

April 16, 1946.

L. C. WERNER ET AL
ELECTRON DISCHARGE DEVICE

2,398,608

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2 Sheets-Sheet 1

Fig. 1.

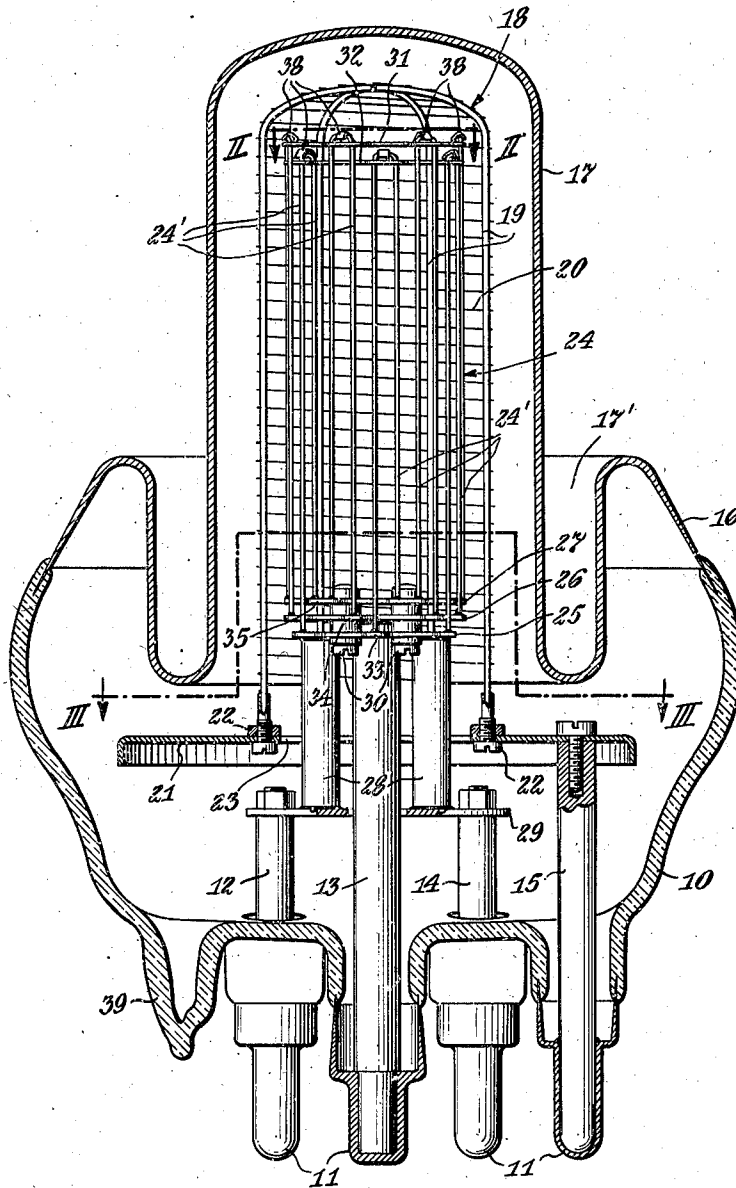


Fig. 6.

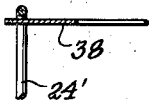
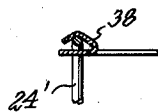


Fig. 7.



