISCHARGE DEVICE

Filed Dec. 17, 1931 2 Sheets-Sheet 2

FIG. 2

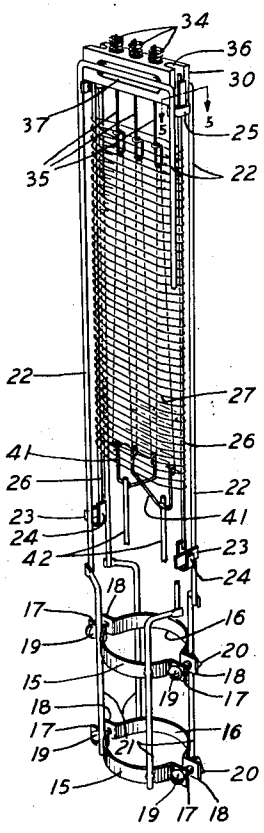


FIG. 8

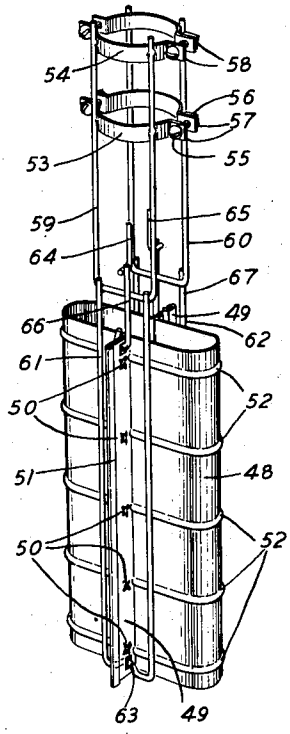


FIG. 9

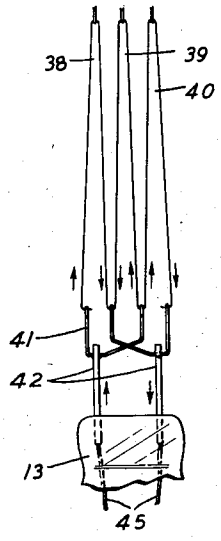


FIG. 4

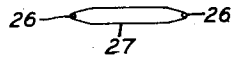


FIG. 5

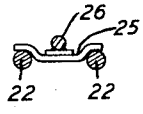


FIG. 6

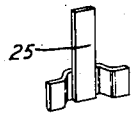


FIG. 3

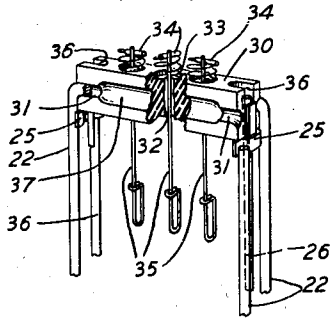
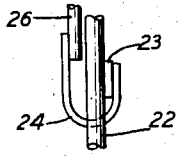


FIG. 7



INVENTORS V. L. RONCI
J. P. LAICO

BY

Walter C. Kiesel

ATTORNEY

Patented Dec. 18, 1934

1,984,993

UNITED STATES PATENT OFFICE

1,984,993

ELECTRON DISCHARGE DEVICE

Victor L. Ronci and Joseph P. Laico, Brooklyn, N. Y., assignors to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application December 17, 1931, Serial No. 581,548

12 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices and more particularly to such devices of high power capacity.

An object of this invention is to prevent excessive changes in the space relation of the electrodes of an electron discharge device during the evacuation treatment and during the operating life of the device.

Another object of this invention is to facilitate the accurate alignment of the several electrodes in an electron discharge device.

A further object of this invention is to expedite the assembly and manufacture of electron discharge devices.

In one embodiment, an electron discharge device constructed in accordance with this invention, comprises a double-ended enclosing vessel in which an anode assembly is supported from one end of the enclosing vessel and a unitary cathode and control electrode or grid assembly is supported from the other end of the vessel. The cathode and control electrode or grid assembly comprises a pair of rigid frames which extend parallel to each other within the anode. An insulating block is carried by the frames and supports a plurality of resilient hook members. A filamentary cathode is suspended between the hook members and conductors extending from the stem. A pair of uprights are yieldingly supported between corresponding arms of the frame members and carry a helical wire control electrode or grid which encircles the cathode and substantially conforms in contour to the shape of the anode.

In accordance with one feature of this invention, the grid uprights are supported from the frame by flexible arms which allow both lateral and longitudinal expansion of the control electrode or grid with temperature variations during the out-gassing treatment of the electrodes and during the operation of the device and thereby maintain the grid in proper space relation with respect to the cathode and anode.

