

April 19, 1938.

J. E. CLARK ET AL
ELECTRON DISCHARGE DEVICE

2,114,439

Filed July 3, 1936

3 Sheets-Sheet 1

FIG. 1

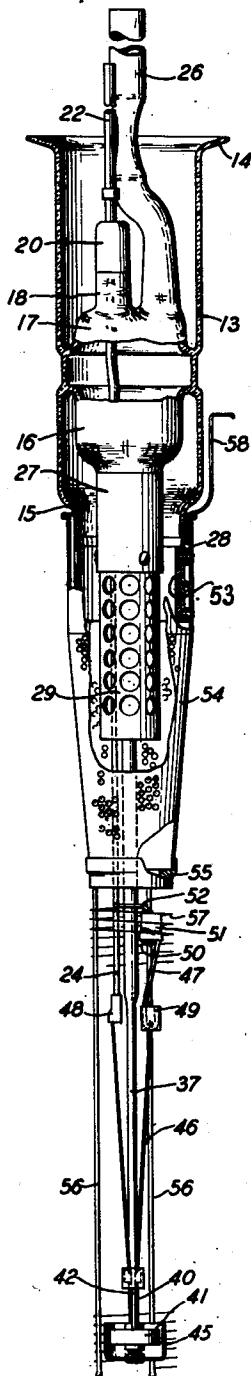


FIG. 2

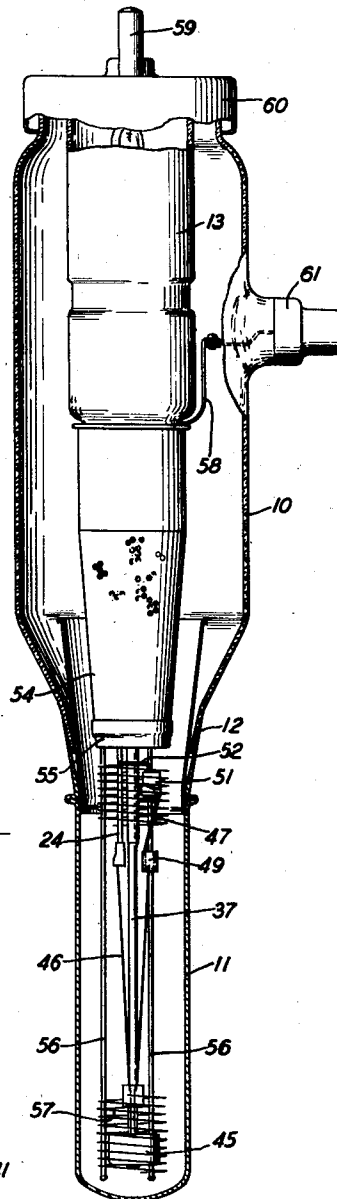


FIG. 7

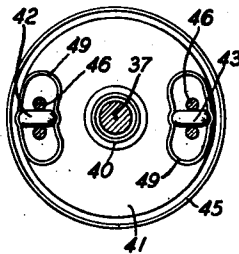
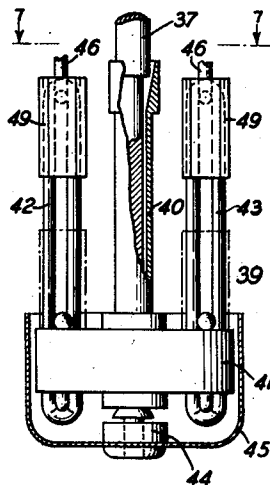


