Nov. 9, 1937. H. E. MENDENHALL 2,098,301

GLOW DISCHARGE DEVICE

Filed Oct. 3, 1935

FIG. 1

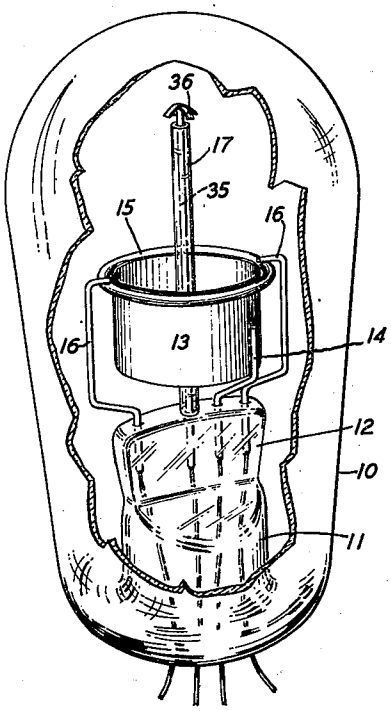


FIG. 4

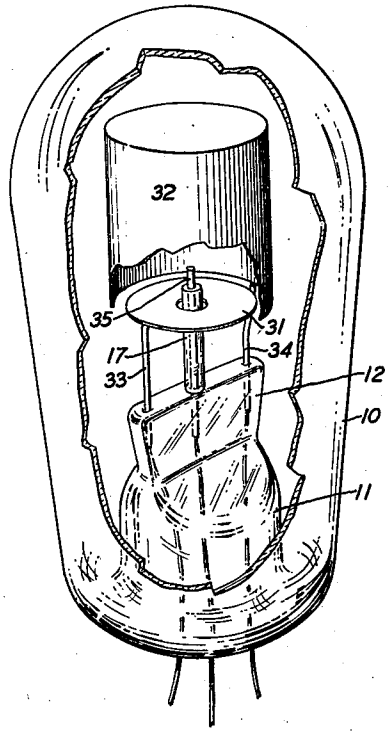


FIG 2

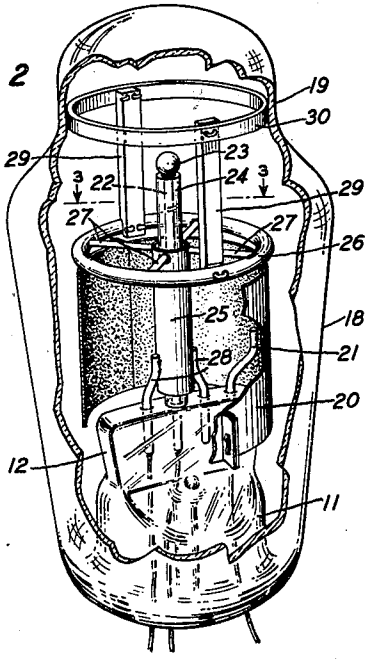
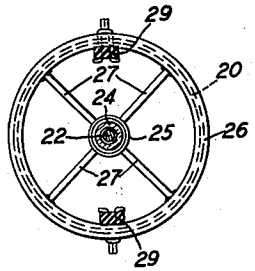


FIG. 3



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GLOW DISCHARGE DEVICE

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8 Claims. (Cl. 250—27.5)

This invention relates to glow discharge devices and more particularly to such devices having a large surface cold cathode and wherein the initiation of a discharge between the cathode and an anode is controlled by the potential upon an auxiliary or control electrode.

One object of this invention is to reduce the transfer current and breakdown voltage in glow discharge devices having an auxiliary or control electrode.

Another object of this invention is to obtain substantially uniform and simultaneous activation of a large surface cathode in glow discharge devices.

In one illustrative embodiment of this invention, a glow discharge device comprises an enclosing vessel having a gas, such as argon or neon, or a mixture of gases therein, a cylindrical cathode having a coating of thermionic material, such as barium and strontium carbonates, on one of its surfaces, a work anode, and an ignition anode or control electrode. The work anode may be a metallic rod extending through the cathode, all but one end portion of the rod anode being encompassed by an insulating sleeve, and preferably extends an appreciable distance above the cathode so that a high work gap potential may be employed.

In accordance with one feature of this invention, the auxiliary or control electrode is an annular member, for example, a wire ring disposed immediately adjacent one end of the cathode. This construction insures a low transfer current and hence enables control of a large discharge between the cathode and anode by a relatively small discharge between the cathode and control electrode.

In accordance with another feature of this invention, the work anode sleeve is encompassed by a tubular electrode which may be electrically connected to the auxiliary or control electrode, and which assures substantially uniform and simultaneous activation of the entire coated surface of the cathode during the activation period.

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

Fig. 1 is a perspective view of a glow discharge device illustrative of one embodiment of this invention;

Fig. 2 is a perspective view of another illustrative embodiment of this invention wherein an auxiliary electrode is provided in cooperative relation with the cathode for obtaining substantially uniform and simultaneous activation of a large portion of the cathode surface, a portion of the enclosing vessel and of the cathode being broken away to show the auxiliary electrode more clearly;

Fig. 3 is a view along line 3—3 of Fig. 2 of the electrode structure included in the device shown in Fig. 2; and

Fig. 4 is another perspective view of still another illustrative embodiment of this invention wherein the control electrode is an annular member within the cathode and adjacent one end thereof, a portion of the enclosing vessel and of the cathode being broken away to show the control electrode and anode more clearly.

