

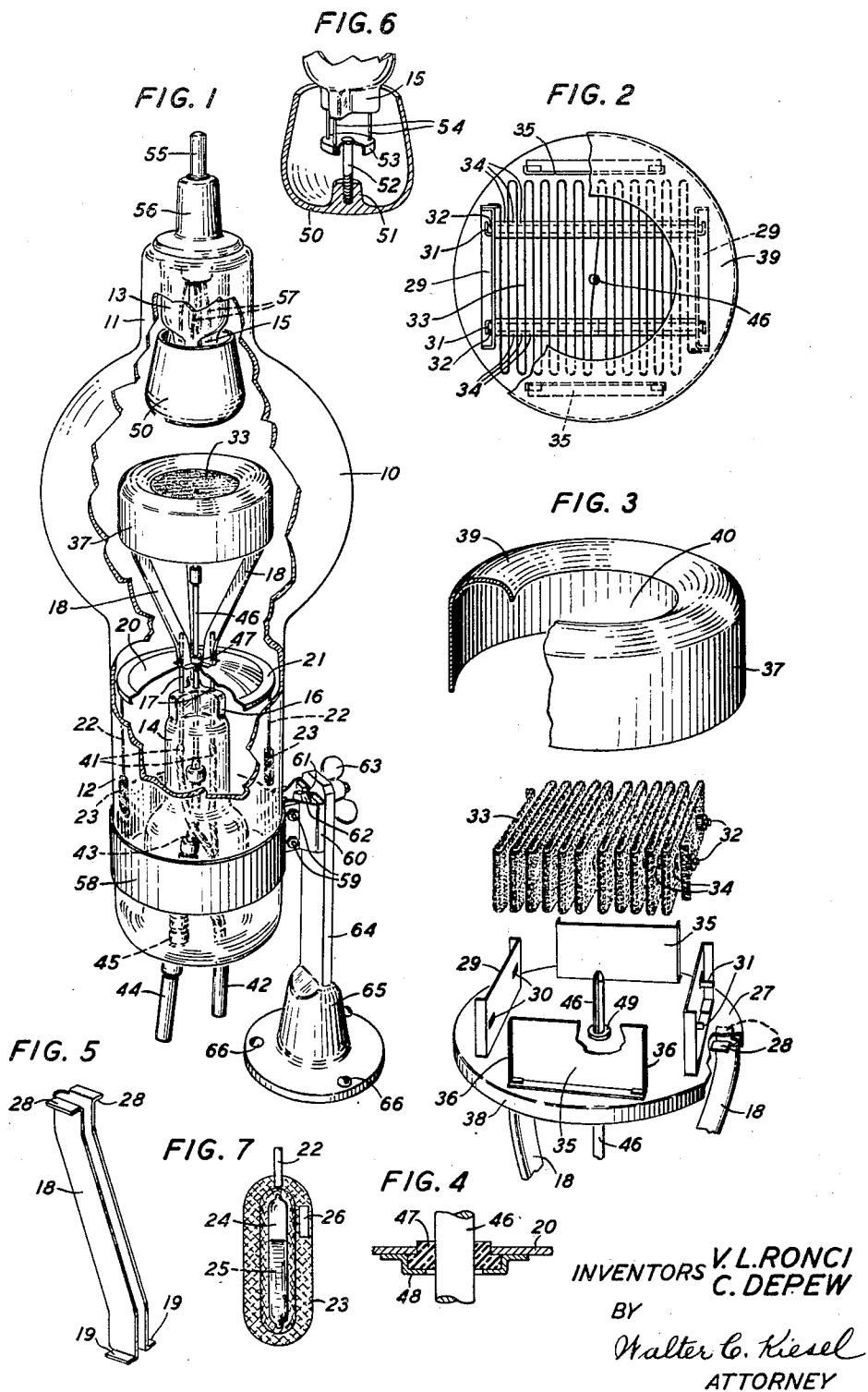
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ELECTRIC DISCHARGE DEVICE

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ELECTRIC DISCHARGE DEVICE

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This invention relates to electric discharge devices and more particularly to an incandescible electron-emitting cathode assembly for high power gaseous rectifier devices.