FIG. 6



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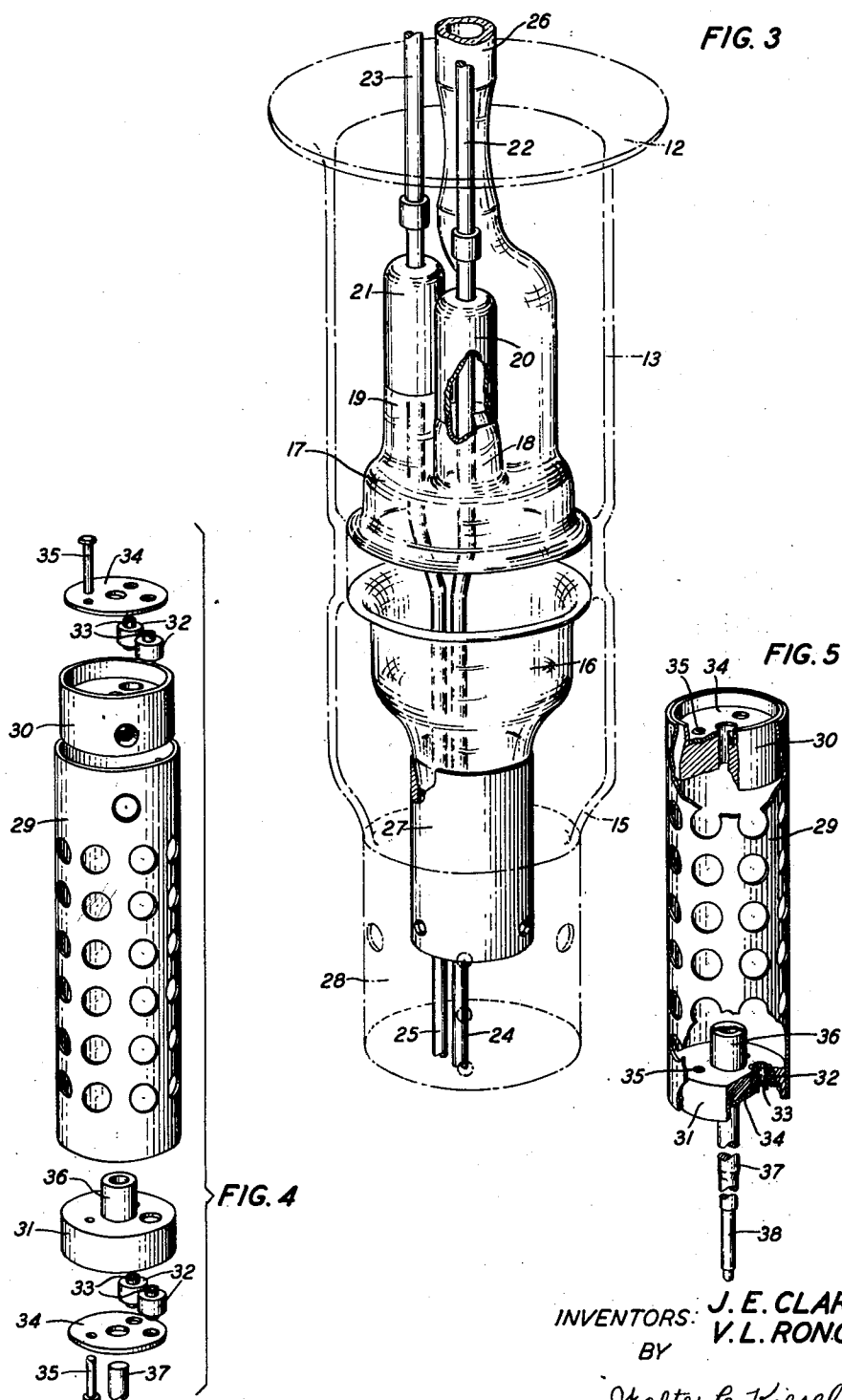
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3 Sheets-Sheet 3

FIG. 8

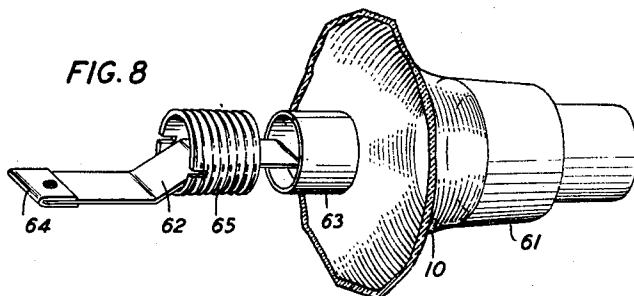


FIG. 9

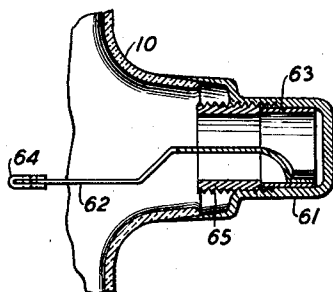
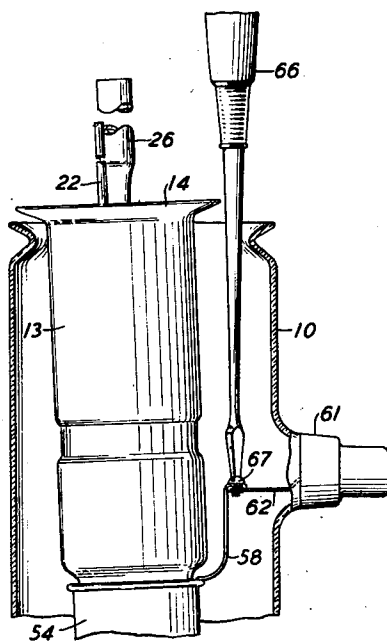


FIG. 10



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2,114,439

ELECTRON DISCHARGE DEVICE

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Application July 3, 1936, Serial No. 88,755

20 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices and more particularly to such devices capable of handling a large amount of power.

