Oct. 9, 1934. V. L. RONCI ET AL 1,976,521

ELECTRON DISCHARGE DEVICE

Filed May 18, 1932 2 Sheets-Sheet 1

FIG. 1

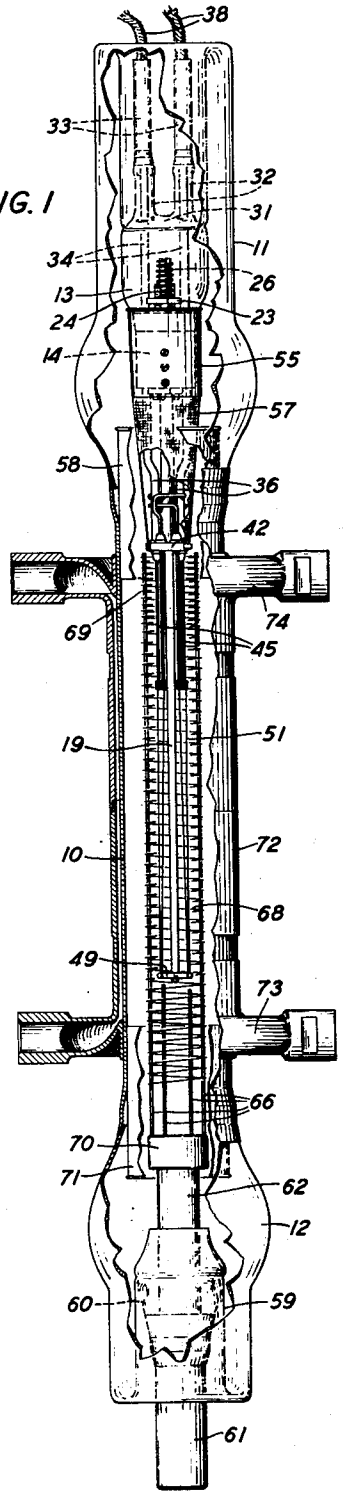


FIG. 2

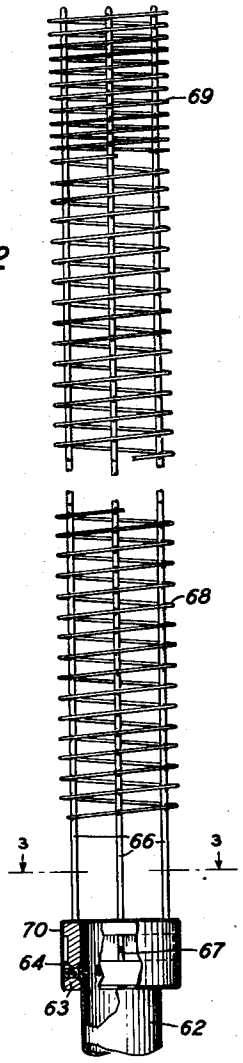
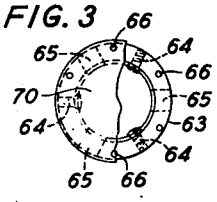


FIG. 3



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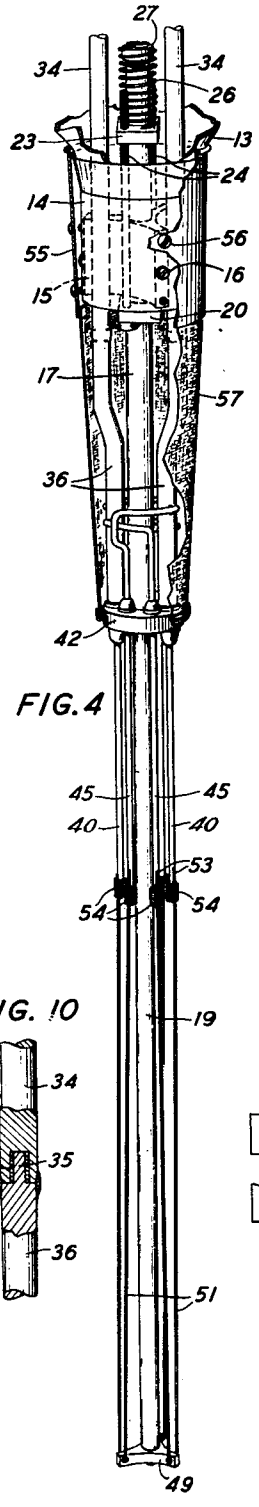