Electric discharge devices such, for example, as mercury vapor rectifiers having an incandescible electron emitting cathode are adapted to be highly conductive on one half or positive part of a cycle of an applied alternating voltage, and substantially non-conductive on the inverse or negative half of the cycle. On the conductive part of the cycle, the gas or vapor is ionized and greatly increases the conductivity of the device, so that a current, which consists of a large electron current and a relatively small ion current, flows between the anode and cathode of the device. On the inverse or negative part of the cycle of the applied alternating voltage, it is desirable that there be substantially no ions between the anode and the cathode. In such devices, particularly those adapted to rectify high voltages and having a large surface cathode, the end portions of the cathode tend to be at a materially lower temperature than the remaining portions and a high potential gradient may be extant between the end portions of the cathode and other sharp edges of the cathode assembly, and the anode so that ionization may occur on the negative part of the cycle of the applied alternating voltage. As a result of such ionization, a relatively large undesired ionization current is established between the anode and cathode with a resultant undesired current flow in a circuit associated with the anode and cathode of the device. This ion discharge, furthermore, deleteriously affects the cathode of the device and impairs the operating life and efficiency thereof.

One object of this invention is to prevent ionization in high voltage electric discharge devices on the negative portions of the applied alternating voltage.

Another object of this invention is to improve the thermal efficiency of incandescible electron-emitting cathodes in high power electric discharge devices.

In one embodiment illustrative of this invention, a rectifier device comprises an enclosing vessel having an ionizable medium, such as mercury vapor therein, and an anode and a cathode disposed in cooperative relation within the vessel. The cathode may comprise a conductive ribbon coated with a material having good emission characteristics and folded to form an ac-

cordion-like assembly to provide a large concentrated electron-emitting surface.

In accordance with one feature of this invention, the cathode is mounted in a receptacle comprising a disc and a shell which encloses the cathode and is provided with an aperture to allow egress of electrons from the cathode. A plurality of heat-reflecting members are mounted adjacent the cathode within the receptacle and serve to confine and to concentrate the cathode heat so that all portions of the cathode are maintained at substantially the same temperature.

The invention will be understood more fully and clearly from the following detailed description with reference to the accompanying drawing in which:

Fig. 1 is an elevational perspective view of an electric discharge device illustrative of one embodiment of this invention, with portions broken away to show details of construction more clearly;

Fig. 2 is a top view partly broken away of the cathode assembly of the device shown in Fig. 1;

Fig. 3 is an exploded view of the cathode assembly showing the constituent elements and the assembly of portions thereof;

Fig. 4 is an enlarged detail view in cross-section showing details of assembly of the cathode support and a heat shield adjacent the cathode supporting stem;

Fig. 5 is an enlarged perspective view of one of the supports for the receptacle in which the cathode is contained;

Fig. 6 is an enlarged detail view partly in cross-section of the anode assembly; and

Fig. 7 is an enlarged detail view of the unitary getter and capsule support embodied in the device shown in Fig. 1.

Referring now to the drawing, a high voltage vapor rectifier discharge device, illustrative of one embodiment of this invention, comprises an enclosing vessel having an enlarged bulbous central portion 10 and axially aligned cylindrical end portions 11 and 12. The end portion 11 is provided with a reentrant stem 13 and the end portion 12 is provided with a reentrant stem 14, the stems 13 and 14 terminating in axially aligned tri-armed presses 15 and 16, respectively.

A unitary cathode assembly is supported from the stem 14 and comprises a plurality of rigid rods 17 embedded one in each of the arms of the press 16 and extending therefrom. A plurality of channeled sheet metal supports 18 (shown more clearly in Fig. 5) which may be of nickel,

are secured, as by welding, at one end to the rods 17 and are each provided at the one end with integral flanges 19. The flanges 19 are suitably secured, as by welding, to a dome-shaped shield 20, which is preferably of a good heat-conducting material such as nickel, disposed adjacent the press 16 and extending immediately adjacent but out of contact with the inner wall of the cylindrical end portion 12. The shield 20 is provided with a peripheral flange 21 to which a plurality of supporting wires 22 are attached. Each of the supporting wires 22 carries a unitary capsule and getter support (shown more clearly in Fig. 7) comprising a wire mesh cage 23 which encloses a vitreous capsule 24 containing a vaporizable material 25, such as mercury. A strip of getter material 26, such as magnesium, for fixing residual gases in the enclosing vessel is secured to each of the wire cages 23. In the manufacture of the device, the enclosing vessel is evacuated to a high degree and the unitary getter and capsule assemblies are heated, as by high frequency induction, to vaporize the getter material 26, which combines with residual gases in the enclosing vessel. The unitary assembly is then heated further to burst the capsules 24 whereby the vaporizable material 25 is liberated and deposited at the outer end of the cylindrical portion 12 of the enclosing vessel. During the operation of the device the material 25 is vaporized and forms a conductive vapor between the anode and cathode of the device.