In high power devices, the relatively heavy filamentary cathode or thermal electron emitter is liable to be distorted by repeated expansion and contraction during the operating life of the device. Furthermore, the differences in expansion of the various components of the cathode structure cause stresses, either in the supporting assembly or the glass portion of the device to which the structure is fixed, to occur which endanger the useful life of the device and cause it to be removed from service long prior to the probable decay period of the cathode.

An object of this invention is to increase the operating life of filamentary cathodes in high power discharge devices.

Another object of the invention is to attain high efficiency in the manufacturing technique of high power devices in order to reduce their cost.

In accordance with one aspect of this invention as applied to a water cooled type device having an external anode, a glass portion is sealed thereto to insulate the inner electrodes from the anode. The glass portion is provided with a reentrant cylindrical stem having two oppositely disposed pre-cast glass stems peripherally joined to the inner wall of the cylindrical stem and conjointly forming a mount on which the cathode assembly and the grid structure are supported in uniform space relation to the inner surface of the anode.

A feature of the invention relates to a cathode assembly in which stresses which may deform or fracture the filamentary strands of the cathode are eliminated or materially lessened so that the operating life of the device is substantially prolonged. The cathode assembly comprises a structure in which rigid conductors are sealed in the stem and are slidably movable through a guiding casing which also supports a central standard. A gravity hanger member is supported by the standard and is provided with guiding loops engaging a formed filament which is also attached to the rigid conductors.

This arrangement insures a uniform relationship between the cathode and the other electrodes of the device and decreases the tendency of the cathode to buckle or break due to excessive stresses endangering the filament. During the initial heating of the cathode to operating temperature, the hanger member imparts a definite suspended weight to the filament to pull it during elongation but when the filament has reached its

normal operating temperature, in which state the filament is quite plastic, the weight of the hanger member does not affect the filament but the guiding loops permit the bights of the filament to creep along the restraining side portions of the loops so that the cathode is in a semi-floating condition. The hanger member also automatically applies a definite mass to the filament when the heating current is disconnected to preserve the symmetry of the strands during a certain temperature range of the cooling period.

Another feature of the invention relates to the fabrication of the glass stem principally with the aid of glass working machinery so that the production may be expedited at low cost and with a minimum of skilled labor. This is accomplished by forming a unit including molded elements comprising a cylindrical stem, an apertured dish-type stem, and a chimney-type stem. The dish-type and the chimney-type stems are arranged coaxially in the interior of the cylindrical stem, spaced with their larger diameter portions in close parallel relation, and fused to the inner wall of the cylindrical stem to form a compound glass stem having true alignment, adequate strength and low manufacturing cost. Furthermore, the internal stems facilitate the mounting of the cathode assembly and center the cathode with respect to the grid structure supported by the cylindrical stem.

A further feature of the invention relates to the coupling of the grid structure to a terminal provided on the enclosing vessel of the device without contaminating the internal structure by high heat and oxidation. This is accomplished by forming a terminal seal on the external glass portion of the device prior to inserting the internal electrode mount in the device. The grid is connected to the terminal by offsetting the unit in the vessel sufficiently to couple the extension of the grid to the terminal. The mount is then fused to the reduced end of the glass portion of the device to complete the assembly.

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

Fig. 1 shows in elevation an electrode mount embodying features of this invention with portions of the elements broken away to show various details of construction;

Fig. 2 illustrates in elevation the complete discharge device according to this invention, partly in cross-section to show the relationship of the electrodes;

Fig. 3 is an enlarged perspective view of the compound stem of this invention with portions shown in outline to more clearly depict the various elements of the assembly;

5 Fig. 4 is an enlarged perspective view, in exploded relation, of the elements entering into the assembly of the shield casing and guide of the cathode unit;

10 Fig. 5 is a perspective view of the assembled casing with portions broken away and the end closures shown in cross-section;

Fig. 6 is an enlarged view in elevation of the hanger for the cathode unit with portions shown in cross-section to distinguish the elements of the assembly;

15 Fig. 7 is a plan view of the hanger shown in Fig. 6;

Fig. 8 is a perspective view of the elemental parts of the grid terminal provided on the exterior of the glass portion of the device;

20 Fig. 9 is a cross-sectional view of the same parts as shown in Fig. 8 but arranged in their normal fixed positions; and

Fig. 10 illustrates a method of coupling the electrode unit to the external terminal prior to completing the fabrication of the device.