FIG. 4

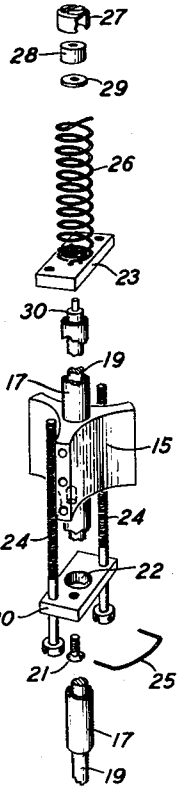

FIG. 5

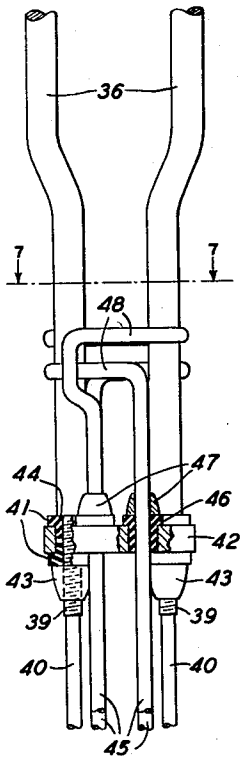

FIG. 6

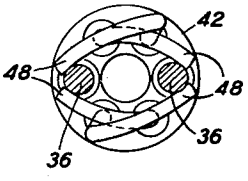

FIG. 7

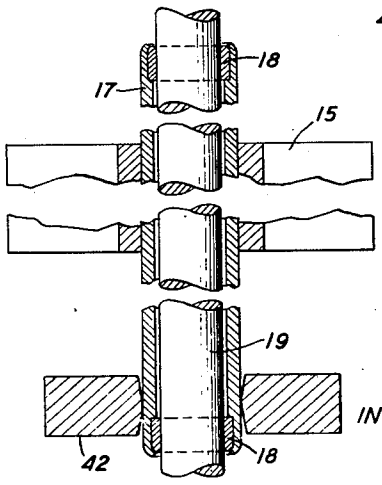

FIG. 8

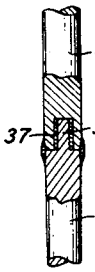

FIG. 10

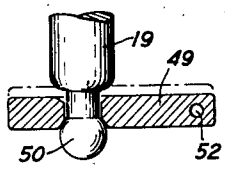

FIG. 9

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Patented Oct. 9, 1934 1,976,521

UNITED STATES PATENT OFFICE

1,976,521

ELECTRON DISCHARGE DEVICE

Victor L. Ronci, Brooklyn, and James E. Clark, Astoria, N. Y., assignors to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application May 18, 1932, Serial No. 612,143

15 Claims. (Cl. 250—27.5)

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

An object of this invention is to maintain uniform spacing between an incandescible electrode and other electrodes in electron discharge devices and to prevent setting up deleterious stresses in the incandescible electrode.

In one embodiment of this invention an electron discharge device comprises an enclosing vessel consisting of two vitreous end portions hermetically sealed to an intermediate cylindrical metallic portion which serves as the anode of the device. A grid assembly is supported from one end portion and a cathode assembly is supported from the other end portion.

The cathode assembly includes a metallic collar which is sealed to a stem and a spider member mounted within the collar and supporting a plate member. Another plate member is supported from the first plate member by a plurality of machine screws which are threaded into the former plate member and enable adjustment of the spacing of the plate members. A rigid metallic standard extends through the guide in the spider and is slidable therein. A tension spring encircling an end portion of the standard, is secured to one of the plate members and bears against the end of the standard.