The member 20 forms a heat shield between the cathode, to be described in detail hereinafter, and the press and the vaporizable material and protects the press 16 against the heat radiated from the cathode and also protects the vaporizable material 25 so that too great a vapor pressure will not be developed in the enclosing vessel.

A peripherally flanged disc 27 which may be of nickel, is secured, as by welding, to flanges 28 on the supports 18 and carries diametrically disposed parallel plates 29, each of which is provided with apertures 30 and integral tabs 31 disposed adjacent the apertures. A pair of parallel insulating rods 32, such as of "isolantite" or magnesium oxide, extend through the apertures 30 and are locked in position by the tabs 31 which are bent over the ends of the rods 32 as shown in Fig. 2. The electron-emitting cathode 33 comprises a wire mesh ribbon, such as nickel, coated with thermionically active materials, for example, barium and strontium carbonates, folded to form an accordion-like structure consisting of a plurality of closely spaced substantially parallel sections. Each of the sections is provided with apertures to allow passage of the rods 32 therethrough, the sections being separated by insulating spacers 34, such as "lavite". The ends of the folded cathode 33 are secured to end flanges on the plate 29 as shown more clearly in Fig. 2. A pair of parallel plates 35, which may be of nickel, having reinforcing flanges 36, are disposed substantially at right angles to the plates 31 and immediately adjacent the connected edges of the sections of the cathode. The plate 29 and 35 define heat-reflecting members and serve to confine the heat of the cathode so that during the operation of the device all portions of the cathode are maintained at substantially the same temperature with a resultant uniform electron emission from all parts of the cathode. The plates 29 and 35 and the disc 27, together with the close spacing

of the folds of the cathode conserve the cathode heat with a resultant high thermal efficiency for the cathode.

In order to conserve the cathode heat further, the cathode is substantially enclosed by a shell which also may be of nickel, including a cylindrical portion 37 secured to a peripheral flange 38 on the disc 27, and an annular top portion 39 having a restricted central aperture 40, the top portion being curved, as clearly shown in Fig. 3 to present a continuous smoothly rounded surface.

The form of the shell, together with the fact that all portions of the cathode are maintained at substantially the same temperature, reduces the potential gradient extant between the anode and cathode assembly of the device, and thereby reduces the tendency for the formation of deleterious ionic discharges, particularly on the negative portions of an alternating potential applied between the anode and cathode of the device. This construction renders the device substantially non-conductive on the negative portion of the alternating potential and prevents the flow of undesired currents in an external circuit associated with the anode and cathode of the device. On the positive portions of the applied alternating potential, the device is highly conductive and a large current, consisting in the main of an electron current with a small ion current, flows between the anode and the cathode.

The heating current for the cathode 33 may be supplied through leading-in conductors 41 which are connected to the supporting rods 17 at one end and are connected to each other and to a terminal plug 42 at the other end. A leading-in conductor 43 having a terminal plug 44 at one end and insulated from the conductors 41 by insulating beads 45, is connected to one end of a metallic rod 46 sealed in the center of the press 16 and extending therefrom. The rod 46 extends through a central aperture in the disc 20 and is insulated from the disc 20, as shown more clearly in Fig. 4, by a flanged insulator 47 which is held in position by a metallic cup 48 secured, as by welding, to the disc 20. The rod 46 also extends through an aperture in the disc 27 and is insulated from the disc by an insulating collar or washer 49. The free end of the rod 46 is attached to the cathode 33 at substantially the midpoint thereof. The cathode heater circuit, therefore, includes the conductors 41, rods 17, supports 18, disc 27, plates 29, cathode 33, rod 46 and conductor 43. The cathode consists of two sections electrically connected in parallel so that a relatively low voltage source may be utilized for supplying the heating current.

The anode 50 comprises a truncated pear-shaped shell, preferably of carbon, having a flat base portion disposed substantially parallel to the top or outer edges of the cathode 33, and disposed in axial alignment with the aperture 40 in the shell 37. As shown in Fig. 1, the outer surface of the anode presented to the cathode is smoothly rounded and devoid of sharp edges so that the potential gradient and the tendency for the formation of disruptive ionic discharges is reduced. The anode is provided with an interior hub 51 into which a metallic supporting stub 52 is threaded, as shown more clearly in Fig. 6. The outer end of the stub 52 is secured, as by welding, to a metallic flanged disc 53 which is supported by

a plurality of rigid wires 54 extending one from each of the arms of the press 15. The rigid wires 54 are electrically connected to a terminal pin 55 mounted on a thimble type insulator 56, which is secured as by cementing, to the end portion 11, by a plurality of leading-in conductors 57.