Referring to the drawings, the electron discharge device of this invention comprises an enclosing vessel having a glass portion 10, and a metallic cup-shaped portion 11 serving as the anode of the discharge device, which are hermetically sealed at 12 in accordance with the method disclosed in United States Patent 1,294,466 issued February 18, 1919, to W. G. Houskeeper. During the operation of the device the cup-shaped anode 11 is supported in a cooling jacket (not shown) in the position shown in Fig. 2. In this position the internal electrodes are suspended inside the anode and insulated therefrom by the glass portion of the device. The internal electrodes are formed as a unitary mount, shown in Fig. 1, which is developed from a compound vitreous stem 13 of cylindrical form having a flared portion 14 at one end and a reduced neck portion 15 at the other end. A precast or molded chimney-type stem 16 is coaxially positioned within the cylindrical stem 13 while a molded dish-type stem 17 is uniformly spaced from the stem 16 and is arranged in opposed relation so that the flared ends of both stems are close to the inner wall of the cylindrical stem 13 while their ends extend toward the adjacent ends of the cylindrical stem. The two inner stems are simultaneously fused to the inner wall of the cylindrical stem by glass working machinery so that the difficulties of blowing and forming the individual stems are eliminated, losses by waste are avoided, production can be controlled and the manufacturing cost considerably reduced.

Prior to inserting the dish-type stem 17 in the cylindrical stem the short tubulations 18 and 19 are closed by metallic cap seals 20 and 21 in the same manner as the seal produced between the anode and the vitreous portion of the enclosing vessel, the cap seals being provided with external leading-in conductors 22 and 23 and long internal rigid conductors 24 and 25. The internal conductors extend through the chimney-type stem 16 and terminate within the anode 11, as shown in Fig. 2. The dish-type stem is also provided with an exhaust tubulation 26 to facilitate the evacuation of the complete device. The compound stem is also provided with coaxial metallic collars 27 and 28, the smaller diameter collar be-

ing sealed to the reduced end of the chimney-type stem 16 while the larger diameter collar is sealed to the reduced end 15 of the cylindrical stem 13.

Since the conductors 24 and 25 are relatively long, it is essential to maintain them in proper alignment and still keep the aligning structure a sufficient distance from the high temperature area of the anode to prevent breakdown in the device caused by loss of insulation resistance between the conductors. This is accomplished in accordance with this invention by providing a tubular shield or casing 29, formed of perforated metal with metallic closure members 30 and 31 secured in opposite ends thereof. These closure members are formed of recessed discs and are provided with counter sunk apertures to receive a pair of insulating bushings 32 which are held in place by a plate 34 secured to the disc by an escutcheon pin 35. The bushing is provided with a molybdenum sleeve bearing 33 to reduce friction on the conductors 24 and 25 and protect the joint of the collar 27 and the stem 16. The metallic disc 30 is provided with a central aperture to permit the passage of air and gases into the stem leading to the evacuation tubulation 26 while the disc 31 is provided with a central aperture and an extension sleeve 36 to support a central standard 37 which extends almost to the end of the cup-shaped anode 11. The tubular shield 29 and the closure members 30 and 31 render sufficient support to the conductors 24 and 25 which extend through the insulating bushings 32 and permit the conductors to slide freely through the bushings when they expand in a longitudinal direction due to changes in temperature. The perforated shield or casing 29 is rigidly fastened to the inner collar 27 so that the standard 37 is axially arranged with respect to the stem and the conductors 24 and 25 are maintained in parallel spaced relation with respect to the standard. The advantages of perforating the casing 29 are to reduce its weight, to reduce the temperature of the enclosed conductors 24 and 25 and to reduce conduction of heat to the seal between the collar 27 and the stem 16.

The standard 37 is provided with a reduced end section 38 for supporting a hanger member or gravity weight 39. This weight is formed of a sleeve 40 which slides on the reduced section 38 of the standard, a highly refractory insulating disc 41 and a pair of closed loop hooks 42 and 43 which extend from the disc 41 in parallel relation to the sleeve 40. The closed hooks are secured to the insulating disc 41 by headed tie wires which extend through the disc and are secured at the opposite ends to the knee portion of the loop hooks by welding the junctions. A stop member 44 is rigidly fastened to the end of the standard 37 and a cap shield 45 is fastened to the standard and encloses the insulating disc 41 of the hanger member. It will be noted from Fig. 6 that there is a clearance between the stop member 44 and the adjacent end of the slidable sleeve 40. This arrangement forms a particular feature of this invention and the function thereof will be explained hereinafter in connection with the operating action of a filamentary cathode 46.