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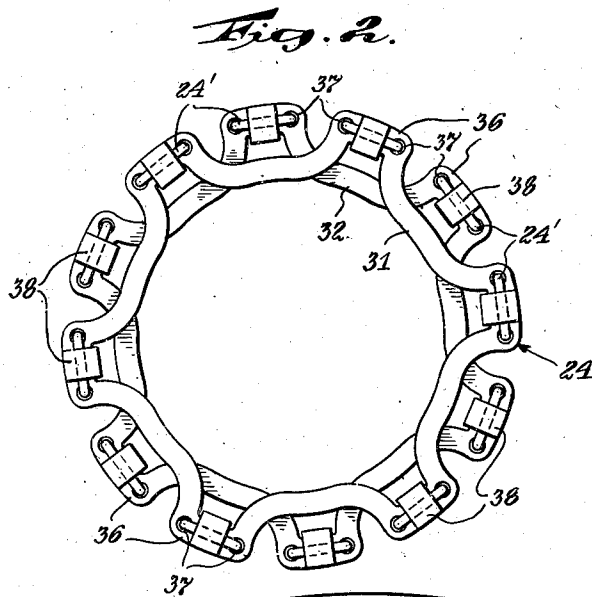
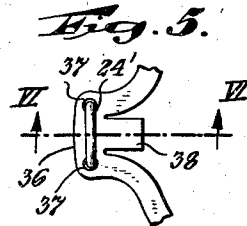
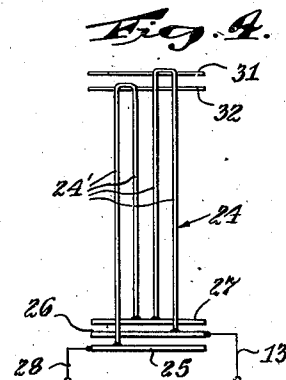
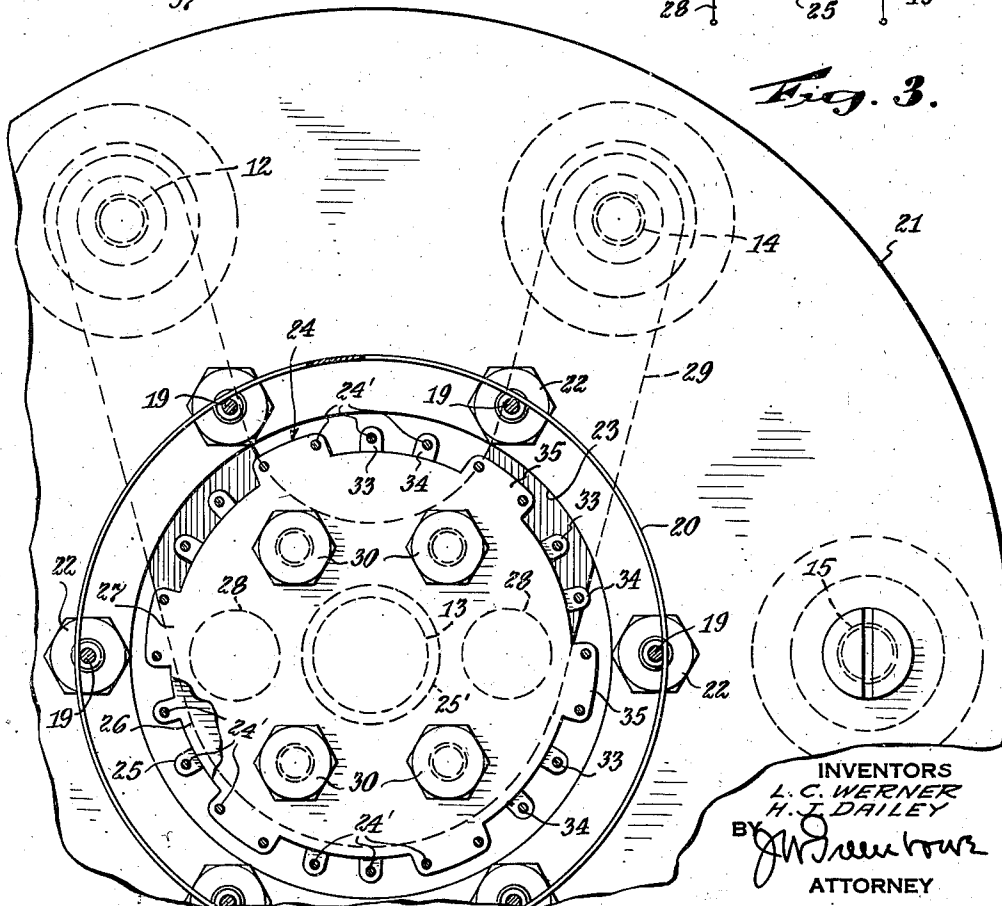
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UNITED STATES PATENT OFFICE

2,398,608

ELECTRON DISCHARGE DEVICE

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Application October 1, 1941, Serial No. 413,168

8 Claims. (Cl. 250—27.5)

This invention relates in general to electron discharge devices, and more particularly to filaments and the mounting therefor.