The electric discharge device may be conveniently supported, as shown in Fig. 1, by a metallic band 58 which is clamped about the end portion 12 of the enclosing vessel by nuts and bolts 59 and terminates in an outwardly extending bracket or arm 60 having a longitudinal slot 61 therein. The slot 61 is adapted to accommodate the shank of a bolt 62 carrying a wing nut 63 whereby the arm or bracket 60 may be securely clamped to a supporting bar 64. The supporting bar 64 is mounted upon a pedestal or base 65 which may be attached to a support, not shown, by bolts or screws 66.

Although a specific embodiment of the invention has been shown and described, it is to be understood, of course, that various modifications may be made without departing from the scope and spirit of the invention as defined in the appended claims.

What is claimed is:

1. An electrode assembly for an electric discharge device, comprising a support, a receptacle mounted on said support, a folded ribbon cathode within said receptacle, and a plurality of heat-reflecting members adjacent and substantially encompassing said cathode, said cathode being supported from certain of said heat reflecting members.

2. An electrode assembly for an electric discharge device, comprising a stem, a support extending from said stem, a metallic receptacle mounted on said support, an incandescible cathode having a plurality of closely adjacent sections mounted within said receptacle, and a plurality of metallic plates secured to and mounted within said receptacle and immediately adjacent outer edges of said cathode.

3. An electrode assembly for an electric discharge device, comprising a stem, a plurality of supports extending from said stem, a metallic receptacle mounted on said supports, a pair of metallic plates mounted within said receptacle, an incandescible cathode supported between said plates and within said receptacle, and a plurality of heat-reflecting members mounted within said receptacle adjacent said cathode.

4. An electrode assembly for an electric discharge device, comprising a stem, a plurality of supports extending from said stem, a metallic receptacle having a restricted opening therein mounted on said supports, heat-reflecting plates mounted within said receptacle, a plurality of supports extending between two of said plates, and a large surface incandescible cathode mounted on said supports and disposed adjacent said opening.

5. An electrode assembly for an electric discharge device, comprising a stem, a plurality

of supports extending from said stem, a plate member carried by said supports, a hollow cylindrical shell mounted on said plate member, a plurality of heat-reflecting members mounted on said plate member and disposed within said shell, and a large surface incandescible cathode mounted within and connected to said heat-reflecting members, said supports, plate member shell and heat-reflecting members forming a leading-in connection to said cathode.

6. An electrode assembly for an electric discharge device, comprising a stem, a plurality of supports extending from said stem, a metallic disc mounted on said supports, a cylindrical metallic shell carried by said disc, a plurality of metallic plates mounted within said shell, a plurality of rods extending between certain of said plates, and a folded ribbon cathode carried by said rods, having its edges immediately adjacent said plates.

7. An electric discharge device comprising an anode, a large surface incandescible cathode, and a heat conserving shield for said cathode including a metallic receptacle encasing said cathode and having a portion between said anode and cathode provided with a restricted opening to allow egress of electrons, and a plurality of heat-reflecting members mounted within said receptacle and substantially encircling said cathode, said cathode being supported from certain of said heat reflecting members.

8. An electrode assembly for an electric discharge device, comprising a stem, a plurality of metallic supports extending from said stem, a metallic disc mounted on said supports, a pair of parallel electrically conductive heat-reflecting members mounted on said disc, a plurality of insulating rods extending between said members, a folded ribbon cathode carried by said rods, having its folds substantially parallel to said members and connected at its ends to said members, a metallic rod extending from said stem and connected to said cathode intermediate the ends thereof, leading-in conductors connected to said metallic supports and to said rod, a plurality of heat reflecting plates disposed adjacent the joined edges of the folds of said cathode, and a metallic cylindrical shell having a restricted opening therein mounted on said disc and encircling said heat-reflecting members and plates.

9. An electric discharge device comprising an enclosing vessel having a stem, a plurality of supports extending from said stem, a receptacle having a restricted opening mounted on said supports, a large surface incandescible cathode consisting of a ribbon folded to form a plurality of closely spaced sections mounted within said receptacle adjacent said opening, a plurality of heat-reflecting members secured to and mounted within said receptacle and substantially encircling said cathode, and an anode in juxtaposition to said opening.

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