Nov. 15, 1949 V. L. RONCI 2,488,331

FILAMENT MOUNTING ASSEMBLY

Filed Sept. 14, 1948 2 Sheets-Sheet 1

FIG. 1

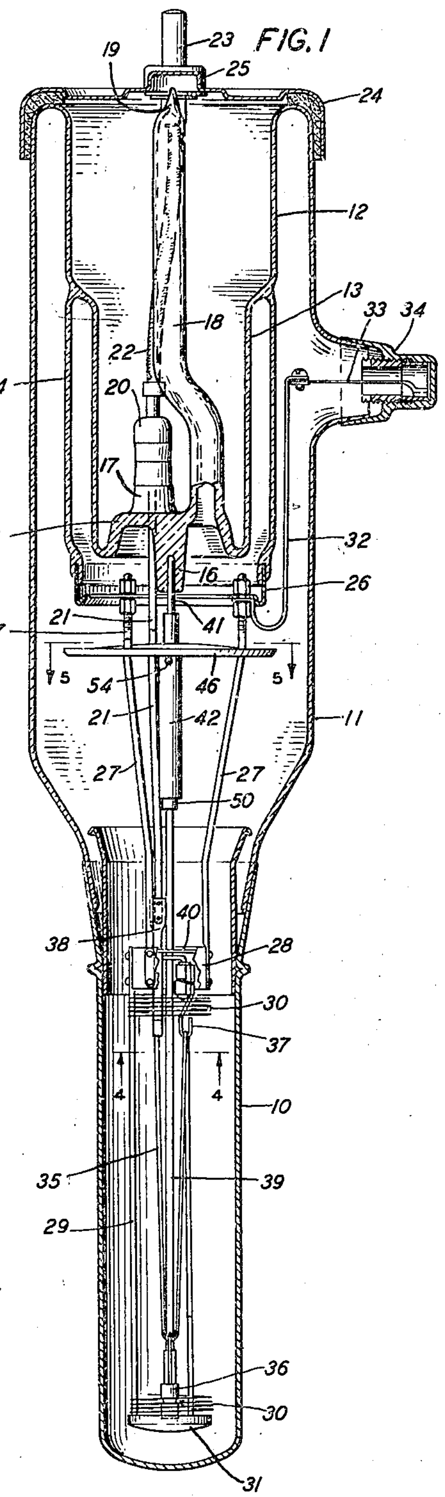


FIG. 2

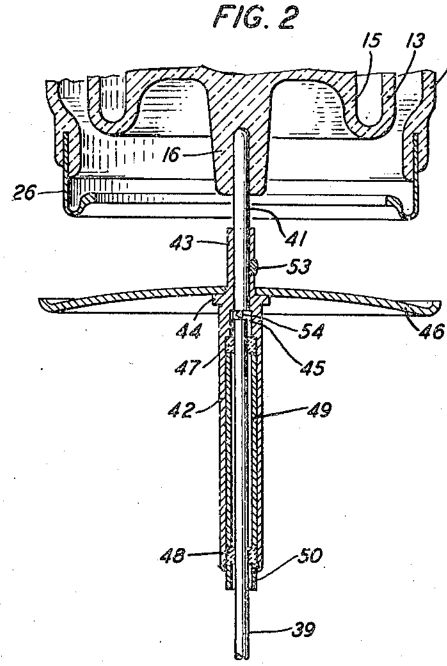
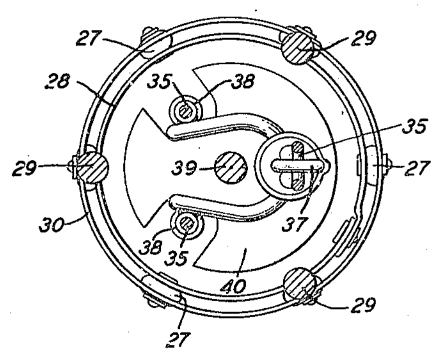


