May 10, 1938. D. A. S. HALE ET AL 2,117,001

ELECTRON DISCHARGE DEVICE

Filed Jan. 9, 1936

FIG. 1

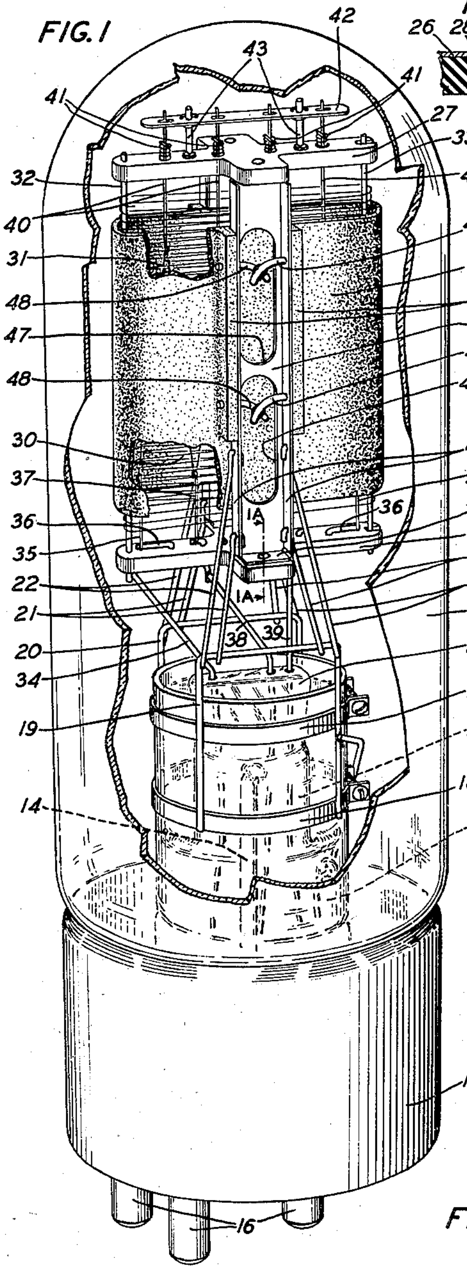


FIG. 1A

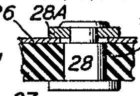


FIG. 2

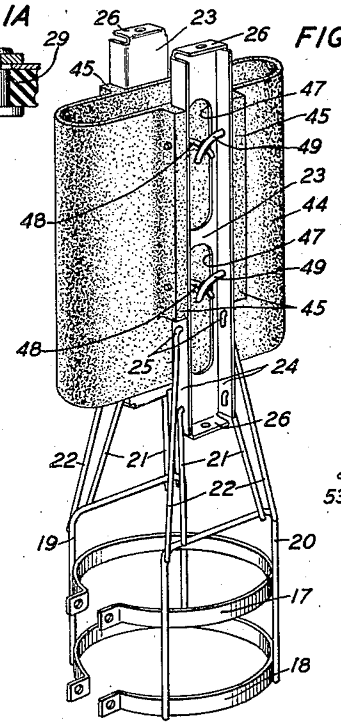


FIG. 6

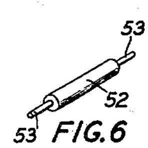


FIG. 7

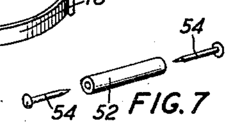


FIG. 3

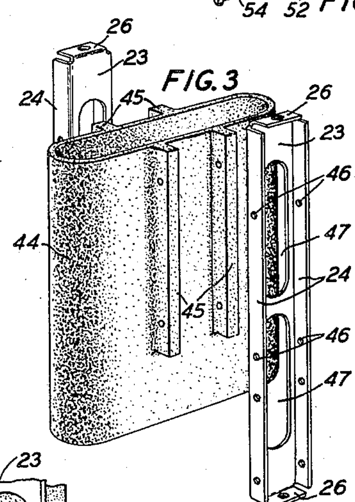


FIG. 4

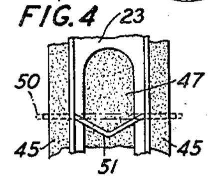
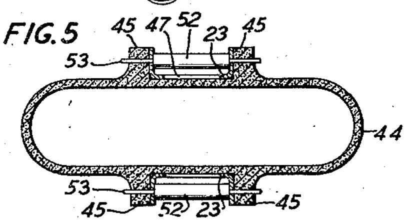


FIG. 5



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UNITED STATES PATENT OFFICE

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ELECTRON DISCHARGE DEVICE

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Application January 9, 1936, Serial No. 58,317

7 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices and more particularly to such devices capable of dissipating considerable heat during operation.

An object of the invention is to secure an efficient electrode structure for an electron discharge device in which the output electrode is supported in such a manner that a large effective area is available for dissipating the heat energy consumed in the electrode.

