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D. S. BOND ET AL
ELECTRIC DISCHARGE DEVICE
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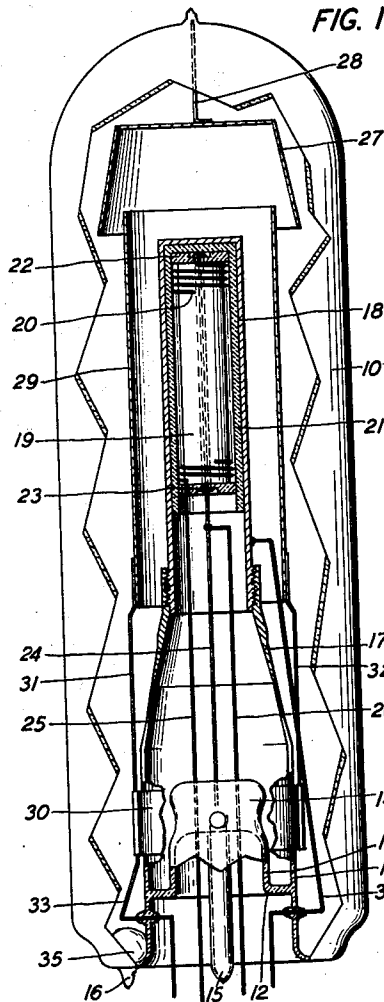


FIG. 2

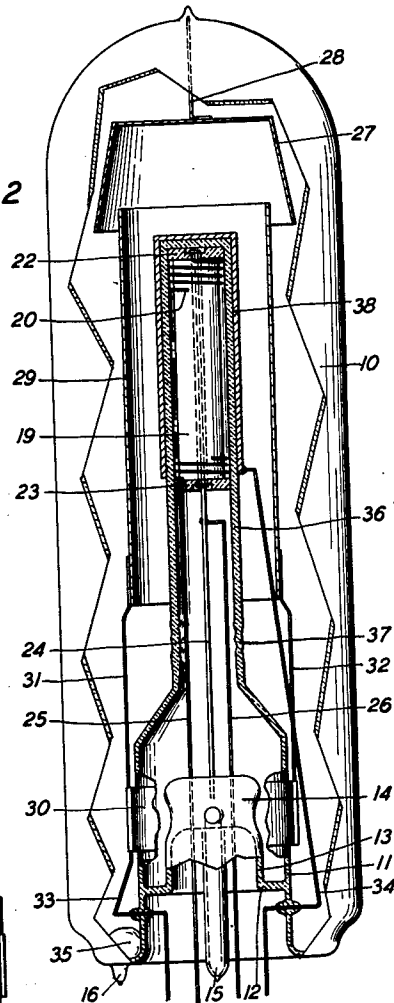


FIG. 3

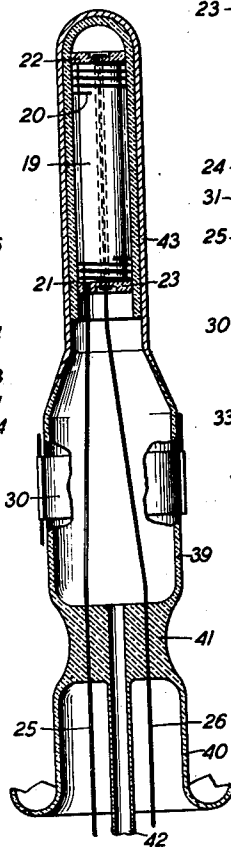
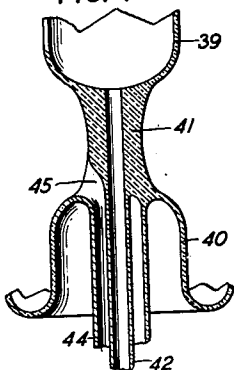


FIG. 4



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ELECTRIC DISCHARGE DEVICE

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11 Claims. (Cl. 250—27.5)

This invention relates to electric discharge devices and more particularly to such devices having a high current output and employing a cathode of the equi-potential type.

One object of the invention is to prevent arcing between the ends of the heater element associated with the equi-potential cathode.

Another object is to secure a large amount of electron emission at a low voltage without encountering difficulty in the structure of the leading-in wires and glass parts of the device.

In accordance with the broad aspect of this invention the enclosing vessel of the discharge device is provided with an inner highly evacuated compartment containing the heater element and the leading-in wires for supplying current to the heater. The cooperating electrodes, such as the cathode and anode are supported within the enclosing vessel, the cathode being in the form of a cylinder in contact with the inner compartment so that the heat conducted from the heater within the compartment raises the temperature of the cathode to the required degree for electron emission.