FIG. 4



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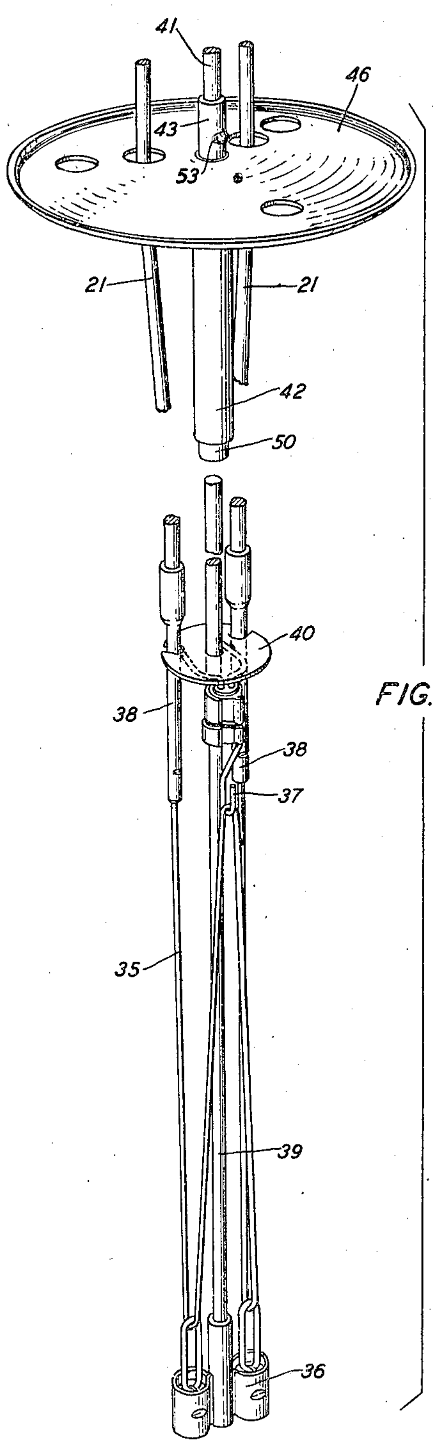
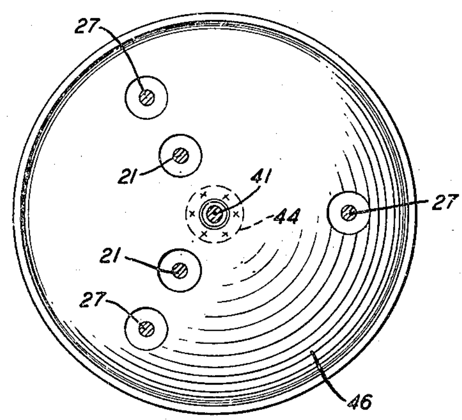


FIG. 3

FIG. 5



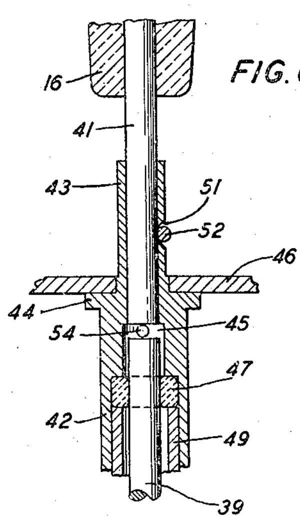


FIG. 6

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FILAMENT MOUNTING ASSEMBLY

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10 Claims. (Cl. 250—27.5)

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This invention relates to high power electronic discharge devices and more particularly to filament mounting assemblies therefor.

In electronic discharge devices of the external anode type having a grid and filament linearly and coaxially related to the inner surface of the anode the operating characteristics depend on the spacial relation of the electrodes. Since the filament usually employed in such devices is formed of wire folded into a desired configuration to meet certain voltage and current requirements, it is essential for the attainment of constant operating characteristics that the filament be uniformly spaced with respect to the other cooperating electrodes.

Considerable difficulty has been experienced due to distortion of the filament strands occasioned by high thermal operating conditions which result in breakage when the filament is placed under strain and "bowing" or changing its space relation to the other electrodes. These conditions considerably reduce the stability or curtail the useful life of the device.

An object of this invention is to increase the efficiency in operation of high power discharge devices.