Another object of the invention is to insure an effective and inexpensive coupling between connected elements having different physical characteristics in a discharge device so that transient deleterious causes do not break or fracture the electrode.

A further object of the invention is to facilitate the efficient assembly of the discharge device by proportioning the elements so that they may be fabricated with dispatch by unskilled labor.

In accordance with the general aspects of the invention, an electrode, such as an anode, is formed of a friable mass material, such as graphite, with parallel flanged portions which extend outwardly from the surface of the anode. A metallic post or channel member is situated between the flanged portions and a locking member extends through the flanged portions and the channel member to secure the anode in position in a unit with other cooperating electrodes, such as a cathode and a control electrode.

According to a specific aspect of the invention, the locking member comprises a pair of wire pins which have straight portions extending through the channel walls adjacent the parallel flange portions of the anode and arcuate portions which intersect in the center of the channel member and are preferably welded together at the point of intersection. In this arrangement the tight fit of the straight portions of the pins in the graphite mass of the anode flanges provides a rigid mounting for the anode and the slight curvature of the pins in the anode flanges reenforced by the walls of the channel member forms a wedge for the pins to avoid a loose connection. Furthermore, the welding of the pins at the intersection of the arcuate portions facilitates the assembly of the electrode unit and provides an efficient and inexpensive connector for the support of the anode. A straight pin may be used for the connector with the intermediate portion provided with an offset notch to lock the pin in position.

In accordance with a further modification of the invention, a single pin extends through the flanges of the anode and the adjacent channel walls and is surrounded by an intermediate metallic sleeve, the sleeve and pin being welded together at a central point. A modification of the latter arrangement comprises a pair of headed pins which are inserted in the flanges of the anode and the channel walls from opposite directions and joined by a sleeve interposed between the channel walls.

These and other features of the invention will be apparent from a perusal of the following description when read in connection with the accompanying drawing:

Fig. 1 is a perspective view in elevation of an electron discharge device made in accordance with this invention and having a portion of the enclosing vessel and the output electrode broken away to show the internal elements of the structural assembly;

Fig. 1A is an enlarged view in cross-section of the detail assembly of the anode structure taken on the line A—A of Fig. 1;

Fig. 2 is a perspective view from a different angle of the principal elements involved in this invention as applied to Fig. 1, and illustrating the configuration of the output electrode and the supporting assembly;

Fig. 3 is an exploded perspective view of the anode and channel members of this invention showing the prealignment of the elements to facilitate assembly;

Fig. 4 is a fragmentary view of the elements of the anode structure showing a modification of the locking pin assembly according to this invention;

Fig. 5 shows a cross-sectional view of the anode structure and illustrates another modified form of locking member for connecting the anode to the channel members;

Fig. 6 is a detailed perspective view of the locking member assembly shown in Fig. 5; and

Fig. 7 illustrates another form of locking member for uniting the anode to the channel members in which a central sleeve is telescoped over the projecting ends of contraposed pins when assembled in accordance with this invention.

This invention in one of its aspects may be adapted to a structural assembly disclosed and claimed in our Patent 2,019,492, issued November 5, 1935.

The discharge device comprising an enclosing vessel 10 having an inwardly projecting cylindrical stem 11 and an inner coaxial stem 12 terminating in a press 13, the inner stem being provided with an internal outwardly extending tubulation 14 which forms the exhaust tube of the device. The stems 11 and 12 and also the enclosing vessel 10 preferably are formed of a borosilicate glass having high mechanical and dielectric strength and low coefficient of expansion, such as "Nonex". An insulating cup-shaped base 15 is secured to the end of the enclosing vessel adjacent the stems and carries a plurality of terminals or prongs 16.

The electrode unit of the discharge device is completely supported from the cylindrical stem 11 by a pair of spaced bands or collars 17 and 18 which are secured to the stem by clamping bolts and nuts. These bands are fastened to a pair of parallel inverted U-shaped frames 19 and 20 which extend above the edge of the cylindrical stem 11 and form a base for a plurality of supporting members connected to the electrode unit. Each frame carries two pairs of converging braces 21 and 22 which are welded to the frames and extend upwardly to a pair of channel-shaped metallic support posts or members 23 and 24. The braces are mechanically locked to the channel members by inserting the ends thereof through apertures in the side walls of the channel members and crimping the ends into engagement with the channel walls as shown at 25, in Fig. 2.