The filamentary cathode 46 is a folded strand of refractory metal, such as tungsten, which serves as the electron emitter when heated to operating temperature. The filament is bent to a zig-zag form with parallel elbow portions engaging the closed hooks 42 and 43, another elbow

portion adjacent the ends of the filament engaging a hook 47 and the terminations of the filament connected to the leading-in conductors 24 and 25 by strap clamps 48 which are welded to the filament and to the conductors. These clamps are provided with enlarged ends which serve as heat shields around the contact ends of the filament, to retain the heat and overcome the normal cooling effect of the ends of the filament. Furthermore, they prevent discharge to the ends of the filament which might cause pitting of the filament and consequent failure. The bights or elbow portions of the filament located in the hooks 42 and 43 are also surrounded by oval-shaped heat shields 49, to overcome the cooling effect of the filament in contact with the hooks. The filament is threaded through the hooks by introducing the ends into the closed hooks 42 and 43 while the shields are positioned adjacent the insulator 41, as shown in dotted line in Fig. 6. When the bights of the filament reach the knees of the hooks 42 and 43, the folded filament is swung in an arc to adjust the remaining bight of the filament in contact with the hook 47 and seated therein while the oval shield 49 is slid down on the hook. The ends of the filament are attached to the leading-in conductors by the clamps 48 and the shields 49 are then adjusted in position and welded to the hooks. The hook 47 is arranged with its bent end approximately in the same transverse plane as the ends of the leading-in conductors 24 and 25 and this hook is seated in an insulating block 50 having a metallic casing 51. The hook assembly is strapped to the leading-in conductors 24 and 25 by a pair of bent bridging wires 52. This arrangement prevents loss of heat energy in the portion of the filament supported by the hook 47 and prevents twisting action of the assembly since the hook is not connected to any large mass of metal which might render the specified portion of the filament cooler than the remaining portions. The cap shield 45 and the casing 51 prevent vaporization of the insulators by flash arcs to protruding metallic parts in the insulators.

The primary cathode elements, namely the filament and the leading-in conductors, extend the entire length of the device and since these elements are supplied with heating current of high amperage it is evident that sufficient longitudinal play is necessary in the structure to compensate for differences in expansion of the elements. In accordance with this invention, the cathode elements are unrestrained in a longitudinal direction so that elongation and contraction takes place without setting up stresses which might deform the fragile filament or endanger the hermetic seals of the conductors. The elongation of the rigid conductors is permitted by the slidable guiding action provided by the insulating bushings 32 in the guiding discs 30 and 31 mounted in the perforated shield 29. The elongation of the filament, caused by the incandescent state of the filament during operation, is compensated by the gravity hanger member which is suspended from the filament and slides on the standard 37.

In certain types of high power discharge devices, for instance, those having a capacity of 10 kilowatts, the small diameter of the filament and the inherent characteristics of tungsten contribute to the destruction of the filament if undue strains or stresses are imposed on the filament. Other deficiencies are inherent in the tungsten filament due to the changing character of the

filament under heating conditions. For instance, fracture of the filament occurs when abnormal bending stresses act on the strand in a cold state. On the other hand, when the filament is in an incandescent state, such as produced when heated to a high temperature, the filament is quite plastic and is liable to be fractured by an undue pulling force. Similarly, when the filament is in an incandescent state and a pressure force is applied to the filament, it will probably be deformed and upon cooling may be fractured due to the rigidity of the filament.

These disadvantages are overcome in accordance with this invention by providing a gravity hanger member which is suspended by the filament and imposes a definite weight on the filament during a transient period while the filament is being heated up to its normal operating temperature. During this period the filament is elongated to a certain extent due to expansion and the weight applies a certain tension to the filament to maintain it in uniform spacial relation with respect to the anode. However, the weight or hanger will strike the stop member 44 at the termination of this interval, since the spacing between the ends of the sleeve 40 and the stop member is approximately .020 inch. The contact of the hanger member with the stop member automatically relieves the filament of the weight of the hanger and, consequently, when the filament is in an incandescent or plastic state, the hanger does not apply any stress to the filament to cause fracture or deformation. However, the filament is maintained in proper spacial relation due to the fact that the bends of the filament engaging the closed hooks 42 and 43 creep along the hooks in the guiding slot provided by the parallel arms of the hooks. When the heating current is disconnected, the gravity member is automatically suspended by the filament when it reaches a low temperature prior to the cold state. If the filament sticks in the closed hooks 42 and 43 due to the high temperature of the filament at these points, distortion of the filament is overcome by the riding effect of the gravity weight 39 during contraction. When the filament cools, the hooks free themselves and the gravity weight drops to its normal position. However, if the freeing action does not occur the subsequent heating cycle will release the hooks at the operating temperature. The arrangement of this invention prevents deformation of the filament or fracture thereof due to stresses in the mounting assembly. The sliding weight 39 also prevents a condition where the filament is compelled to push down along the sides of the hooks when it is initially heated. The gap between the weight and the stop member 44 should be of sufficient length to provide the minimum sliding friction between the filament and the hooks. Furthermore, the sections of the filament are held in uniform relation due to the spacing of the leading-in conductors and the standard by the shield casing which incidentally also protects the metal-to-glass seal from the excessive heat generated in the device. The insulation resistance between the leading-in conductors is materially preserved by the mounting of this invention, since the insulating bushings in the spacing discs are mounted in a relatively cool portion of the tube and are not close to the high temperature zone within the anode.