Another object of the invention is to eliminate torsional strains on the filament strands in the mounting assembly.

A further object of the invention is to reduce the bowing tendency of the filament during high temperature operation, thereby to stabilize the characteristics of the device.

Another object of the invention is to permit the filament to assume a natural position free from distortion either in the cold or plastic state after assembly in the device.

A further object of the invention is to maintain axial linearity of the filament assembly so that the operating characteristics are constant.

These objects are attained, in accordance with this invention, by the provision of a rugged mounting structure which imposes no torsional or axial stresses on the delicate filament strands so that the filament is allowed to assume a normal and unstrained position in relation to the other cooperating electrodes. This is accomplished by attaching the ends of a folded filament to conductors in the stem, coupling the sections of the filament to a central standard and mounting the standard in a frictionless guiding sleeve member associated with the stem. This construction permits the filament strands to expand and contract uniformly and during expansion compensates for residual elongation by the weight of the standard whereby bowing or lateral displacement and curvature are prevented while the filament is in an incandescent state. Furthermore, as the filament cools when the heating current is discontinued, the filament returns to its original length normally and without contractile stresses being imposed by the supporting assembly.

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A feature of the invention relates to the mounting of the filament supporting standard in the assembly of the device. This involves a tubular socket member axially secured to a central post in the stem and provided with internal spaced concentric jewel bearings in which the standard is reciprocally and rotatably movable within the limits of the positions of the filament strands as the filament normally expands and contracts during operation of the device.

Another feature of the invention relates to the yieldable coupling of the filament and standard with the stem whereby the total weight of the standard is impressed on the filament strands during their plastic deformation stage, to prevent the strands assuming curvilinear or catenary form with respect to the adjacent electrode surfaces which would result in variation in spacial relation of the electrodes.

A further feature of the invention relates to the alignment of the bearings in the sleeve support to insure axial mounting of the filament assembly regardless of the reciprocal and rotative movements of the standard during transition phases of the filament in the device. This arrangement involves a pair of synthetic jewel bearings mounted concentrically in opposite ends of the supporting sleeve with an inner tubular spacer engaging both bearings and a metallic eyelet on the outer end of the sleeve to lock the bearing assembly in position. The standard in the device is in a depending position with respect to the supporting sleeve during operation so that the standard can ride freely within the sleeve in an axial direction and thereby maintain sufficient gravitational pressure on the plastic strands to prevent bulging or bowing of the strands to change the spacial relation of the filament with respect to the adjacent electrodes of the device.

These and other features and advantages of the invention will be more clearly understood from the following detailed description when considered in connection with the accompanying drawings in which:

Fig. 1 is an elevational view in section of one form of an electron discharge device embodying a filament supporting assembly illustrative of this invention;

Fig. 2 shows part of the structure of Fig. 1 in an enlarged cross-section view with the filament guiding assembly shown in greater detail;

Fig. 3 is a perspective view of the filament assembly shown in Fig. 1 illustrating the mounting support of the filament and the associated guiding support in aligned relation.

Fig. 4 is a plan view along the section 4—4 of Fig. 1 showing the detail assembly of the components in conjoint relation;

Fig. 5 is a plan view of the shield structure taken on the line 5—5 of Fig. 1; and

Fig. 6 is an enlarged detail view in section of the coupling joint between the guide sleeve and post in the stem of the device.

This invention is particularly applicable to electron discharge devices of the high power type, such as disclosed and claimed in United States Patent 2,173,679 issued September 19, 1939 to J. E. Clark and V. L. Ronci. The improvements pertain specifically to the mounting assembly to the filament structure in order to overcome difficulties due to bowing or bulging of the multiple sections of the filament during high temperature operation. The alteration in position of the central filament with respect to the other cooperating surrounding electrodes of the device results in unstable operating characteristics, due to variation in spacing, shorting contact with the control electrode and breakage of the fragile refractory filament by torsional stresses imposed on the filament when it cools after sustained operating periods.