The channel posts form the rigid upright supports of the electrode unit and are arranged in parallel relation to the axis of the vessel. These posts are provided with integral flanges or extensions 26 at opposite ends which are bent up to close the ends of the channel posts. A pair of cross-shaped insulating members 27 and 29 are positioned on the end flanges and are rigidly fixed thereto by a metallic rivet 28 which is inserted through the insulating member, such as 29, shown in Fig. 1A, and extends through an oversize aperture in the flange 26. The rivet 28 is secured to the assembly by placing a washer 28A over the end of the rivet and spinning over the rivet. This assembly avoids placing undue strain on the graphite anode and the insulating member during fabrication since the elements may be easily aligned due to the clearance provided by the oversize aperture in the channel post flange. The insulating members serve as spacers and supporting members for a control electrode or grid 30 and a double M-shaped filamentary cathode 31.

The control electrode or grid 30 is in the form of a continuous helical wire having the configuration of a flattened cylinder and is supported between the insulating members 28 and 29 by upright posts or rods 32 and 33 which are welded to successive turns of the helical wire. The grid 30 is held in normal relation between the insulating members 28 and 29 by the leading-in wire 34 extending from the press 13, the wire 34 being attached to the upright rod 32 of the grid below the insulating spacer 29 and at the other end is connected to one of the terminal prongs 16 on the base 15.

The ends of the preformed filamentary cathode 31 are secured to hook members 35 while the mid-point of the filament is attached to another hook member extending through the insulating member 29, the end hooks being attached to arms 36 of a tie wire extending below the insulator 29 to which the center hook is also attached. The centers of the two M-shaped sectons of the cathode are secured to separate hooks 37 which are held in position by anchor wires in the insulator member 29 and the anchor wires are connected to leading-in wires 38 and 39 which extend from the press 13 and are connected to suitable terminals on the base of the device.

The filamentary cathode 31 is held under suitable tension by a number of hook members 40 engaging the bights of the formed cathode, the hook members being provided with elongated shanks which extend through the insulating member 28, and individual compression springs 41 are secured to an intermediate point of the shank of each hook member. In order to maintain the filamentary cathode in a medial plane, an insulating guiding strip 42 is supported above the insulating member 28 by a pair of pins or posts 43. This guiding strip is provided with a number of elongated slots through which the free ends of the hooks 40 extend and limit the movement of the hooks to a single plane.

The power or output rating of electron discharge devices necessitates the employment of large electrode surfaces. Furthermore, the high temperature operation and large effective area of the filamentary cathode cause considerable heat radiation. These factors impose considerable strain on a sheet metal electrode surrounding the cathode and grid. Since the heat energy is absorbed by the output electrode it is evident that if the radiation constant of the electrode is not high enough considerable damage can be caused due to buckling, or strains may be developed which endanger the relationship of other elements in the device. Furthermore, the buckling effect may alter the internal resistance and capacitance characteristics of the device to such an extent that the efficiency of the device is considerably impaired. These defects are materially overcome by employing a more stable material for the output electrode which is capable of dissipating the heat energy transmitted to it with a greater efficiency than a metallic surface. It has been found that a friable material, such as graphite, which has a high black-body constant, is admirably suited to this task. The use of this material heretofore has been handicapped by certain inherent characteristics and the dominant drawback of this material is its brittle texture which causes it to fracture when subjected to mechanical strains.

In accordance with this invention, graphite is used as the anode structure to utilize the exceptional qualities of this material and the anode is rigidly fabricated in the electrode unit without subjecting the friable material to mechanical strain. This is accomplished by forming the anode 44 of a friable material, such as graphite, either molded from a plastic mass or machined from a solid block into a configuration simulating a flattened cylinder having parallel side walls and small diameter end portions to correspond with the configuration of the control electrode 30. The graphite anode is also provided with two parallel outwardly extending flanged portions 45 which extend from each outer parallel surface of the anode and are formed integral therewith as shown more clearly in Fig. 5. These flanges extend from the upper edges of the anode and terminate slightly above the point where the mechanical joint 25 is made between the braces 22 and the side walls of the channel member 23 as shown in Figs. 1 and 2. The flanges 45 are interspaced on the anode structure sufficient to receive the channel members 23 so that the side walls 24 of the channel members abut against the inner surfaces of the flanges 45. The flanges are also drilled to correspond with the apertures 46 in the side walls 24 of the channel member 23.

A large portion of the flat area of the channel members 23 is cut away in the form of elongated slots 47 to expose a greater area of the anode surface, and thereby increase the heat radiation of the anode.

The anode 44 is rigidly secured to the channel members 23, in accordance with one embodiment of the invention, by metallic locking members or wire pins 48 and 49 which form connectors between the flanged portion 45 of the anode and the side walls 24 of the channel members. These pins are provided with a short, straight portion which extends through the flange 45 of the anode and the remaining portion of the pin is curved downwardly in an arcuate form so that the corresponding pins 48 and 49 converge at the center of the channel member to provide a cruciform joint which may be conveniently welded at the point of intersection of the pins.