Some attempts have heretofore been made to construct and use filaments of a multiple group of strands in electrical series, and duplicated by other groups in electrical parallel therewith and with each other. Difficulties have arisen both in the manufacture of the strands forming such a filament and in the assembly and retention of those strands in the electrode structure. Precision of bending of filament wires has necessitated more or less elaborate dies and mandrels as well as methods to be employed which have been time-consuming and otherwise unsatisfactory in use. The distortion of the wire used has left stresses therein, not immediately apparent always, but which develop a warping of the filament in service, and such as to affect the tube characteristics. The difficulty mentioned appears to result in many instances from the fact that the part of the filament wire which is bent during fabrication becomes in use part of the length of filament between supports. In consequence of that fact, even very slight stresses in the curved portion of the filament produce considerable deflections in the otherwise straight part of the filament. Furthermore, a die- or mandrel-formed filament, in view of the resiliency of the wire when bent, has to be baked while held in the die or on the mandrel, to "set" the metal to the shape to which it is bent. After the baking process, the wire is exceedingly brittle and requires extra care in handling, even with which, spoilage is considerable both before and after installation in an electron discharge device. Again, even though baking may be carried out at high temperatures, it is not as intense or effective as heating obtained by bringing the filament to incandescence with current passing there-through. Consequently, a baked filament very frequently warps after installation and when then rendered incandescent in use, often results in the rejection of the whole device, thus representing a substantial financial loss.

An object of the present invention is accordingly to provide a construction of a bent filament wherein the "set" may be performed after installation on its support and before completion of the electron discharge device.

Another object of the present invention is to confine the bend to a part of the filament where any stresses developed will have minimum deflecting or deforming effect upon the general length of the filament.

A further object of the invention is to provide a filament in which the "set" may be accomplished by heating in hydrogen while the filament is rendered incandescent from passage of an electric current therethrough.

Again, an object of the invention is to provide a simple, light and effective spacer element which will position and hold the filament.

A still further object of the invention resides in the method of manufacture of an electron discharge device, particularly as to application and retention of a filament therein.

Other and further objects of the invention will appear to those skilled in the art as the description progresses, both by direct statement thereof and by implication from the context.

In the accompanying drawings, wherein like numerals of reference indicate similar parts throughout the several views, and wherein a preferred physical embodiment of the invention is disclosed by way of example:

Figure 1 is a central vertical section of an electron discharge device embodying the present invention;

Figure 2 is a plan of the filament assembly as viewed on line II—II of Fig. 1, but with increased scale thereover;

Figure 3 is a cross-sectional view on line III—III of Fig. 1, and on a scale corresponding to that of Fig. 2;

Figure 4 is an elevation of one group of filament strands forming a complete series circuit with the source of current supply;

Figure 5 is a plan of a portion of one of the upper spacer elements with the bight of the filament section therein and showing the parts before the clinching tab is bent to holding position;

Figure 6 is a sectional view on line VI—VI of Fig. 5; and

Figure 7 is a similar sectional view showing the tab bent to its holding position.

In the specific embodiment of the invention illustrated in said drawings, a part of an electronic discharge device, generally identified as a transmitting tube, is depicted exemplifying the invention as part thereof. It should be understood, however, at the outset, that the invention is applicable to other electronic devices than the particular transmitting tube here selected for illustrative purposes.

The specific tube shown comprises a glass or other ceramic bowl or casing portion 10, here represented as part of an evacuated envelope, and as also constituting the base portion for the

device, for which purpose it is equipped with appropriate prongs 11 protruding from the bottom thereof. These prongs are each preferably unified with appropriate posts, such as 12, 13, 14 and 15 shown in Fig. 3, extending upwardly within the interior of said bowl or base portion 10. At the upper rim of the bowl portion 10, there is sealed into the glass or other ceramic a feather edge of a connecting ring-like portion 16 to a metal upper portion which in part also constitutes the anode 17. A part of the anode proper is shown re-entrant with respect to the connecting rim or ring portion 16, thereby providing an annular upwardly opening exterior groove 17' serviceable in connection with cooling the anode in use.

