

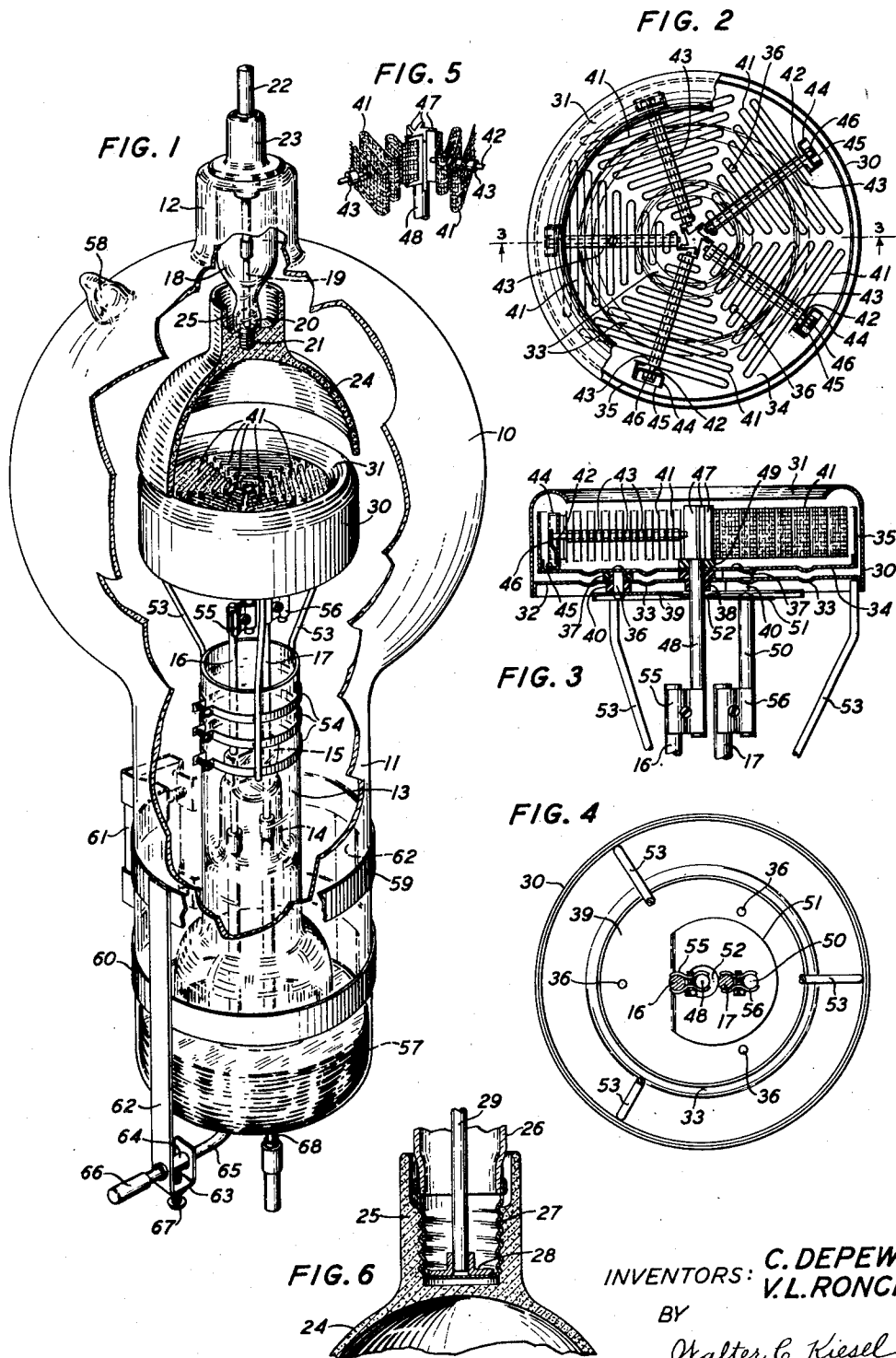
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ELECTRIC DISCHARGE DEVICE

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## ELECTRIC DISCHARGE DEVICE

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This invention relates to electric discharge devices capable of operating at high voltages and more particularly to such devices in which a vapor or gas is utilized in the discharge between the electrodes.

An object of the invention is to facilitate the attainment of high power output in vapor or gaseous discharge devices.

Another object of the invention is to conserve the heat energy for maintaining an electron emitting cathode at a uniform operating temperature and to dissipate the heat energy in an anode in order that the device may operate at high efficiency for a long period of time.