A method of fabricating the anode with the remaining structure of the electrode unit consists in placing each channel member in the space between the flanged portions of the anode, then inserting each preformed pin through the aperture 46 in the channel member 23 and projecting the straight portion of the pin through the aperture of the flange 45 on the anode, until the curved portion of the pin forms a wedge in the aperture 46 in the channel member 23. When all the pins are in position, the junction points of the pins are welded to prevent displacement of the pins and to insure positive rigid contact of the pins with the channel walls and the flanges of the anode. It will be noted that any strain produced by the pin being inserted in the channel members and flanges is sustained by the side walls 24 of the channel members and this strain is not imparted to the fragile flange portions 45 of the anode. Therefore, the locking pins of this invention, securely anchor the fragile anode material to the superstructure of the electrode unit without endangering the anode material by mechanical strain which might cause fracture of the anode.

In the form of locking connector previously described, it is necessary to insert the locking pin through the side walls of the channel members and then through the flanged portions of the anode due to the curvature of the locking pins 48 and 49. While this assembly may be accomplished with dispatch even by an unskilled worker, another convenient connector may be employed, as shown in Fig. 4. In this arrangement a straight pin 50, shown in dotted line, may be inserted through the aligned holes in the anode flanges and the channel walls and locked in position by offsetting the center portion in a V-shaped configuration 51.

Another pin arrangement shown in Fig. 6 also may be employed in assembling the cooperating elements in Fig. 5. In this arrangement a metallic sleeve 52 is positioned interjacent the side walls of the channel member 23 in alignment with the apertures 46 therein and the corresponding apertures in the flanges of the anode 44, and a straight pin 53 is threaded successively through the flange 45, channel wall 24, sleeve 52 and then through the remaining channel wall and anode flange on the opposite side of the sleeve 52. The sleeve is then welded to the locking pin 53 to form a rigid joint.

In another modification of the invention embodying a telescopic joint as above described, the metallic sleeve 52 is positioned between the side walls of the channel member and contraposed locking pins 54 having headed terminations are inserted from opposed direction through the flange portions 45 of the anode and into the metallic sleeve 52 where they are welded to form a rigid connection. In this arrangement it is not essential to drive the pin 54 to such an extent that the heads of the pins are in contact with the flanges 45 of the anode, since the locking joint is determined by the welded connection with the sleeve 52 and the pins do not exert any strain on the fragile flange portions of the anode.

While various embodiments of the invention have been disclosed as above described, it is of course understood that various modifications may be made in the detailed structure of the assembly without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. An electrode unit for an electron discharge device including an output electrode of a homogeneous mass having parallel integral flanged portions projecting outwardly from the surface thereof, a metallic channel support extending between said flanged portions having the side walls thereof contiguous with said flanged portions, wire pins extending through said flanged portions and channel side walls, and means locking said wire pins together to prevent movement of said output electrode with respect to said channel support.

2. An electron discharge device electrode unit including an electrode of a mass of conducting material having integral parallel flanged portions extending from the surface thereof, a channel member interjacent said flanged portions, and anchor pins extending successively through said channel walls and flanged portions, said pins being welded together at a point out of alignment with the portions extending through said channel members and anode.

3. An electron discharge device electrode unit comprising a graphite electrode having parallel flanged portions extending from the surface thereof longitudinally of the electrode, a channel support interposed between said flanged portions, and arcuate pins interjacent said channel walls, said pins having terminating ends extending through said walls and anode flanged portions.

4. An electrode unit for an electron discharge device, comprising an output electrode of homogeneous graphite material having parallel flanged portions projecting outwardly from the surface thereof, a metallic channel support extending between said flanged portions having the side walls thereof contiguous with said flanged portions, and telescoped members having contraposed portions extending through said flanged portions and channel walls.

5. An electron discharge device electrode unit including a graphite unit having parallel flanged portions extending from the surface thereof, a metallic support interposed between said flanged portions, and connecting members joining said flanged portions to said support, said members intersecting each other at a medial point between said flanged portions.

6. An electron discharge device electrode unit including a graphite anode having parallel flanged portions extending from the surface thereof, a channel upright member interposed between said flanged portions, and locking means for said anode including a sleeve interjacent said channel walls and contraposed anchor pins extending through said anode flanges and secured to said sleeve.

7. An electrode unit for an electron discharge device including a graphite anode of flattened cylindrical form having a pair of integral parallel flanges projecting outwardly from each outer parallel surface thereof, a channel metallic support between each pair of flanges, each of said supports having walls abutting against the inner surfaces of said flanges and a plane wall having elongated cut-out portions abutting the outer surface of said anode between said flanges, the abutting flanges of said anode and the side walls of said supports having aligned apertures in a horizontal plane adjacent opposite ends of said flanges, and pairs of arcuate pins interjacent the support side walls and divergently extending through said apertures, the pins of each pair being welded to maintain said pins in locking engagement with said flanges and supports.

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