The grid-cathode structure forms a compact, rigid unitary assembly which has a relatively large degree of freedom of movement within the anode and may also vibrate as a whole on the supports. This substantially cushions the assembly against shocks to which the device may be subjected during transportation or mounting and thereby prevents damage of the electrodes. The structure is sufficiently rigid, however, to maintain the proper space relation of the cathode and grid within the anode during the operation of the device.

The various features of the invention will be understood more clearly from the following detailed description with reference to the accompanying drawings in which:

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

Fig. 2 is a perspective view of the cathode-grid assembly employed in the device shown in Fig. 1;

Fig. 3 is an enlarged detail view in perspective illustrating the mounting of the cathode supporting insulator from the grid frames, a portion of the insulator and one of the frames being broken away to show the construction more clearly;

Fig. 4 is an end view of the control electrode or grid showing the configuration of this electrode;

Fig. 5 is an enlarged detail view in cross-section along line 5—5 of Fig. 2;

Fig. 6 is an enlarged detail view in perspective of a flexible arm for supporting one of the grid uprights from the grid frames;

Fig. 7 is an enlarged detail side view illustrating the connection of one of the flexible arms to the grid upright and the grid frames;

Fig. 8 is a perspective view of the anode assembly in the device shown in Fig. 1; and

Fig. 9 shows the form of the cathode and its association with the leading-in conductors.

Referring now to Fig. 1 of the drawings, an electron discharge device, in one embodiment of this invention, comprises a double-ended enclosing vessel 10 having reentrant stems 11 and 12 at opposite ends thereof. The stems 11 and 12 terminate in substantially rectangular presses, 13 and 14 respectively, which are disposed at substantially right angles to each other. An anode assembly, shown more clearly in Fig. 8 is supported from the stem 12, and a unitary cathode and control electrode or grid assembly, shown more clearly in Fig. 2 is supported from the stem 11.

The cathode and control electrode or grid assembly comprises a plurality of spaced split metallic bands or collars each having similar opposed arcuate portions 15 and 16 and integral flanges 17 and 18 at the ends thereof which are clamped on the stem 11 by bolts 19 and nuts 20. A plurality of inverted L-shaped rigid wires 21 are affixed to the arcuate portions 15 and 16 of the split bands or collars and carry two rigid U-shaped wire frames 22 which extend parallel to each other and to the longitudinal axis of the enclosing vessel 10. A pair of metallic strips 23 are secured in any suitable manner for example by welding, between contiguous arms of the frames 22 at the end of the frames adjacent the rigid wires 21 and each strip has secured thereto a flexible or resilient U-shaped metallic finger or strip 24, as shown clearly in Fig. 7. A pair of flexible or resilient metallic T-shaped fingers 25 are secured in any suitable manner,

for example by welding, between the frames 22 at the end thereof remote from the rigid wires 21. A pair of parallel rigid rods or uprights 26 are secured at their ends to the flexible fingers 24 and 25 and carry a helical wire control electrode or grid 27.

This assembly allows both lateral and longitudinal movement of the grid uprights 26 with temperature variations in the grid and the rods during the operation of the device. The flexible fingers maintain the control electrode or grid 27 in its proper form and position and prevent the setting up of deleterious stresses in the lateral wires of the grid.

In the fabrication of the control electrode or grid it sometimes occurs that the lateral grid wires are slightly bent inwardly, and as a result when the lateral wires become heated during the operation of the device there is danger of their expanding inwardly and contacting with a cooperating electrode, such as a filamentary cathode, within the grid. To avoid this difficulty the convolutions of the grid 27 may be formed, as shown in Fig. 4, with substantially parallel intermediate portions and tapering or substantially V-shaped end portions. When the grid of this form becomes heated, the intermediate portions necessarily move outwardly, because of the expansion of the end portions so that even if the portions are accidentally bowed inwardly during the process of assembly, sufficient clearance will be maintained to prevent contact of the grid wires and an electrode within the grid.

In the assembly of the grid structure, the frames 22 are preferably welded to the wires 21 before the wires are attached to the bands or collars 15 and 16. This enables the rotation of the wires 21 about the longitudinal axes of the arms thereof parallel to the frames to a limited extent due to the depth of the weld between the frame 22 and wire 21. After this weld is made the wires 21 are welded to the collars 15 and 16 and no abnormal stresses are introduced into the wires 21 or frames 22.