In accordance with this invention, these objects are attained in one embodiment of a mercury vapor rectifier device comprising an enclosing vessel having an electron emitting cathode of large capacity mounted as a unit on a stem at one end of the device and a large surface anode mounted on a supporting member sealed to the opposite end of the device.

The cathode unit comprises a tripod mounting secured to a stem which supports a heat conserving shell or shield consisting of a double walled enclosure having a plurality of spaced members projecting from the wall of the shield for supporting the ends of a plurality of folded ribbon sections which are coated with electron emitting material, such as barium and strontium oxides. The sections are formed of triangular segments and their converging ends are secured to a central support insulated from the heat shield. Each triangular segment of ribbon is maintained in its folded condition by an insulating bar which extends through the ribbon in a radial direction and insulating bushings maintain the adjacent folds in spaced relation.

A feature of this cathode assembly is the provision of a floating support for the ribbon segments at a central point to compensate for expansion and contraction of the cathode. The ribbon segments are heated to an operating temperature through current conductors, one being the central support attached to all the segments at one end and the other conductor being a rod secured to a resilient portion of the double walled heat shield to which the other end of the ribbon segments are attached.

Another feature of the invention relates to the anode mounting and comprises a reentrant metallic cup member which is sealed to the wall of the enclosing vessel and is provided with a spiral groove to receive a threaded portion on a neck of the anode. The anode is formed from a block

of carbon or graphite and is machined into a cup form with a concave surface and the neck portion is internally threaded for mechanical attachment to the terminal portion of the vessel. This structure of the anode readily dissipates the heat generated during operation, facilitates the mounting of the anode and provides a large surface terminal conductor for impressing high voltages on the anode.

These and other features of the invention will be more clearly understood from the following detailed description taken in connection with the accompanying drawing:

Fig. 1 is a perspective view of a high voltage thermionic rectifier device embodying features of this invention with portions of the enclosing vessel and the anode broken away to show details of construction more clearly;

Fig. 2 is a plan view of the cathode unit made in accordance with this invention with a portion of the shell cut away to clearly show the arrangement of the ribbon segments of the cathode and the manner in which they are supported in the unit;

Fig. 3 is a cross-sectional view of the cathode unit on the line 3—3 of Fig. 2 and illustrates the construction of the cathode enclosure and the floating support of the ribbon segments;

Fig. 4 is a plan view of the rear portion of the cathode unit as shown in Fig. 3, illustrating the resilient connection of one of the conductors to the cathode unit and the clamping connection of the cathode conductors to the leading-in wires of the device;

Fig. 5 is an enlarged perspective view of the shape of the central support of the cathode unit with several sections of the ribbon cathode attached thereto; and

Fig. 6 shows a partial cross-sectional view of a modification of the anode assembly in which the anode is threaded to a cup terminal sealed to the enclosing vessel.

Referring to the drawing, the discharge device comprises a large enclosing vessel having a substantially spherical portion 10 joined to a large diameter cylindrical portion 11 at one end and a small diameter cylindrical portion 12 at the other end. The large diameter cylindrical portion 11 is provided with a reentrant tubular wall 13 in which is located a glass stem 14 which is peripherally sealed to the tubular wall 13 intermediate the ends thereof. The stem 14 is formed with a press 15 at one end in which a pair of leading-in wires 16 and 17 are hermetically sealed. The small diameter cylindrical portion 12 at the other

end of the vessel is provided with a reentrant stem 18 and a leading-in wire 19 is sealed in the stem 18 adjacent its inner end while the inner end of the stem is formed into a cup portion 20 just beyond the seal. The leading-in wire 19 is provided with an integral threaded head 21 which extends beyond the cup portion 20 of the stem 18. The leading-in wire 19 is connected to an external terminal 22 supported on an insulating bushing 23 which is cemented to the end of the cylindrical portion 12.

An anode 24 of large hemispherical or dome-shaped form is preferably made of a solid block of carbon or graphite, and machined to a smooth finish in the form shown in which the base is of large diameter while the nodal portion is provided with an integral extending neck portion 25 which forms a hollow seat. This anode is supported from the stem 18 by threading the head 21 of the leading-in wire 19 into a cooperating threaded portion in the center of the neck portion until the seat engages the edge of the cup portion 20 on the stem 18. This arrangement forms a tight mechanical joint between the leading-in wire and the anode. The neck portion 25 in combination with the cup portion 20 protects the mechanical joint against the effects of the vapor in the device. Other advantages of this construction are the strength of the solid block anode, the high heat dissipating properties of graphite or carbon and the confinement of the energizing stream of electrons from the cathode unit which is arranged close to the periphery of the anode 24 and therefore confines the energy to a useful area for highly efficient operation.