Within the anode 17, spaced in parallelism to the same, is a bird-cage dome-like grid 18 providing a plurality of similar strands 19 in generally vertical planes, evenly distributed circumferentially and providing lower portions which are parallel to each other and upper portions which curve upwardly inward to a common vortex to obtain the dome-like contour of grid. Said grid is also shown as having a helically wound wire 20, each point of crossing of which with the strands 19 is spot welded or otherwise secured, to constitute the strands and helically wound wire a unitary grid structure. The lower ends of the several strands 19 are secured to a horizontally disposed plate 21, as by screw and nut means 22 shown. Said plate is provided with a central opening 23 therein for passage of other terminal connections and posts therethrough, and is also provided with a peripheral rim or skirt at its edge for obtaining desired rigidity. A plurality of posts, of which post 15 is representative, support said plate from the bowl and provide electrical connection from the said plate to one or more of the prongs depending from and sealed with respect to the bowl.

The filament designated generally by reference numeral 24 comprises a plurality of strands, the major portions of which are parallel and together constitute a cylindrical assembly. The assembly provides a plurality of groups of strands, of which one group is shown in Fig. 4, and wherein the strands 24' of the group are in electrical series to the source of current supply. Other like groups are in parallel to each other although the strands of each group are in electrical series within the group. A maximum electron emitting surface area for copious flow of electrons is thus provided with minimum current consumption.

In the fabrication of the filament assembly 24, a plurality of generally parallel spacer members are provided, namely, three next the bottoms of the strands and two next the top. Of the bottom three spacer members, the lowermost one is designated by numeral 25 and is situated horizontally or transverse to the filament strands. Physically and electrically spaced a short distance above this lower spacer member 25, and parallel thereto, is a second or intermediate spacer member 26. These two spacer members are connected to opposite poles of the source of filament current supply, as indicated in Fig. 4. Next above the intermediate spacer member 26 is a third or neutral spacer member 27 likewise parallel to and electrically distinct from the other said spacer members. All of these spacer members are preferably of plate formation, the lowermost one, 25, having a central aperture 25' permitting free passage therethrough without contact, of post 13 the upper end of which is electrically and

physically secured to the next or intermediate plate-like spacer member 26. This post 13 represents one lead-in means for the supply current to the filament. The lower spacer member 25 is supported by welding, brazing or otherwise securing the same physically upon upper ends of connector posts 28, 28 in turn secured near the apex of an A-bracket 29 horizontally disposed below and parallel to plate 21, with the legs of said bracket secured upon the tops of posts 12 and 14 and forming therewith electrical circuit from the filament to the other pole of the source of current supply. Bolts or other holding means 30 extend through the three spacer members described with suitable insulation from at least two thereof, thereby obtaining rigidity with electrical separation.

At the top of the filament assembly are provided two spacer members forming an important part of the present invention. Each of said spacer members for the top part of the filament is of a generally flat, ring-like or endless configuration. Said members are also physically and electrically spaced from each other and arranged to provide an upper spacer member 31 and a subtended parallel spacer member 32, both also being parallel to the spacer members at the bottom part of the filament.

It is now appropriate to point out that each group of strands constituting an electrical series, is made up of two lengths of wire each bent in the form of a hair-pin and referred to here as a filament section. Two such sections are shown as comprising each group of series-connected strands. The bent portion, referred to as the bight of the filament section, is engaged in one of the upper spacer members, whereas the bight of the other hair-pin formation is engaged in the other spacer element. As the potential at the bight of all filament sections engaged in one spacer member is the same, said spacer members are conveniently made of metal, but may be of non-conductive material if found more expedient. A desirable characteristic is that they shall be of minimum mass or light in weight as they are entirely supported by the filament strands, and should develop minimum momentum under conditions of jarring the electron discharge device.