A pair of relatively rigid conductor rods are sealed in the cathode supporting stem and extend within, but out of contact with the cylindrical collar. A platform is slidably mounted upon the guide for the standard, adjacent the cylindrical collar and is supported solely by the conductor rods. Another platform is mounted upon the end of the standard remote from the cylindrical collar and is substantially universally rockable with respect to the standard. A multi-section filamentary cathode is suspended between the two platforms and supports the standard. The standard constitutes a gravity actuated or mass member and produces a tension in the cathode, which may be adjusted by varying the spacing between the plate members with a resultant variation in the tension of the spring engaging the standard.

This construction enables expansion and contraction of the filamentary cathode with temperature variations, maintains a uniform tension in the several sections of the electrode, and preserves the form of the cathode and the proper space relation between the cathode and the other electrodes of the device.

The invention and the features thereof will be understood more clearly and fully from the following detailed description, reference being had to the accompanying drawings in which:

Fig. 1 is an elevational view of an electron discharge device illustrative of one embodiment of the invention with portions broken away to show details of the cathode and grid assemblies more clearly;

Fig. 2 is an elevational view of the grid assembly of the device shown in Fig. 1, partly in section and partly broken away, to show the grid assembly more clearly;

Fig. 3 is a plan view partly broken away, taken along line 3—3 of Fig. 2;

Fig. 4 is an enlarged view in perspective of the cathode assembly of the device shown in Fig. 1, partly broken away to show the association of the cathode leading-in wires and the cathode more clearly;

Fig. 5 is an exploded view showing the support for the cathode standard;

Fig. 6 is an enlarged detail view of the upper platform of the cathode assembly;

Fig. 7 is a cross-sectional view along line 7—7 of Fig. 6;

Fig. 8 is an enlarged detail view in cross-section showing the guide and the bearings for the cathode standard;

Fig. 9 is an enlarged detail view, partly in section, showing the mounting of the lower platform upon the cathode standard; and

Fig. 10 is an enlarged detail view partly broken away and partly in section of the cathode conductor rods.

Referring now to the drawings, an electron discharge device illustrative of one embodiment of this invention, comprises an enclosing vessel including a cylindrical metallic portion 10 which is adapted to serve as the anode of the device and two vitreous portions 11 and 12 each hermetically sealed at one end to the metallic portion 10. The vitreous portion 11 is provided with a hollow reentrant stem 13 to the inner end of which a cylindrical metallic sleeve or collar 14 is sealed. A tri-armed metallic spider 15 (shown more clearly in Fig. 5) is secured within the sleeve 14 by a plurality of screws 16, and is provided with an axial bore in which a tubular guide member 17, which may be of steel, is securely fitted. A pair of metallic sleeve inserts 18, which may be of molybdenum, are provided at the ends of guide member 17 and form bearings for a slidable elongated rod or standard 19 which extends axially of the anode portion 10 and projects beyond the

end of the spider 15 nearest the stem 13. A metallic plate 20 is secured to one end of the spider 15 by a screw 21 and is provided with a centrally disposed aperture 22 through which the guide member 17 extends. Another metallic plate 23 is positioned adjacent the other end of the spider 15 but out of contact therewith and is supported solely by machine screws 24 which are threaded into the plate 23, and extend slidably through the rigid plate 20. The screws 24 may be locked relative to each other by a cotter wire 25. A helical spring 26 encircles the standard or rod 19 and is seated upon the plate 23. One end of the spring 26 is secured to the plate member 23 and the other end of the spring is seated on a cap 27 which is seated upon an insulating collar 28. The collar 28 is seated, together with an interposed washer 29, upon a shoulder 30 of the standard 19.

The stem 13 is provided intermediate its ends with an internal vitreous flange 31 which carries a pair of outwardly directed vitreous tubulations 32. Metallic sleeves 33, such as copper, are hermetically sealed to one end of the tubulations 32 and have secured therein metallic rods forming leading-in conductors for the cathode of the device.