Another arrangement for the support of the large area anode 24 is disclosed in Fig. 6 in which a tubular reentrant wall 26 is formed on the cylindrical portion 12 of the vessel instead of the stem 18 shown in the device of Fig. 1, and a metallic cup-shaped member 27, preferably of copper, is sealed to the glass wall 26 in a manner disclosed in W. G. Houskeeper Patent 1,294,466, February 18, 1919, to provide a hermetic seal between the copper cup member 27 and the glass wall 26. The copper cup member is provided with a spirally threaded portion in the cylindrical wall thereof in order to accommodate a similarly threaded portion on the interior of the neck portion 25 of the graphite anode 24. An external connection for the anode may be secured by a metallic disc member 28 which is brazed or welded to the bottom of the cup member 27, the disc carrying a central wire or rod 29 which is connected to the external terminal 22, as described above in connection with Fig. 1.

The other features of this invention are particularly concerned with the assembly and structure of an electron emitter or cathode of a high generating capacity which is arranged in a compact unit and may be assembled independent of the structural assemblies of the enclosing vessel. The relationship of this cathode unit to the anode 24 is shown clearly in Fig. 1 in which it is assembled on the cylindrical wall 13 of the device, the active area being arranged close to and within the boundary of the anode 24. The detailed structure of this unit is shown in Figs. 2, 3, 4 and 5. The large area cathode of this invention which is adapted to supply a copious flow of electrons to the anode 24 is compactly arranged in a heat conserving shell, shield or casing formed of a cylindrical metallic member 30 having the end adjacent the anode 24 formed with an inwardly turned annular edge 31 in order to pre-

vent the establishment of corona discharges between the edge of the anode and the sharp edges of the internal structure within the casing or shell 30. This construction provides a large diameter opening for the flow of electrons to the anode 24. A metallic disc 32 having a downwardly extending flange fits into the opposite end of the shell 30, and the flange and the edge of the shell are welded together to form a chamber. The metallic disc 32 is provided with a plurality of coaxial corrugations 33 to increase the strength of the disc and to avoid distortion of the heat shield or shell 30. Within the shell 30 is arranged an internal shell formed of a metallic disc 34, similar to the disc 32 but having the peripheral flange turned upwardly and the peripheral flange welded to a cylindrical metallic member or wall 35. The internal shell formed by the disc 34 and the wall 35 is secured to the heat retaining casing but insulated therefrom by a plurality of rivets 36 and insulating spacing washers 37 and a central bushing 38. A flanged metallic disc 39 is also secured externally to the parallel discs 32 and 34 by the rivets 36 and spacing bushings 40. The bushings 40 extend through the disc 32 and surround the rivets 36 up to the surface of the disc 34 while the spacing washers 37 fit around the portion of the bushing located between the discs 33 and 34. This arrangement forms a double walled container or casing for the large area cathode in which no current is dissipated in the outer shell or heat retainer casing. This construction also reflects the radiated heat from the cathode back to the surface of the cathode and consequently maintains the cathode at a more uniform temperature during operation since no heat is conducted through the outer shell of the casing due to current being applied thereto. The fact that no current traverses the outer shield 30 causes this part of the container to be relatively cool in comparison to the internal shell of the casing formed by the disc 34 and the wall 35.

The electron emitting surface of the cathode is formed of a large number of sections of mesh ribbon 41, folded in accordion fashion, in order to obtain as large a surface area as possible in a relatively small space. This is accomplished, as shown more clearly in Fig. 2, by forming each section as a segment of a circle and preferably of triangular formation so that the bases of the sections are arranged near the periphery of the heat shield while the remainder of the sections taper towards the axis of the shield. In this arrangement, the sections are positioned with the ribbon 41 edgewise with an insulating bar 42 extending through the center of the folds of the ribbon sections and insulating washers 43 are supported on the bar 42 between the adjacent folds of the ribbon to maintain the adjacent folds of the ribbon in uniform spaced relation while the insulating bar 42 increases the rigidity of the assembly. Each section of the cathode has the end adjacent the periphery of the shell secured to an ear 44 of a rectangular shaped piece 45 welded to the metallic disc 34 and extending upwardly and substantially parallel to the metallic wall 35 attached to the disc 34. The parallel ends of the piece 45 are bent outwardly to form the ear 44 and the center of the piece 45 is pierced to receive the bar 42. This bar is prevented from outward movement by a metallic tab 46 which extends out from the surface of the piece 45. The inner ends of the sections 41 are attached to tangential fins 47 formed on an en-

larged head of a central rod or conductor 48 which passes through the bushing 38. An insulating washer 49 spaces the enlarged head of the rod 48 from the disc 34 and also insulates the rod from the internal shell formed by the disc 34 and the cylindrical wall 35.