In the general assembly of the filament, alternate sections thereof are duplicates. Two adjacent sections comprising a single group in effect constitute an M-shape with one top bight a little lower than the other due to the spacing of the two upper spacer members one below the other. The end legs of the M-shape have their lower ends correspondingly one lower than the other since one such outside leg is connected to the lower or first spacer member and the other outside leg is connected to the next above or intermediate spacer member. The two middle legs of the M-shape are both physically and electrically connected to the third or neutral spacer member and are accordingly shorter than either of the end legs. All three of these lower spacer members are electrically conductive and are provided with projecting and staggered ears 33, 34 and 35 at the peripheries thereof, so that strands to the lower spacer member ears 33 may pass between the ears 34 and 35 of the other two members, strands to the intermediate member may be secured to the projecting ears 34 thereof and pass between the ears 35 of the upper one of said members, whereas the strands to the upper one of the members may be secured to the ears 35 thereof and thus locate all of the strands in a single circle with

each attached to its proper spacer member without making undesired contacts with either of the other spacer members.

The spacer members located next the top of the filament are both preferably alike, each formed to appear in plan as a wavy continuous ribbon, the waviness providing thereby protruding ears 36 each having two holes 37 appropriately spaced in a circular direction and all equidistant from a common center, to receive the two strands therethrough consisting of a filament section with the bight of the section overlying the portion of the ear intervening between said holes. A tab 38 is formed integral with and at the inside edge of the ear, said tab being bent upwardly outward to clinch over the top of the bight after the filament section is slid home through said holes. If desired, the tab and/or filament bight may be spot welded or otherwise rendered that much more secure to the spacer member.

It now follows from the foregoing description, that assembly is effected by inserting the legs of appropriate hair-pin filament sections, while the metal is still in pliable form, through the prepared holes in the spacer member ear, duplicating the procedure for all ears of both spacer members. Since substantially all of the bend effected in the metal forming the bight is situated in the ear above the holes, the walls around the holes will resist any effort made by the resiliency of the wire or by internal stresses, from deflecting the strands out of parallel relation. Clinching of the tabs may now be effected, either before or after which the lower ends of the strands are welded or otherwise secured to their respective lower spacer members. The filament assembly is then introduced in hydrogen and rendered incandescent while therein by passage of an appropriate electric current through the filament, and the filament assembly thereafter inserted in place with other parts forming and completing the electron discharge device. Heat treatment by current causing incandescence obtains a permanent set in the filament metal, and accomplishment of this set prior to incorporating the filament in the electron discharge device enables said filament to be inspected while still a separate entity. However, mounting in place may take precedence to setting the metal if preferred, in which event the device may be evacuated through tubulation 39, hydrogen introduced therethrough, the filament ignited, the tube again evacuated and completed in usual manner.

We claim:

1. A spacer member for filaments and the like, comprising an endless narrow ribbon-like member having pairs of holes at intervals for recep-

tion of strands of filament wire bent in the area spanning the holes of a pair of holes.

2. A spacer member for filaments and the like, comprising an endless narrow ribbon-like member having pairs of holes at intervals for reception of strands of filament wire bent in the area spanning the holes of a pair of holes, and means for retaining said filament wire in place in said holes.

3. A spacer member for filaments and the like, comprising an endless narrow ribbon-like member having pairs of holes at intervals for reception of strands of filament wire bent in the area spanning the holes of a pair of holes, and means bendable over the bight of said filament wire for holding the said filament wire in place.

4. A spacer member for filament wires and the like wherein said wire is bent intermediate its length to provide parallel strand portions and a bight portion, and wherein said spacer member provides holes for passage of said parallel strand portions therethrough, the combination of a tab integral with said member and bendable over said bight portion of the filament wire for retaining the bight portion next the member at the area intervening between the holes.

5. A spacer comprising an endless ribbon member having portions protruding and other portions receding, said protruding portions constituting ears, each said ear having a pair of holes and all of said holes equi-distant from a common center, filament strands in each said hole, and means supporting said member from said strands.

6. A filament structure comprising a pair of spaced and parallel endless ribbon members each having peripherally projecting ears with the ears of one member staggered with respect to the ears of the other member, each said ear having a pair of holes, filament strands depending from each said hole, the strands from the upper of the said members passing out of contact from the other member, and means at the lower end of said strands for completing the electric circuit with respect thereto.

7. A filament structure in accordance with claim 6, wherein means is provided at the upper parts of the filament strands securing the same to their respective said members.

8. A filament structure in accordance with claim 6 wherein means is provided integral with said members and in intimate contact with said filament strands for supporting the said members from the respective said strands in the holes thereof.

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