As shown more clearly in Fig. 10, the conductor rods include a copper section 34 which is secured within the sleeves 33, having a bore into which a reduced end portion 35 of a molybdenum section 36 extends. The sections 34 and 36 are preferably arc welded together, a nickel welding sleeve 37 being interposed between the reduced end portion 35 of the molybdenum section 36 and the copper section 34. The conductor rods may be connected to an appropriate source of current by stranded conductors 38 secured to the metallic sleeves 33.

The metallic rod sections 36 extend between the arms of the spider 15 and out of contact with the spider and the sleeve 14. Each of the rod sections 36 is formed with a short threaded portion 39 and an elongated linear portion 40 extending lengthwise of the enclosing vessel and within the anode portion 10. The threaded portions 39 extend through opposed flanged insulators 41 positioned in apertures in a metallic platform 42, and each portion has mounted thereon a metallic nut 43 which clamps the insulators 41 against a shoulder 44 on the rod section 36 and thereby secures the platform 42 in position. A plurality of rods 45 extend through flanged insulators 46 in the platform 42 and have secured thereto, as by welding, metallic buttons 47 which lock the insulators in position. The rods 45, which may be of molybdenum, are provided with bent portions 48 which are secured to the rod sections 36. In the particular embodiment shown there are four rods 45, two of the rods being secured to one of the rods 36 and two to the other of the rods 36, as shown in Fig. 7, so that three conductors of positive polarity and three of negative polarity are provided. The rods 45 and 40 and rods 34, 36 and the platform 42, in the specific construction shown are therefore rigidly interconnected and form a unitary assembly supported from the stem 13. The platform 42 is slidably mounted upon the guide member 17 adjacent the lower end thereof. A tri-armed platform or spider 49, which may be of molybdenum, is mounted upon a reduced headed extension 50 of the standard 19, as shown more clearly in Fig. 9, and is universally rockable with respect to the standard 19.

A filamentary cathode consisting of a plurality of V-shaped sections 51, which may be of tungsten, is suspended between the platforms 42 and 49 and is arranged within a substantially cylindrical boundary concentrically within the anode portion 10 of the enclosing vessel. The V-shaped sections of the cathode are threaded through bores 52 in the arms of the platform 49 and the ends of the sections are disposed in slots 53 in the rods 40 and 45. The ends of the cathode sections are secured in the slots by tightly wound wire helices 54, which may be arc welded to the ends of the cathode sections 51 and the rods 40 and 45. In view of the connections shown in Fig. 7, it will be apparent that the sections of the cathodes are electrically in parallel.

The normal position of the cathode structure is as shown in Fig. 4. The standard 19 which is freely slidable in guide member 17, constitutes a gravity actuated or mass member, the mass of which acts along the length of the cathode and thereby produces a tension in the filamentary sections 51 of the cathode. The degree of the tension may be adjusted by varying the separation of the plates 20 and 23, thereby varying the tension of the helical spring 26. During the operation of the device the expansion and contraction of the leading-in conductor rods 34, 36 are accompanied by movement of the platform 42 along the guide 17 so that no buckling or deleterious stresses in the rods are produced. The expansion and contraction of the filamentary sections 51 of the cathode are compensated by the helical spring 26 acting upon the standard 19. An unequal expansion of the sections 51 is compensated by the rocking movement of the spider or platform 49. This construction, therefore, maintains a substantially uniform and constant tension in the sections 51 and preserves the form of the cathode as a whole so that the spacing of the cathode with respect to the anode is substantially uniform and the electrical characteristics of the device are maintained substantially constant. Moreover since the setting up of deleterious stresses in the cathode structure are prevented, the operating life of the device is materially extended.

In order to prevent arcing discharges between the anode and the relatively sharp edges on portions of the cathode supporting structure, a shield is provided about the assembly adjacent the stem 13. This shield comprises a cylindrical supporting band 55 which is secured to the sleeve 14 by screws 56, and a frusto-conical perforated or wire mesh portion 57 which extends between the band 55 and the platform 42 and makes sliding contact with the platform. A cylindrical shield 58 which may be of a good heat conducting material, such as nickel, extends from the anode portion 10. The shield 58 decreases the potential gradient between the anode and the portions of the filament assembly adjacent the stem 13 and also protects the seal between the anode 10 and the vitreous end portion 11 by reflecting heat away therefrom.