Referring to Fig. 1, a preferred embodiment of the invention is shown in an external anode triode having a tubular anode section **10**, of copper, hermetically sealed to a borosilicate glass vessel section **11** terminated by an internal hollow portion **12** joined to concentric and coaxial sleeve extensions **13** and **14** which project toward the anode section of the vessel. A pressed or molded glass stem **15** is fused to the inner end of the sleeve **13** and is provided with the central portion **16** projecting inwardly along the axis of the enclosing vessel and a pair of outwardly extending terminal projections **17**, only one of which is shown in Fig. 1. An exhaust tubulation **18** is also provided in the stem and terminates in a sealed tip **19** adjacent the outer end of the portion **12** at the center thereof. The terminal projections are sealed to copper cup terminals **20** which support internal rigid lead-in conductors **21** and external flexible metal braided conductors **22**. The latter are attached to a pair of contact pins **23** on the metallic base **24** cemented to the end of the glass section with a central recessed cap of the base protecting the sealing tip **19**.

A flanged metallic ring **26**, of Kovar alloy, is sealed coaxially to the inner end of the sleeve portion **14** and provided with apertures to receive rigid posts **27** which are fixed to the ring by lock nuts. These posts extend within the upper end of the anode portion **10** and are bent inwardly and secured to a metallic collar **28**, for example by rivets. A corresponding set of parallel rods or heavy wire supports **29** are also secured to the collar **28** in spaced relation between the rods **27** and extend into the anode in uniform space relation to the anode surface. A continuous helical wire grid or control electrode **30**, preferably of molybdenum wire, surrounds the grid rods **29** so that the helix is coaxial with the anode. A shielding cap **31** terminates the grid structure to strengthen the assembly and forms a baffle adjacent the closed end of the anode. The grid is connected

to an external circuit by a strap **32** joined to a transverse lead **33** attached to a cup terminal **34** sealed to the side of the glass section **11** of the vessel.

A tungsten or thoriated tungsten wire **35**, for example of .045 inch or .050 inch diameter, is preformed into a double hairpin configuration, to provide a multisection or multistrand electron source extending along the length of the grid and anode and mounted within these elements. Since the material of the filament is extremely brittle in a cold state and quite plastic in an incandescent state, it is necessary to control and protect the delicate filament after complete manufacture of the device so that long life and stable operation are attained.

When the filament is substantially rigidly mounted in the device, many difficulties are encountered during manufacture and use in operation due to contact or shorting on the grid which closely surrounds the filament assembly, or hot spots on the anode occasioned by a shift in operating characteristics which tend to cause boiling of the cooling fluid at a low dissipation rate, or bowing of one or more of the strands toward the grid during high temperature operation, or sticking or fusing of the filament to the supporting joints of the assembly which results in a tendency to bend the central support when the filament cools after use. Furthermore, experience has shown that changes in composition of raw materials, in finished parts and different assembly techniques have increased shrinkage loss of assembled devices during exhaust and final testing at a high rate.

The preformed filament **35** is supported at the folds or bights in the same manner, as disclosed in the patent hereinbefore mentioned, by a double closed hook or loop assembly **36** at the lower end, a single intermediate hook **37** at the medial junction of the filament to the supporting structure and the free ends are coupled to the rigid lead-in conductors **21** by socket rods **38**. The hook assembly **36** is affixed to the lower end of a central standard or main axial support rod **39**, preferably of tungsten. The intermediate insulatingly supported hook **37** is attached to the coupling rods **38** and a heat shield or deflector **40** having slotted portions, as shown in Fig. 4, to clear the socket coupling rods **38** is attached to the standard, the shield being transversely in line with the upper edge of the collar. Since the standard is movable with respect to the filament the attachment of the hook **37** to the rods **38** provides a positive position of the upper bight of the filament to the mounting so that relative movement between the filament and hook during the heating cycle is prevented.