The mount, shown in Fig. 1, also embodies the grid structure as one of the units and this assembly will now be described. The neck portion 15

of the cylindrical stem 13 has a metallic collar 28 sealed to the edge thereof in the same manner as the collar 27. This collar supports a tapered shield 54 which is perforated to reduce the heat retaining characteristic of the metal and the shield encloses the tubular shield 29 of the cathode assembly, a portion of the standard 37 and the leading-in conductors 24 and 25. The shield is attached to the collar by screws and a backing plate 53. A flanged metallic ring 55 is supported on the small diameter end of the shield 54 and a plurality of parallel rods 56 are spaced around the ring and form a boundary around the filament structure. These rods support a helical grid of spirally wound wire 57 which forms the control electrode of the device and is coaxially positioned with respect to the anode 11, as shown in Fig. 2. The tapered shield which is in conductive relation to the helical grid is provided with a flexible extension 58 which extends along the cylindrical stem 13.

In the operation of a high power discharge device of the water-cooled type the efficiency of the device is increased when the insulation resistance or the insulating paths are relatively long between the low voltage terminals, such as the cathode and the grid, and the high voltage applied to the anode. In accordance with this invention the terminals of the cathode, such as 59 are mounted on a metallic base 60, one of the terminals being insulated from the base in a well-known manner. The grid terminal is also segregated from the anode and the cathode terminals and, as shown in Fig. 2, comprises a cap member 61 which is sealed to the side wall of the vessel 10. This arrangement of the grid terminal presents a manufacturing difficulty in that the internal elements of the electrode mount may be considerably oxidized if the terminal is sealed to the vessel while the mount is in normal position. This difficulty is overcome in accordance with this invention by sealing the cap terminal 61 to the vitreous portion 10 prior to the insertion of the mount in the vessel.

After the completion of the sealing of the terminal 61 to the vessel an insert is locked in the terminal and the extension 58 is mechanically connected to a member 62 leading to the terminal 61 to eliminate the use of fires or welding equipment for making the connection. As shown in Figs. 8 and 9, the terminal 61 is a hollow cap coupled to a flexible member 62 having a cylindrical enlargement 63 at one end and a threaded thickness of metal 64 at the other end. The member 62 is inserted in the cap terminal 61 with the enlargement 63 seated in the small end of the cap and a cylindrical locking screw 65 is threaded into the internal surface of the cap 61 to secure the enlargement in rigid position in the cap.

The method of assembling the grid terminal and the electrode mount is shown in Fig. 10 and comprises inserting the mount in the open end of the vitreous portion 10 to adjust the grid extension 58 with respect to the thickened portion 64 of the flexible member 62 and then offsetting the mount with respect to the axis of the vessel 10 either parallel or at an angle to the axis, to permit the insertion of a screw driver 66 into the space between the stem 13 and the wall of the vitreous portion 10 of the device. A screw 67 is threaded through the thickened portion 64 of the lead 62 to lock the bent end of the extension 58 to the member 62 and thereby rigidly couple the grid to the external terminal 61 on the vessel. The mount is centered in the vessel and the flare

14 is sealed or fused to the reduced end of the vessel 10 to complete the assembly after which the device is evacuated in a well-known manner and the tubulation 26 sealed off.

While the various features of the invention have been described in a specific embodiment as shown, it is of course understood that various modifications may be made in the details of construction without departing from the spirit and the scope of the invention. Furthermore, while all of the features have been disclosed in a single embodiment it is to be understood that the invention is not limited to such a combination, since under certain conditions the operating characteristics of the device may be sufficiently improved by employing one or more of the various features and, therefore, the invention is only to be limited within the scope of the appended claims.

What is claimed is:

1. A cathode mount for an external anode type discharge device comprising a stem, leading-in conductors sealed in said stem, a standard extending beyond said conductors, a filamentary cathode connected to said conductors, and means on said standard engaging said cathode for applying a gravity force thereto, only during a limited temperature range.

2. A cathode mount for an external anode type discharge device comprising a stem, leading-in conductors sealed in said stem, a standard extending beyond said conductors, a filamentary cathode connected to said conductors, a weight carried by said standard to apply a pull to said cathode during a transient period, and stop means for suspending the effect of said weight on said cathode during normal operation.