The opposite end portion 12 of the enclosing vessel is formed with a reentrant stem 59 having an outwardly extending neck portion 60. A metallic cap 61 which may be of copper is hermetically sealed to the neck portion 60 and extends outwardly beyond the end of the portion 12 to form an external terminal for the grid of the device. The grid assembly, as shown more clearly in Fig. 2, comprises a cylindrical support 62, preferably of copper, which may be secured within the cap 61 as shown and described in a Patent

No. 1,907,123 granted May 2, 1933, of Victor L. Ronci. A metallic collar 63 encircles the inner end of the support 62 and is secured to the support by a plurality of screws 64. The collar is provided with counter-sunk portions adjacent the heads of the screws 64 so that the material of the support may be forced into the counter-sunk portions, and the collar and support securely locked with respect to each other. A plurality of apertures 65 are provided in the collar, one in axial alignment with each of the screws 64 to allow the insertion of a screw-driver for fixing or removing the screws. The collar 63 is also provided with a plurality of equally spaced bores parallel to the axis thereof into which rigid parallel uprights 66, such as of molybdenum, extend. The uprights 66 may be secured to the collar by welding as shown at 67, and extend parallel to the axis of the anode portion 10. A helical wire control electrode or grid 68, which may be of molybdenum, is carried by the uprights 66, each convolution of the control electrode or grid being spot welded to each of the uprights. This construction provides a rigid structure which will not distort during the operation of the device.

The convolutions 69 at the end of the grid remote from the support 62 are preferably spaced less than the remaining convolutions of the grid in order to appreciably block electrons and to thereby confine the anode space current. The collar 63 is preferably enclosed in a shield 70, which may be of nickel, to prevent deleterious heating of the support 62. A cylindrical shield 71 of a metal having good radiating properties, for example, nickel, extends from the anode 10 and protects the seal between the anode and the vitreous end portion 12, and reduces the potential gradient between the control electrode or grid and the end of the anode.

In order to prevent excessive heating of the anode 10 during the operation of the device, a cooling jacket is provided comprising a metallic casing 72 concentrically disposed about the anode 10 and secured thereto at opposite ends, by brazing. The jacket is provided with an inlet 73 at one end of the casing, and an outlet 74 at the other end of the casing. The construction and features of the cooling jacket are described in greater detail in a copending application of Victor L. Ronci, James E. Clark, and Douglas A. Hale, Serial No. 612,144 filed May 18, 1932.

Although the invention has been described in detail with reference to a specific embodiment in high power electron discharge devices, it is to be understood, of course, that modifications may be made in the specific structure shown without departing from the spirit and scope of this invention as defined in the appended claims.

What is claimed is:

1. An electrode assembly comprising a support, a standard extending through said support and slidable therein, a filamentary electrode having portions fixed with respect to said support and supporting said standard, and an adjustable resilient connection joining said standard and said support.

2. An electrode assembly comprising a support, a standard extending through said support and slidable therein, a filamentary electrode having one end fixed with respect to said support and connected to said standard remote from said support, said electrode supporting said standard and being tensioned thereby, and a helical tension spring coupled to said support and said standard.

3. An electrode assembly comprising a support, a standard extending through said support and slidable therein, a filamentary electrode coupled to said support and connected to said standard remote from said support, said electrode supporting said standard and tensioned thereby, a tension spring secured to said support and engaging said standard, and means for adjusting the tension of said spring.

4. An electrode assembly comprising a support, a standard extending from said support, a platform slidably disposed about said standard intermediate the ends thereof, a second platform mounted on said standard adjacent one end thereof and universally rockable with respect to said standard, and a filamentary electrode extending between and coupled to said platforms.

5. An electrode assembly comprising a stem, a support mounted on said stem, a standard extending from said support, leading-in conductors extending through said stem, a platform supported by said conductors loosely surrounding said standard, a second platform mounted on said standard and universally rockable with respect thereto, and a filamentary cathode coupled to and extending between said platforms.