Former failures originate primarily in the "galling" or fusing of the filament bights to the upper hook and lower loop supports of the filament as a result of temperature and pressure conditions at the friction points of the filament and support in the structure. This difficulty may be explained by following the motion of the filament during the heating and cooling cycles of the device in operation. When the filament is first heated, the two lower bights must move downward in the loops and conversely, upward when the filament cools. This motion is relatively rapid, coming to equilibrium in a few moments. A slower motion takes place at the upper hook as the filament leads and standard are heated by conduction and convection. The latter action tends to impart a rocking or rotary motion to the filament structure, The upper hook 37 is designed and so positioned and supported that the filament rests with the bight seated in the bend of the hook in both hot and cold equilibrium positions. During the interim periods, the filament rides with respect to the hook.

The "galling" or sticking action occurs when the filament is fused or contact-welded to the hooks at some points due to a combination of forces caused by friction between two metallic parts, high temperature and low pressure environment which result in distortion and permanent bowing of the filament when cold and consequent shorting with the grid helix which surrounds the filament structure. If sticking occurs while the filament is hot and in an expanded condition, the standard or central support rod will sometimes be displaced laterally by the contraction forces during cooling. If in the contracted condition, the filament will bow or assume a curved or catenary form. In either case grid to filament contact or shorting will be the ultimate result.

As shown in Fig. 2, the connection of the standard on the stem is such as to permit longitudinal and rotative movement of the standard comparable to the movement of the filament to compensate for the forces imposed on the filament during operational cycles. In this arrangement, a central post 41, preferably of tungsten, is sealed in the projection 16 on the stem and forms a rigid anchor axially fixed on the coaxial glass section of the vessel of the device. This post supports a guiding sleeve or elongated tubular socket 42 which is provided with a short extension 43 surrounding the post, a shoulder 44 and an axial bore of uniform diameter terminating in a cylindrical recess 45 of smaller diameter. The stem heat shield 46 is spot welded to the shoulder 44, as shown in Fig. 5, and provided with clearance apertures to permit the passage of the grid rods 27 and the filament leads 21 therethrough, the shield protecting the seals within the stem from the high heating energy generated in the device within the anode section.

A synthetic sapphire jewel bearing or bushing ring 47 is seated within the sleeve adjacent the shoulder formed by the recess 45 and a similar aligned bearing 48 is mounted in the outer end of the sleeve. These bearings are maintained in spaced and concentric relation by a tubular metallic spacer insert 49, of nickel, and the bearing assembly is locked in the sleeve by an annular cap or eyelet 50 which projects from the open end of the sleeve, the eyelet being held to the sleeve by spinning the lip over the flanged portion in contact with the bearing 48. The extension 43 of the guiding socket is welded to the post 41 by forming a side slot 51 therein, as shown in Fig. 6, and inserting a piece of welding material 52 in the slot so that when brazed the welding metal flows into intimate contact with the post 41 to form an external joint 53, as shown in Fig. 2. In addition, a transverse drill hole 54 extends through the wall of the sleeve adjacent the recess 45 to permit evacuation of the cavity within the guiding socket of the assembly and to aid in the spacing and assembly of the various elements. For example, the end of the standard 39 may be spaced from the end of the socket cavity 45 by inserting a piece of drill rod into the hole 47 to gauge the position of the standard in the socket. Since the jewel bearings are coaxially aligned in the guiding sleeve and the internal diameter of the bearings is slightly larger than the diameter of the tungsten standard 39 which extends into the sleeve, the standard will have free movement in the sleeve both axially in and rotatably due to the frictionless contact of the standard in the guiding socket. Therefore, the standard while maintaining axial support of the filament assembly is permitted to assume any position relative to the filament so that distortion and bowing are prevented. In the relations presented by the filament bights, hooks and standard, the lower bights will always rest in the upper ends of the loops of the hook assembly 36 due to the weight of the standard imposed on the filament and the standard will follow the motion of the filament as it expands and contracts, the sliding and rotative movements taking place between the bearings and the standard. Thus, even if galling of the filament to the hooks occurs there is no tendency to bend or bow the filament or impose stresses on the standard so that shorting and variation in spacing of the filament with respect to the grid are eliminated and the operating characteristics of the device are held uniform and constant throughout a greatly increased operating life of the device.