The cathode is suspended from the grid structure by means of a support 30 which is clamped between the grid frames 22 as clearly shown in Fig. 3. This support comprises a block of insulating material, such as "lavite", provided with end grooves 31 on the longitudinal surface in which the short portions of the frames 22 are seated. The block 30 is formed with a plurality of bores 32 and circular recesses 33, and carries a plurality of helical springs which are seated in the recesses 33. These springs support metallic hook members 35 the shanks of which pass through the bores 32 and the hooks engage the apices of a filamentary cathode to be described in detail hereinafter. The block 30 is further formed at its ends with slots 36 in which the ends of the grid supports 26 are disposed out of contact with the block, and is provided with longitudinal cut-out portions or recesses 37 intermediate the end grooves 31 which form an open space on each side of the block between the ends of the grid frames 22 and the block. Since the grid frames 22 are in engagement with the block 30 only in the grooves 31 a resistance path of maximum length through the block 30 is provided between the frames 22 and the hook members 35 so that very high insulation is obtained between the grid 27 and the cathode.

The cathode, as shown more clearly in Fig. 9 consists of a plurality of V-shaped sections 38, 39 and 40, preferably of thoriated tungsten wire, which are disposed uniformly within the grid 27 and are suspended between the hook members 35 and a pair of U-shaped members 41 supported adjacent the stem 11 by short rigid wires 42 embedded in the press 13. The rigid wires 42 are electrically connected by leading-in wires 45 to certain of the terminal pins 43 carried by an insulating base 44 which is attached to one end of the enclosing vessel 10. As is evident from Fig. 9, in which the arrows indicate the direction of current flow, the sections 38, 39 and 40 of the cathode are electrically connected in parallel so that a relatively low voltage source may be utilized for supplying the heating current to the cathode. It is also possible to obtain with this arrangement a low potential drop through the sections of the cathode and a uniform electron emission throughout the length of the cathode.

The control electrode or grid 27 is electrically connected to one of the terminal pins 43 by a leading-in conductor 46 which is sealed in the wall of the stem 11 and is connected to one of the grid frame supporting wires 21 by a metallic band 47.

The grid frames 22 are vibratile about the point of attachment to the bent wires 21, so that the grid and cathode assembly is capable of movement substantially as a whole. This protects the assembly against shocks to which the device may be subjected during shipment or mounting and thereby protects the cathode and grid against damage. The structure is sufficiently rigid, however, to maintain the grid-cathode assembly in proper space relation within the anode during the operation of the device.

An anode assembly, shown clearly in Fig. 8, comprises a flattened cylindrical anode 48 uniformly disposed about the grid 27 and substantially conforming to the contour thereof. The anode consists of two similar opposed U-shaped portions having large surface integral flanges 49 which are joined by integral bent tabs 50, the ends of the flange of one section being crimped about the edge of the corresponding flange of the other section as shown at 51. The U-shaped portions of the anode are provided with parallel corrugations or embossments 52, to prevent excessive distortion of the anode by heating to high temperatures. The anode is supported from the stem 12 by a pair of split metallic bands or collars 53 and 54 which are clamped about the stem 12 by bolts 55 and nuts 56 passing through flanges 57 and 58 integral with the bands or collars. A pair of rigid hair-pin-shaped metallic frames 59 and 60 extend from the collars 53 and 54 parallel to the longitudinal axis of the enclosing vessel, and each supports a rigid wire frame or hanger 61 and 62 respectively. The frames or hangers 61 and 62 pass through apertures in the end of the flanges 49 remote from the stem 12 and are bent as at 63 to prevent movement of the flange along the end of the frames. A pair of rigid bent wires 64 and 65 extend from the press 14 and carry hook members 66 and 67 respectively which pass through apertures in the end of the flanges 49 of the anode, nearest the stem 12 and are secured as by welding to the frame members 59 and 60 respectively. This construction, which is described in greater detail and claimed in a copending application of V. L. Ronci and J. E. Clark, Serial No. 530,198, filed April 15, 1931, accurately positions the anode 48, allows longitudinal movement of the anode, and insures

uniform expansion and contraction thereof during the operation of the device. The anode 48 is electrically connected to an external terminal 68 carried by a flanged insulator 69 secured to the enclosing vessel 10, through leading-in conductors 70 sealed in the stem 12 and attached to the bent wires 64 and 65.

A grooved getter ring support 71 carrying a quantity of vaporizable material, such as magnesium, for fixing residual gases within the vessel 10, is supported from the band or collar 54 by a metallic strip 72.

Although a specific embodiment of this invention has been disclosed and described, it is, of course, to be understood that various modifications may be made in the assembly, without departing from the scope and spirit of the invention as defined in the appended claims.