6. An electrode assembly comprising a stem, leading-in conductors extending through said stem, a platform supported by said conductors, a filamentary electrode coupled to said platform, gravity actuated means for tensioning said filamentary electrode, and means for adjusting said gravity actuated means.

7. An electrode assembly comprising a stem, leading-in conductors extending from said stem, a platform supported by said conductors, a filamentary electrode coupled to said platform, gravity actuated means for tensioning said filamentary electrode, and means regulating the tensional force of said standard during expansion and contraction of the filamentary electrode.

8. An electrode assembly comprising a stem, a support mounted on said stem, leading-in conductors extending through said stem, a platform supported by said leading-in conductors, a filamentary electrode coupled to said platform, and a standard extending through said platform and support and slidable therein, said standard being connected to said filamentary electrode and supported thereby.

9. An electrode assembly comprising a stem, a support mounted on said stem, leading-in conductors extending through said stem, a platform supported by said leading-in conductors, a filamentary electrode coupled to said platform, a mass member extending from said support and guided thereby, said mass member being supported by said electrode and applying tension to said electrode, resilient means between said mass member and said support, and means for varying the tension of said resilient means whereby the tension in said electrode is adjusted.

10. An electrode assembly comprising a stem, a support mounted on said stem, a pair of plate members carried by said support, a filamentary electrode coupled to said support, a rod member supported by said electrode and extending through said support and plate members, for tensioning said electrode, a spring member secured to one of said plate members and engaging said rod, said spring member acting to hold said rod against said electrode, and means for varying the spacing between said plate members whereby the tension in said spring member and said electrode is adjusted.

11. An electrode assembly comprising a stem, a

support mounted on said stem, a guide member extending through said support, a pair of plate members adjacent said support, one of said plate members being secured to said support, means adjustable in length supporting the other plate member from said one plate member, leading-in conductors extending from said stem, a platform adjacent said support carried by said conductors, a filamentary electrode coupled to said platform, a rod member supported by said electrode and extending through said guide member and platform and a helical spring secured to said other plate member and engaging said rod member, the tension in said spring being variable by said adjustable means to adjust the tension in said filamentary electrode.

12. An electron discharge device comprising an enclosing vessel including a cylindrical metallic portion serving as an anode, vitreous portions sealed to opposite ends of said metallic portion, each of said vitreous portions having a reentrant stem, a grid electrode supported from one of said stems and concentrically disposed within said anode, a support mounted on the other reentrant stem, a cathode coupled to said support including a plurality of V-shaped sections lying in a cylindrical boundary concentrically within said grid electrode and anode, means including a gravity actuated member for tensioning said sections simultaneously, said means being variable to compensate for expansion and contraction of said sections, and additional means for compensating for unequal expansion in said sections to maintain the cylindrical form of said cathode.

13. An electron discharge device comprising an enclosing vessel having a reentrant stem, a standard extending from said stem, leading-in conductors adjacent said standard and extending through said stem, a platform slidably encircling said standard and carried by said leading-in conductors, a filamentary electrode coupled to said platform, an anode encircling said electrode, and a hollow shield encircling said standard and said conductors, said shield being secured to said stem at one end and slidably contacting with said platform at the other end.

14. An electrode assembly comprising a stem, a collar mounted on said stem, a support mounted within said collar, a guide member within said support, a plurality of spaced bearing sleeves in said guide member, a standard extending through said guide member and slidable on said bearing sleeves, a resilient connection between said standard and said support, a rockable spider member mounted on said standard, a platform slidably mounted on said standard remote from said spider member, and a filamentary electrode coupled to said platform and said spider member.

15. An electron discharge device comprising an enclosing vessel having a stem, a metallic support extending from said stem, a collar encircling said support and carried thereby, a plurality of rods supported by said collar, a helical grid carried by said rods, a cathode within said helical electrode, an anode encircling said helical electrode, and a heat radiating shield mounted upon said collar, having a portion disposed between said cathode and said collar.

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JAMES E. CLARK.