Due to the intense heat generated in the cathode assembly during operation, it is evident that considerable expansion will occur in the sections of the cathode when they are heated to operating temperature. In order to prevent distortion of these sections, the central rod or conductor 48 is slidable in the heat shield structure and upon expansion of the cathode sections, the whole cathode assembly adjacent the axis of the shield is maintained in a floating condition due to the sliding support of the rod 48.

As before stated, another feature of this invention is the radial arrangement of the cathode sections whereby all the ends of the sections converge at the axis of the casing and are attached to a central support which serves as a current conductor for applying the heating current to the sections. The heating current is also supplied to the other ends of the sections through the internal shell, formed by the disc 34 and wall 35, which is electrically connected to the ends of the cathode sections and also to the disc 39 in the bottom of the casing. The disc 39 is connected to a conductor 50 which is attached to the disc within the boundary of an arcuate slot 51 and eccentric with respect to the conductor 48, the portion of the disc within the slot forming a resilient connection to compensate for expansion and contraction, in order to prevent distortion of the disc and also protect the seals in the glass stem 14. A large aperture 52 in the resilient portion of the disc prevents contact between the disc 39 and the central rod 48 which is the insulated conductor for the center portion of the cathode sections.

While the above description relates to the configuration of the cathode sections as shown in the drawing, it is evident that these sections may assume other configurations than the specific triangular formation. Furthermore, it is not necessary, in accordance with this invention, to segregate the cathode into five sections as shown since it is obvious that the specific example disclosed is merely a representative illustration of the invention and other ramifications may be developed within the purview of this invention provided the principle of a floating support is adhered to in accordance with this invention.

It is evident from the previous description of the cathode assembly that it is not necessary to assemble this unit on a glass stem or associate it with any part of the device during manufacture since it is possible to construct the unit independently and after complete assembly it may be mounted on the stem of the device as shown. This is accomplished by attaching a tripod support formed of a number of supporting wires 53 and the metallic collars 54 to the metallic shell 30 by welding the rods 53 to the inner edge of the shell adjacent the flange of the disc 32. The unit is mounted in the device as shown in Fig. 1 by clamping the bands 54 around the cylindrical wall 13 and securing the conductors 48 and 50 to the leading-in wires 16 and 17, respectively, by metallic clamps 55 and 56.

After the device is completely evacuated, a supply of mercury 57 is injected into the vessel and the vessel sealed off at 58. A mounting for the device, as shown in Fig. 1, may be formed by

bands 59 and 60 which are clamped together to rigidly secure the glass vessel to a mounting block 61 which extends between the bands 59 and 60 and is spaced from the glass vessel. The bands 59 and 60 also carry oppositely disposed downwardly extending straps 62 (one of which is shown in Fig. 1). These straps are provided to maintain the conductors for the cathode structure in spaced relation to avoid shorting. The strap 62 is provided with a U-shaped bend 63 and a split insulating sleeve 64 extends between the parallel portions of the bend to receive a flexible conductor 65 which is attached to the leading-in wire 16 and provided with a metallic terminal 66 to which an external connection may be made. The split sleeve 64 holds the flexible conductor 65 in position due to the pressure on the sleeve by a clamping screw 67. A similar conductor 68 is attached to the leading-in wire 17 and extends vertically to be held in that position by the other strap extending along the opposite side of the vessel.

While the device of this invention, in its preferred form, may contain all of the features enumerated, 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 scope of this invention is represented in the appended claims.

What is claimed is:

1. An electron discharge device comprising an enclosing vessel, a cathode unit supported from one end of said vessel, a metallic terminal sealed in said vessel at the other end, and a cup-shaped anode attached to said terminal, said unit comprising a metallic casing open at one end adjacent said anode and having substantially the same diameter as said anode, an axial support slidably extending into said casing, a plurality of segmented cathode sections extending radially within said casing, each of said sections being connected at one end to said casing and at the other end to said axial support, and an insulated rod extending through each cathode section, all the rods being adapted to elevate at an angle toward the axis of said sections during expansion thereof.