What is claimed is:

1. An electron discharge device comprising an enclosing vessel having a stem, a plurality of rigidly interconnected metallic frame members extending from said stem, and a plurality of electrodes resiliently supported by said frame members, one of said electrodes being electrically connected to said frame members and another of said electrodes being insulated from said frame members.

2. An electron discharge device comprising an enclosing vessel having a stem, a plurality of rigid frame members supported from said stem, a cathode insulatingly suspended from said frame members, a helical electrode encircling said cathode, and means connected to said frame members at spaced points intermediate the ends thereof and flexibly supporting said helical electrode from said frame members.

3. An electron discharge device comprising an enclosing vessel having a reentrant stem, a collar clamped about said stem, a pair of parallel U-shaped metallic frame members carried by said collar, an insulator mounted on said frame members at the end thereof remote from said stem, a rigid conductor embedded in said stem, a filamentary cathode resiliently suspended from said insulator and connected to said conductor, a helical grid electrode encircling said cathode, electrically conductive means connected to said grid electrode and to said frame members and resiliently supporting said grid electrode from said frame members, and an anode surrounding said cathode and grid electrode.

4. In an electron discharge device, an electrode assembly comprising a plurality of metallic frame members, parallel metallic supporting members disposed between said frame members, flexible electrically conductive means connecting said supporting members to said frame members, and a helical wire electrode mounted on said supporting members.

5. An electron discharge device comprising an enclosing vessel having a stem, a pair of frames having parallel arms supported from said stem, a rectilinear rod disposed between adjacent arms of said frames, resilient means supporting said rod from said frames allowing both lateral and longitudinal movement of said rod, a helical grid electrode carried by said rod, a cathode within said grid electrode, and an anode adjacent said grid electrode.

6. An electron discharge device comprising an enclosing vessel having a stem, a unitary assembly mounted on said stem including a plurality of parallel frames, a plurality of rigid parallel supporting members, resilient means connecting opposite ends of said supporting members to said frames, a helical wire electrode mounted on said supporting members, an insulating member carried by said frames, and a cathode suspended from said insulating member and disposed within said helical electrode.

7. In an electron discharge device, an electrode assembly comprising a plurality of juxtaposed frames, a plurality of laterally and longitudinally flexible members connecting said frames, a plurality of parallel rigid rods supported by said flexible members, and a helical wire electrode mounted on said rods.

8. An electron discharge device comprising an enclosing vessel having a reentrant stem, a plurality of collars clamped about said stem, a pair of parallel U-shaped frames extending from said collars, a plurality of pairs of spaced flexible members supported between juxtaposed arms of said frames, a rigid rod carried by each pair of said flexible members, a helical wire electrode carried by said rods, an insulating support clamped between said frame members, a filamentary cathode disposed within said electrode and suspended from said insulating member, and an anode encircling said cathode and said electrode.

9. An electron discharge device comprising an enclosing vessel having a stem, a plurality of collars clamped about said stem, a plurality of L-shaped supports each having one arm parallel to the longitudinal axis of said stem secured to said collars and an outwardly extending arm at substantially right angles to said axis, a plurality of U-shaped frame members having their ends attached to said outwardly extending arms, a cathode and a grid electrode supported from said frame members, and an anode adjacent said cathode and grid electrode.

10. An electron discharge device comprising an enclosing vessel having a reentrant stem at each end, a frame supported from one of said stems, a cathode suspended between the top of said frame and said stem supporting said frame, a helical grid electrode encircling said cathode, resilient means mounting said grid electrode from said frame for both lateral and longitudinal movement, a plurality of frame members extending from the other of said stems, an anode disposed about said cathode and said grid electrode, and means mounting said anode from said frame members allowing longitudinal movement of said anode.

11. An electrode assembly for an electron discharge device, comprising a frame having a plurality of parallel arms, a plurality of parallel rods adjacent said arms, an electrode carried by said rods, and a plurality of spaced members connecting the ends of said rods to the adjacent arms of said frame, said members being flexible to allow lateral and longitudinal movement of said rods.

12. An electrode assembly for an electron discharge device, comprising a frame having a plurality of parallel arms, a plurality of rigid rods, one adjacent each of said arms, a helical wire electrode carried by said rods, a plurality of flexible U-shaped members connecting one end of each of said rods to the adjacent arm of said frame, and a plurality of flexible members connecting the other end of each of said rods to the corresponding arm of said frame.

VICTOR L. RONCI.
JOSEPH P. LAICO.