While the invention has been disclosed in a particular embodiment, it is of course understood, that various modifications may be made in the detailed assembly and association of parts 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 at one end, a hollow electrode extending coaxially with respect to said stem, an axial standard projecting within said electrode, a filamentary electrode supported by said standard and stem, and means between said standard and stem and engaging said standard whereby gravity is the sole force exerted on said filament to tension the strands.

2. An electron discharge device comprising an enclosing vessel having a stem at one end, a hollow electrode extending coaxially with respect to said stem, a multistrand filament within said electrode, a sleeve member fixed to said stem, and a central standard supporting said filament and slidably movable within said sleeve to apply gravity tension to said filament.

3. An electron discharge device comprising an enclosing vessel having a stem at one end, a hollow electrode extending coaxially with respect to said stem, a multistrand filament concentric with said electrode, an axial standard extending through said stem, said filament being connected between said stem and one end of said standard, and a tubular member on said stem enclosing a portion of said standard, said standard being reciprocally and rotatably movable in said tubular member to apply gravity weight to said filament for tensioning the same.

4. An electron discharge device comprising an enclosing vessel having a stem at one end, a hollow electrode extending coaxially with respect to said stem, a multistrand filament concentric with said electrode, an axial standard extending from said stem, said filament being connected between said stem and the end of said standard remote therefrom, a metallic sleeve projecting from said stem, spaced ring bearings within said sleeve, said standard being embraced by said bearings to maintain axiality of said standard, and means associated with said sleeve for securing said bearings therein.

5. An electron discharge device comprising a stem and a filament assembly including a rigid support projecting from said stem, a tubular socket attached to said support, a pair of spaced frictionless bearing members secured in said socket in linear relation, a loose standard in said socket and engaging said bearing members and a filamentary element carried by said standard and attached to said stem.

6. An electron discharge device comprising an enclosing vessel having a stem at one end, a hollow electrode extending coaxially with respect to said stem, a multistrand filament concentric with said electrode, an axial standard extending from said stem, said filament being connected between said stem and the end of said standard remote therefrom, a metallic sleeve projecting from said stem, synthetic sapphire annular bearings fitted within said sleeve, a tubular spacer between said bearings, and an annular cap on the end of said sleeve securing said bearings and spacer therein, said standard extending into said sleeve and being positioned by said bearings.

7. An electron discharge device comprising a vessel having a metallic portion serving as an anode and having also a stem portion, a support rod sealed in said stem portion, a multistrand coaxially mounted within said metallic portion, a central standard connected to said filament adjacent the end within said metallic portion, the free ends of said filament being joined to said stem, a rigid guiding sleeve member attached to said rod, and a disc shield on said sleeve member, said standard extending into said sleeve member for unbiased reciprocal axial movement with respect to said filament.

8. An electron discharge device comprising an enclosing vessel having a stem, and a filament assembly within said vessel including a rigid support projecting from said stem, a tubular socket attached to said support, a loose standard seated in said socket, and a filamentary element carried by said standard and attached to said stem.

9. An electron discharge device comprising a vessel having a metallic portion serving as an anode and having also a stem portion, a support rod sealed in said stem portion, a multistrand filament coaxially mounted within said metallic portion, a central standard connected to said filament adjacent the end within said metallic portion, the free ends of said filament being joined to said stem, and a rigid guiding sleeve member surrounding said rod having a notch for welding said rod to said sleeve and a flush brazed joint between the inner end of said sleeve and said rod for securely fastening said sleeve to said rod, said standard extending into said sleeve member for unbiased axial movement with respect to said filament.

10. An electron discharge device comprising a vessel having a metallic portion serving as an anode and having also a stem portion, a support rod sealed in said stem portion, a multistrand filament coaxially mounted within said metallic portion, a central standard connected to said filament adjacent the end within said metallic portion, the free ends of said filament being joined to said stem, a rigid metallic socket attached to said rod, a pair of aligned jewel bearing rings within said socket, a metallic sleeve spacer in contact with said bearings at opposite ends, and an apertured cap member connected to the open end of said socket to hold said bearings. and spacer in position therein, said standard loosely depending from said socket to impose the weight of said standard on said filament for tensioning purposes.

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