2. An electron discharge device comprising an enclosing vessel, a cathode unit supported from one end of said vessel, a metallic terminal sealed to said vessel at the other end, a cup-shaped anode having its periphery coincident with the circumference of said cathode unit and closely spaced with respect thereto, said anode being threaded to said terminal, said unit comprising a metallic casing, an axial support extending into said casing, a plurality of segmental cathode sections within said casing, each of said sections being connected at one end to said casing and at the other end solely to said central support, and an aligning rod extending centrally through each segmental cathode section, the outer end of each rod being pivotally supported by said casing and the other end being adapted to move axially during expansion of said cathode sections and said central support.

3. An electron discharge device comprising an enclosing vessel, a cathode unit supported from one end of said vessel, an anode supported from the other end of said vessel and facing said cathode unit, said unit comprising a metallic casing, a central support extending into said casing, a plurality of segmental cathode sections within

said casing, each of said sections being connected at one end to said casing and at the other end to said central support, an external metallic disc member having a flexible portion attached to said casing, and an eccentric terminal connected to said flexible portion.

4. An electron discharge device comprising an enclosing vessel, a cathode unit supported from one end of said vessel, an anode supported from the other end of said vessel and facing said cathode unit, said unit comprising a metallic casing, a central conductor extending into said casing, a plurality of segmental cathode sections within said casing, each of said sections being connected at one end to said casing and at the other end to said central conductor, a resilient disc surrounding said central conductor and connected to said casing, and a conductor eccentrically secured to said disc.

5. An electron discharge device comprising an enclosing vessel, a cathode unit supported from one end of said vessel, an anode supported from the other end and facing said cathode unit, said unit comprising a metallic casing, a central support extending into said casing, a plurality of segmental cathode sections within said casing, each of said sections being connected at one end to said casing and at the other end to said central support, a metallic disc attached to said casing and having an arcuate slot, and a terminal member secured to said disc within the boundary of the slot in said disc.

6. In an electric discharge device comprising a vessel having a tubular portion at one end thereof, a metallic casing having an open end directed away from said stem, supports on said tubular portion connected to said casing, a support rod extending centrally through said casing, a plurality of electron emitting cathode sections connected with said rod at one end and to said casing at the other end, a metallic disc having a resilient portion surrounding said rod and secured to the closed end of said casing, a rod connected to said resilient portion, and an anode supported from the other end of said vessel and facing the open end of said casing.

7. An electron discharge device comprising a vessel containing a vapor producing substance, a unitary cathode assembly supported at one end of said vessel, a dome-shaped graphite anode supported from the other end of said vessel, said cathode assembly comprising a cylindrical shell having an inwardly curved edge adjacent said anode, an apertured disc member enclosing the opposite end of said shell, a plurality of folded

ribbon sections within said shell, said folded sections being tapered from the periphery to the center of said shell, a radial support extending through each folded section, means supporting said sections adjacent the periphery of said shell, and a central support extending through said apertured disc member connected to the converging ends of said folded sections.

8. An electron discharge device comprising a vessel containing a vapor producing substance, a unitary cathode assembly supported at one end of said vessel, a dome-shaped graphite anode supported from the other end of said vessel, said cathode assembly comprising a cylindrical shell having an inwardly curved edge adjacent said anode, an apertured disc member closing the opposite end of said shell, a plurality of folded ribbon sections within said shell, said folded sections being tapered from the periphery to the center of said shell, a radial support extending through each folded section, a conductor having integral radiating fins connected to and yieldingly supporting said sections in an axial position, and an eccentric conductor coupled to said shell.

9. An electron discharge device comprising an enclosing vessel having a reentrant stem at each end thereof, a hemispherical graphite anode supported by one of the stems, a pair of leading-in wires sealed in the other stem, a cylindrical wall extending beyond the other stem and surrounding said leading-in wires, a body of mercury in said vessel for producing a vapor conducting atmosphere, a plurality of radially arranged folded triangular cathode sections, a metallic heat shield surrounding said sections, means supporting said shield from said cylindrical wall, a pair of conductors connected to said cathode sections and shield, respectively, and means attaching said conductors to said leading-in wires.

10. A cathode assembly comprising a casing having spaced supports, a plurality of folded segments of electron emitting ribbon attached at one end to said supports, means extending radially of said casing through each folded segment toward the center of said casing to prevent distortion of the ribbon, and metallic supporting means extensible during the high temperature operating period projecting axially through said casing to which the other end of each of said segments is attached, whereby the central portion of said cathode is capable of assuming a convex form during expansion to prevent distortion of the cathode segments.

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