3. A cathode mount for an external anode type discharge device comprising a stem, leading-in conductors sealed in said stem, a standard extending beyond said conductors and supported by said stem, an insulating member carried by said standard adjacent the free end thereof, a pair of closed loop members extending from said insulating member toward said stem, a preformed filamentary cathode supported by said loop members and said conductors, and means slidably supporting said conductors intermediate said stem and said cathode.

4. A cathode mount for an external anode type discharge device comprising a stem, leading-in conductors sealed in said stem, a standard extending beyond said conductors, a filamentary cathode supported by said conductors and said standard, a tubular metallic member surrounding said conductors, and a pair of guiding members for said conductors mounted in the opposite end of said tubular metallic member.

5. A cathode mount for an external anode type discharge device comprising a stem, leading-in conductors sealed in said stem, a standard extending beyond said conductors, a filamentary cathode connected to said conductors, a weight carried by said standard to apply a pull to said cathode during a transient period, means for suspending the effect of said weight on said cathode during normal operation, and means carried by said weight for guiding said cathode during creepage after the gravity pull is released on said cathode.

6. A cathode mount for an external anode type discharge device comprising a stem, leading-in conductors sealed in said stem, a standard extending beyond said conductors, a filamentary cathode connected to said conductors, a movable gravity weight carried by said standard to apply

a pull to said cathode during a transient period, means for suspending the effect of said weight on said cathode during normal operation, and a shield carried by said standard surrounding said gravity weight.

7. An electron discharge device comprising an enclosing vessel having a metallic portion serving as an anode and a glass portion sealed thereto, a reentrant stem sealed to said glass portion, a molded dish stem fused to the inner wall of said reentrant stem, metallic terminals sealed to said dish stem and extending outwardly toward the open end of said glass portion, a preformed filamentary cathode, means for supporting said cathode at one end, rigid conductors connected to said cathode and also to said terminals, and an elongated tubular casing supported by said reentrant stem for guiding said conductors intermediate said cathode and said terminals.

8. An electron discharge device comprising an enclosing vessel having a metallic portion serving as an anode and a glass portion sealed thereto, a reentrant stem sealed to said glass portion, a molded dish stem fused to the inner wall of said reentrant stem, metallic terminals sealed to said dish stem and extending outwardly toward the open end of said glass portion, a preformed filamentary cathode, means for supporting said cathode at one end, rigid conductors connected to said cathode and also to said terminals, and a shield coaxially supported by said reentrant stem, said shield having guiding apertures for the passage of said conductors to maintain them in parallel relation.

9. An electron discharge device comprising an enclosing vessel having a metallic portion serving as an anode and a glass portion sealed thereto, a reentrant stem sealed to said glass portion, a molded dish stem fused to the inner wall of said reentrant stem, metallic terminals sealed to said dish stem and extending outwardly toward the open end of said glass portion, a preformed filamentary cathode, means for supporting said cathode at one end, rigid conductors connected to said cathode and also to said terminals, a tubular shield surrounding said conductors, means carried by said shield for spacing said conductors, a flared stem connecting said shield to said reentrant stem, and a grid structure surrounding said cathode and being supported on said reentrant stem.

10. A mount for electrodes comprising an elongated cylindrical outer stem portion having a flare at one end, an inner reentrant stem sealed within said outer stem remote from said flare, an inverted shallow cup stem sealed within said outer stem in opposed relation to said reentrant stem, and long conductors carried by said cup stem and extending through said reentrant stem.

11. A mount for electrodes comprising an elongated cylindrical outer stem portion having a flare at one end, an inner reentrant stem sealed to said outer stem remote from said flare, an inverted cup stem sealed within said outer stem in opposed relation to said reentrant stem, a plurality of conductors carried by said cup stem and extending through said reentrant stem, a metallic collar attached to said reentrant stem, a perforated shield surrounding said conductors and supported by said collar, a standard supported by said shield, an insulating disc attached to said standard, a folded filament strung between said conductors and said disc, a helical grid surrounding said filament, and a sleeve shield supporting said grid connected to said cylindrical stem and

surrounding said conductors and said perforated shield.

12. An electron discharge device comprising an enclosing vessel having a metallic portion serving as an anode and a vitreous portion sealed thereto, a reentrant stem joined to said vitreous portion, a rigid standard supported by said stem, leading-in conductors extending through said stem, a stop member secured to the free end of said standard, a folded filamentary cathode carried by said conductors at one end, and a gravity member slidably movable on said standard adjacent said stop member, said gravity member being suspended above said stop member by said folded cathode.