In a specific embodiment of the invention an enclosing vessel provided with an inwardly projecting stem has a metallic collar sealed directly to the stem. A hollow tubular member is supported by the metallic collar and forms an inner compartment which may be highly evacuated through the stem. A heater element wound on a support is positioned within the hollow member and transfers heat thereto when current is supplied to the conductors. The hollow member may be coated with suitable electron emitting material on the outer surface which is wholly within the enclosing vessel. Other electrodes may be positioned in spaced relation with respect to the electron emitting surface to obtain a high current output when the device is employed as a rectifier or amplifier. The enclosing vessel may be highly evacuated or filled with a gas or vapor which serves as the conducting medium. Due to the heater element and its associated leading-in wires being wholly within the evacuated inner compartment, a high voltage may be supplied to the heater without the resultant difficulty of arcing between the heater leading-in wires.

The same results may be accomplished in accordance with another embodiment of the invention in which a hollow quartz tubular member is sealed directly to the stem to replace the combined metal to glass seal. The quartz compartment is highly evacuated and contains the

heater element as described above. The inner compartment may then serve as a support for a cylindrical metallic cathode coated with thermionic material and disposed within the outer vessel. The stem of the enclosing vessel may also be modified to provide a double-ended portion sealed at an intermediate point through which the conductors extend and the cathode supported from the upper end of the stem to form the inner compartment. The inner compartment and enclosing vessel may be evacuated by a suitable tubulation extending into the stem.

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

Fig. 1 is a view in element of an electric discharge device made in accordance with this invention with the internal electrode structures shown in cross-section to illustrate the construction of the device;

Fig. 2 illustrates another form of the invention shown partly in cross-section in which the inner evacuated compartment is formed wholly of refractory material;

Fig. 3 illustrates in cross-section another form of the internal compartment supported on a double-ended stem; and

Fig. 4 is a cross-sectional view of a modified form of a double-ended stem shown in Fig. 3.

Referring to Fig. 1, the containing envelope of the electric discharge device made in accordance with this invention comprises an outer enclosing vessel 10 of refractory material, such as glass, and an inner concentric compartment formed substantially of metal and hermetically sealed to the glass stem 11 of the enclosing vessel. The tubular glass stem 11 is provided with an intermediate partition 12 having an inwardly projecting hollow portion 13 terminating in a press 14. A glass tubulation 15 extending outwardly from the press portion 14 permits the evacuation of the inner compartment. The outer enclosing vessel 10 may also be evacuated at the juncture of the vessel and stem and sealed off as shown at 16.

The evacuated inner compartment is supported on the glass stem 11 and comprises a metallic sleeve member 17, such as copper or chrome alloy, having a tapered edge at one end which is sealed to the edge of the glass stem 11, in accordance with a method disclosed in W. G. Houskeeper Patent 1,294,466, February 18, 1919, entitled Combined metal and glass structure and method of

making same. The metallic sleeve 17 is internally threaded at the other end to receive a cup-shaped tubular metallic member 18, preferably of nickel which is also threaded and silver soldered to the threaded portion of the sleeve 17. The exterior surface of the cup-shaped metallic member 18 is preferably coated with alkaline earth oxides, such as barium and strontium oxides, which when heated form a source of electrons which are emitted to the other electrodes supported in the enclosing vessel 10.

A heater element comprising an insulating spool 19 having wound thereon a heater wire 20 is supported within the cup-shaped metallic member 18 by an insulating sleeve 21, preferably of quartz. A pair of quartz discs 22 and 23 are positioned on opposite ends of the heater within the compartment. The heater element is also supported by an upright rod 24 which is sealed in the press 14 and extends through the center of the heater element. A leading-in wire 25 is sealed through the press 14 and is connected to one end of the heater wire 20 while another leading-in wire 26 is joined to the upright support 24 to which the other end of the heater wire 20 is attached. A hollow anode 27, preferably of metallic material and carbonized to increase heat dissipation, is provided with a leading-in wire 28 sealed in the top of the glass enclosing vessel, the anode being concentrically positioned with respect to the cup-shaped member 18 and the vessel 10 at one end thereof.

A metallic heat shield of cylindrical form coaxially surrounds the cup-shaped tubular member 18 and is supported from a metallic collar 30, surrounding the stem 11, by supporting rods or wires 31 and 32. A leading-in wire 33 is attached to the collar and sealed through the stem to apply a potential to the shield whereby it may be bombarded to remove occluded gases. The leading-in wire 34 is sealed to the stem 11 and connected to the cup-shaped metallic member 18 which serves as the cathode or electron emitter of the two-electrode discharge device or rectifier. The outer enclosing vessel 10 containing the electrodes may be filled with an inert gas or a vapor, to serve as the conducting medium between the electrodes. Preferably a body of mercury 35 is held in the outer enclosing vessel to serve as the conducting medium because mercury has a low vapor pressure and is capable of carrying large currents.