13. An electron discharge device comprising an enclosing vessel having a metallic portion serving as an anode and a vitreous portion sealed thereto, a reentrant stem joined to said vitreous portion, a rigid standard supported by said stem, a pair of rigid conductors extending through said stem and arranged parallel to said standard on one side thereof, an offset insulated hook arranged on the other side of said standard, a zig-zag tungsten filament having its ends secured to said conductors and having its midpoint engaging said hook, an insulating disc supported on the free end of said standard, and a pair of closed filament hooks extending from said disc and engaging the bights of said filament.

14. An electron discharge device comprising an enclosing vessel having a metallic portion serving as an anode and a vitreous portion sealed thereto, a reentrant stem joined to said vitreous portion, a central standard supported by said stem, a pair of rigid conductors extending through said stem and arranged parallel to said standard on one side thereof, an offset insulated hook arranged on the other side of said standard, bridge wires connecting said insulating hook to said conductors, a zig-zag tungsten filament having its ends secured to said conductors and having its midpoint engaging said hook, an insulating disc supported on the free end of said standard, a pair of closed filament hooks extending from said disc and engaging the bights of said filament, and metallic shields attached to said hooks and surrounding the bent portions of said filament.

15. A discharge device comprising an elongated vessel having a stem, a cathode adjacent one end of said vessel, leading-in conductors for said cathode extending toward the other end of said vessel and emerging from sealed portions of said stem, a tubular shell supported by said stem and surrounding said conductors, guiding means carried by said shell for aligning said conductors with the sealed portions of said stem and permitting longitudinal movement thereof, and means for evacuating said vessel through said stem, guiding means and shell.

16. An electron discharge device comprising a vessel having a metallic anode portion and a vitreous portion, a stem in said vitreous portion, a cup terminal sealed to the side wall of said vitreous portion, a cathode and a grid within said anode, means for supporting said grid from said stem, a flexible extension on said grid alongside said stem, and a coupling member attached to said extension and locked in said cup terminal.

17. An external anode device having a glass portion forming part of the enclosing vessel, a stem within said glass portion, a cathode and a grid extending from said stem into the anode of the device, a conductor for said grid, a hollow terminal sealed to said glass portion at right an-

gles to said stem, a flexible conductor connected to the grid conductor, said flexible conductor having an enlargement seated in said hollow terminal, and locking means for said enlargement engaging said terminal.

18. In the manufacture of high power discharge devices having an elongated enclosing vessel and an electrode mount, said vessel having a terminal on the side wall thereof perpendicular to the axis of said vessel, and an extension on the electrode mount, the method of fabricating the assembly which comprises inserting the electrode mount in the vessel, arranging the extension adjacent the terminal on the vessel, offsetting the mount with respect to the axis of the vessel, mechanically connecting said extension to said terminal, and sealing the mount to the end of the vessel.

19. In the manufacture of high power discharge devices having an elongated enclosing vessel and an electrode mount, said vessel having a terminal on the wall of said vessel perpendicular to the axis thereof, and an extension on the electrode mount, the method of fabricating the assembly which comprises sealing a hollow terminal to the side wall of the vessel, inserting a connection with an enlargement into the terminal from within the vessel, locking the enlargement in the terminal, inserting the mount into one end of the vessel adjacent said terminal, shifting the mount to bring the electrode extension in contact with the connection of the terminal, joining the connection and extension by a mechanical coupling which is introduced and controlled through the space between the vessel and the mount, readjusting the mount with respect to the axis of the

vessel, and sealing the adjacent ends of the mount and vessel together.

20. An electron discharge device comprising an enclosing vessel having a metallic anode portion and a vitreous portion sealed thereto, a reentrant cylindrical stem joined to the end of said vitreous portion, a coaxial chimney-type stem peripherally joined to the inner wall of said cylindrical stem and extending laterally toward the free end thereof, a dish-type stem having apertures being spaced from said chimney-type stem and peripherally joined to the inner wall of said cylindrical stem, said dish stem projecting toward the sealed end of said cylindrical stem, a pair of terminals closing the apertures, rigid conductors supported by said terminals and extending into said anode, a tubular shield supported by said chimney-type stem and surrounding said conductors, disc spacing members carried by said shield and having apertures permitting free slidable movement of said conductors in a longitudinal direction, a central standard extending into said anode from one of said disc spacing members, a slidable hanger member carried by the free end of said standard, a tungsten filament extending between said conductors and said hanger member, a metallic collar secured to one end of said cylindrical stem, a tapered metallic shield supported on said collar and surrounding said conductors and tubular shield, parallel rods extending from said tapered shield, and a helical grid attached to said rods and positioned between said filament and said anode.

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