In high voltage, high current rectifying devices of the gaseous type, it is essential that the distribution of electron emission be uniform over the whole surface of the cathode. This uniform distribution of electrons cannot be obtained from a filament type cathode, due to the large voltage drop between the ends of the filament. When an equi-potential type cathode is employed to overcome the non-uniformity of emission from a filament type cathode other difficulties arise in the form of arcing between the heater leading-in wires.

In accordance with this invention these difficulties are overcome by employing an equi-potential cathode which distributes electrons over the whole surface of the cathode and segregates the heater elements and the heater leading-in wires from the discharge portion of the device by surrounding the heater and heater conductors with an evacuated chamber or compartment whereby arcing does not occur in the device. Therefore, a large amount of emission can be drawn from the cathode by heating it to a high temperature.

Consequently a high current output may be obtained with a device employing the structure of this invention.

While the gaseous rectifier device of this invention discloses a double chamber vessel having an inner compartment formed substantially of metal in which a portion of the compartment serves as the electron emitting cathode it is also possible to employ an inner compartment of a continuous dielectric, as shown in Fig. 2. In this arrangement the cup-shaped cathode 18 is replaced by a vitreous cup-shaped member 36, preferably of quartz, which may be directly sealed to the glass stem 11 by a graded quartz seal 37. The heater element may be supported within the quartz compartment in the same manner as disclosed in Fig. 1 except that only the discs 22 and 23 are positioned at opposite ends of the heater. A cup-shaped metallic sleeve 38, of platinum-nickel alloy or nickel, is supported on the quartz compartment and coated with thermionic material, to serve as the electron emitter between the cathode and the anode 27. This arrangement eliminates the metal-to-glass seal disclosed in Fig. 1, and forms an hermetically sealed inner compartment which may be evacuated to segregate the heater element and leading-in wires from the gaseous discharge path between the electrodes.

Fig. 3 illustrates another embodiment of the invention in which the glass stem is modified to provide two hollow compartments 39 and 40 connected by a substantially solid portion 41 having a central tubulation 42 extending through the solid portion 41 and entering the hollow portion 39. This type of stem can be easily formed from a section of glass tubing of suitable diameter in which is positioned the heater leading-in wires 25 and 26 and a length of glass tubulation 42 centrally positioned within the section of glass tubing. The glass tubing is heated at an intermediate point to force the plastic glass around the leading-in wires to form a press seal. A metallic rod may be inserted through the tubulation 42 to insure a central opening through the press portion 41. The combination inner compartment and cathode structure may be directly sealed to the glass stem as shown in Fig. 3 by employing a metal which will seal directly to the glass. For instance, the cathode 43 may be formed of platinum, platinum-nickel, chrome alloy, or even copper, since these metals have coefficients of expansion substantially the same as glass. If chrome alloy or copper is employed as the cathode material these metals may be coated or plated with another metal, such as nickel, which serves as the base for the thermionic material.

Fig. 4 shows another modification of the double ended stem in which the central glass tubulation 42 is supplemented by an outer tubulation 44, of larger diameter, which is sealed to the substantially solid press portion 41 of the stem and has an opening 45 which leads into the outer enclosing vessel of the device, whereby the inner compartment and the enclosing vessel may be separately or simultaneously exhausted during the process of manufacture.

While the invention is disclosed in various forms as applied to a half-wave gaseous rectifier device, it is, of course understood, that the invention may also be employed to full-wave rectifier devices. Furthermore, the segregation of the heater compartment from the discharge enclosing vessel may also be applied to high current

discharge devices of the vacuum type. Furthermore, it is to be understood that various modifications may be made in the structure and arrangement of the various elements of the devices above described without in any way departing from the spirit of the invention as set forth in the appended claims.

What is claimed is:

1. In an electric discharge device, an enclosing vessel having a stem, a cup-shaped metallic member sealed to said stem and forming a compartment separate from said enclosing vessel, a heater element enclosed by said compartment, means for evacuating said compartment through said stem, and emitter material coated on said cup-shaped member. 80
2. An electric discharge device comprising an enclosing vessel having a stem, an extension on said stem forming a coaxial compartment within said vessel, a metallic anode supported within said vessel, emitter means on said extension within said vessel for supplying electrons to said anode, means within said extension for heating said emitter means, and concentric tubular members extending from one end of said vessel and compartment. 85
3. An electric discharge device comprising an enclosing vessel having a stem, a cup-shaped tubular metallic member sealed to said stem and forming a compartment separate from said enclosing vessel, a heater element enclosed by said compartment, means for evacuating said compartment through said stem, thermionic material coated on said cup-shaped member, an anode supported in said vessel in cooperative relation to said cup-shaped tubular member, and a cylindrical heat shield surrounding said cup-shaped member. 90
4. A discharge device comprising an enclosing vessel having a stem, a metallic ring member sealed to said stem, a cup-shaped metallic member supported within said vessel by said ring member, electron emitter material coated on the exterior surface of said cup-shaped member, an anode supported in said vessel opposite said stem and cooperating with said coated member, a heater element within said cup-shaped member, and an outwardly extending evacuating tube for said stem leading into said cup-shaped metallic member. 95
5. A discharge device comprising an enclosing vessel having a stem, a metallic ring member sealed to said stem, a cup-shaped metallic member supported within said vessel by said ring member, electron emitter material coated on the exterior surface of said cup-shaped member, an anode supported in said vessel opposite said stem and cooperating with said coated member, a cylindrical heat deflecting shield coaxially positioned with respect to said cathode and anode, means supporting said shield from said stem, a heater element within said cup-shaped member, and a central tube sealed to said stem for evacuating said cup-shaped metallic member. 100
6. A vapor discharge device comprising an enclosing vessel having a stem, a metallic ring member sealed to said stem, a cup-shaped metallic member supported within said vessel by said ring member, electron emitter material coated on the exterior surface of said cup-shaped member, an anode supported in said vessel and cooperating with said coated member, the space in said vessel being filled with mercury vapor and forming an ionization path between said emitter material and said anode, the interior of said cup-shaped member being highly evacuated, a heater element for said emitter material within said cup-shaped member, and insulating material interposed between said heater element and the wall of said cup-shaped member. 105
7. A vapor discharge device comprising an enclosing vessel having a stem and containing a vapor producing substance, a refractory cup-shaped member sealed to said stem, a metallic member surrounding said cup-shaped member and supported thereby, electron emitting material coated on said metallic member, a heater element enclosed in said refractory member and having conductors sealed in said stem, and an evacuating tube sealed to said stem and leading into said refractory member. 110
8. A vapor discharge device comprising an enclosing vessel having a stem, a quartz hollow member sealed to said stem, a cylindrical cathode member supported on said hollow member, said cathode member being coated with alkaline earth oxides, a heater wire wound on a spool and supported within said hollow member, a cylindrical shield member coaxial with said cathode and supported from said stem, a hollow anode arranged in said vessel near one end of said hollow quartz member, said cathode and anode being surrounded by a vapor atmosphere at a suitable pressure, and means extending through said stem for evacuating the space in said hollow member containing said heater wire. 115
9. A vapor discharge device comprising an enclosing vessel having a double ended stem, said stem being formed of two hollow portions joined by an intermediate solid pressed portion, one of said hollow portions being sealed to said enclosing vessel and the other hollow portion projecting inwardly with respect to said vessel, of metallic cup-shaped member within said vessel, a metal-to-glass seal joining said cup-shaped member to said inwardly projecting hollow portion, cathode material supported on said hollow cup-shaped member, an anode supported in said vessel in cooperating relation with said cathode, an ionizable material in said vessel for conducting current between said cathode and anode, a heater element supported in said cup-shaped member, conductors for said heater sealed through the solid portion of said stem, and evacuating means for said hollow cup-shaped member extending through the solid portion of said double ended stem. 120
10. A vapor discharge device comprising an enclosing vessel having a double ended stem, said stem being formed of two hollow portions joined by an intermediate solid pressed portion, one of said hollow portions being sealed to said enclosing vessel and the other hollow portion projecting inwardly with respect to said vessel, a metallic cup-shaped member within said vessel, a metal-to-glass seal joining said cup-shaped member to said inwardly projecting hollow portion, cathode material supported on said hollow cup-shaped member, an anode supported in said vessel in cooperating relation with said cathode, an ionizable material in said vessel for conducting current between said cathode and anode, a heater element supported in said cup-shaped member, conductors for said heater sealed through the solid portion of said stem, and coaxial tubular members projecting into said outer stem portion, one of said tubular members leading into said cup-shaped member and the other tubular member leading into said vessel for si- 125

multaneously exhausting said vessel and cup-shaped member.

11. A vapor discharge device comprising a vessel containing a vapor producing substance, an anode and a cathode contained in said vessel, a heater element within said cathode, a vitreous container secured to and supporting said cathode

and forming with said cathode a chamber adapted to be evacuated, said container having a stem to which said vessel is sealed, and leading-in wires sealed in said stem and connected to said heater element.

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