Referring now to the drawing, the glow discharge device shown in Fig. 1 comprises an enclosing vessel 10 having a stem 11 at one end terminating in a press 12. The vessel 10 has a filling of a rare gas, such as argon or neon, at a pressure of the order of 10 to 40 millimeters of mercury, or a mixture of such gases. A mixture of rare gas with mercury vapor may also be used. A large surface cold type cathode 13 is supported above the stem and may be a cylinder of nickel coated on its inner surface with a thermionic material, such as barium and strontium carbonates, and supported by a wire or rod 14 embedded in the press 12. The outer surface of the cylinder 13 may be treated by a calorizing process to prevent a glow discharge from occurring on the outer surface of the cylinder and to insure thereby a low potential drop between the cathode and the work anode.

Disposed immediately adjacent the upper end of and encircling the cathode 13 is an ignition anode or control electrode 15 which may be an annular band or wire of nickel supported by a pair of wires or rods 16 embedded in the press 12 and which is of substantially the same diameter as the cathode 13. The control electrode 15 preferably is disposed closely adjacent the upper edge of the cathode 13 so that a discharge may be produced between the cathode and control electrode by a relatively low potential and is so disposed that the transfer currents will be small. The control electrode 15 and cathode 13, it will be apparent, form a relatively large gap of uniform width so that a large portion of the cathode will become activated substantially simultaneously upon the application of the proper activation potential between the control electrode 15 and the cathode 13.

A linear rod anode 35 having bent fingers 36 at its upper end extends in the axis of the cathode 13 and control electrode 15 and preferably projects an appreciable distance above the control electrode so that a relatively high work gap potential may be employed and a large output obtained. The rod anode 35 is embedded in the press 12 and all but the upper end thereof may be enclosed in an insulating sleeve 17.

In the embodiment of this invention illustrated in Figs. 2 and 3, the enclosing vessel 18 has a dome or tubular portion 19 at the end remote from

the stem 11. A split cylindrical cathode 20, which may be of nickel and coated on its inner surface with a thermionic material, is supported by a bent wire or rod 21 embedded in the press 12. Disposed within the cathode 20 and coaxial therewith is an anode 22, which may be a linear rod or wire embedded in the press 12 and having a spherical end portion 23. Preferably the anode 22 extends a material distance above the upper end of the cathode 20 so that a relatively high operating potential may be employed and a large output obtained. All but the end portion 23 of the anode 22 is encased in an insulating sleeve 24, such, for example, as a glass tube.

An ignition anode or control electrode, which may have a coating of thermionic material, is provided for controlling the initiation of a discharge between the cathode 20 and the spherical end 23 of the anode 22, and includes a cylindrical shell 25, for example, of nickel, encompassing the sleeve 24, and coaxial and substantially coextensive with the cathode 20, and a metallic or wire ring 26. The ring 26 is disposed immediately adjacent the upper edge of the cathode 20 and is mechanically and electrically connected to the shell 25 by a plurality of rigid metallic arms 27. The shell 25 and ring 26 may be supported from the stem 11 by a pair of rods or wires 28.

The ignition anode or control electrode may be maintained in the proper space relation with the cathode 20 by a bracing structure including a plurality of posts 29, preferably of insulating material, secured at one end to the ring 26 and attached at the other end to a flexible disc or ring 30, such as a sheet of mica, which engages the inner wall of the tubular portion 19 of the enclosing vessel 18.

It will be apparent that the ring 26 and cathode 20 form a relatively large gap of uniform and small width so that but a relatively small potential is necessary to produce a discharge between the cathode and ring, and, furthermore, uniform and substantially simultaneous activation of the portions of the cathode adjacent the ring 26 will be obtained. Moreover, the shell 25, which is at the same potential as the ring 26, assures uniform activation of the entire inner surface of the cathode 20 so that a maximum current to the spherical end 23 of the anode 22 obtains very shortly after the initiation of a discharge between the cathode 20 and the ring 26. Although the shell 25 and ring 26 have been shown and described as electrically connected, they may be electrically separate and have suitable different potentials applied thereto.

In still another embodiment of this invention, illustrated in Fig. 4, the ignition anode or control electrode may be an annular metallic disc 31 disposed within and coaxially with the cylindrical cathode 32, coated on its inner surface with a thermionic material, and is positioned immediately adjacent the lower end thereof. The disc 31 and cathode 32 may be supported by rods or wires 33 and 34, respectively, embedded in the press 12. A rod anode 35 extends through the control electrode 31 and into the cathode 32, all but the upper end of the anode being encased in an insulating sleeve 17, such as a glass tube.

Although specific embodiments of this invention have been shown and described, it will be understood, of course, that various modifications may be made therein without departing from the scope and spirit of this invention as defined in the appended claims.

What is claimed is:

1. A glow discharge device comprising a hollow cathode having a thermionic coating on one of its surfaces, an annular control electrode immediately adjacent one end of said cathode, a rod anode extending entirely through said cathode and control electrode and terminating beyond said one end, and an insulating sleeve encompassing all of said anode except the terminating portion thereof.

2. A glow discharge device comprising a cylindrical cathode having a thermionically activated inner surface, an anode extending through said cathode and having a portion beyond one end thereof, insulating means encasing all of said anode but said portion thereof, and a tubular control electrode within said cathode and substantially coextensive therewith.

3. A glow discharge device comprising a hollow cathode having a thermionically activated surface, an anode in cooperative relation with said cathode, and a control electrode including a portion adjacent one end of said cathode and a portion extending at an angle to said first portion and disposed in juxtaposition to said surface.

4. A glow discharge device comprising a cylindrical cathode having a coating of thermionic material on one of its surfaces, an anode in cooperative relation with said cathode, and a control electrode including an annular member adjacent one end of said cathode and a cylindrical member coaxial with said surface.

5. A glow discharge device comprising a cylindrical cathode having a coating of thermionic material on its inner surface, a rod anode extending in the axis of said cathode and beyond one end of said cathode, an insulating sleeve encompassing said anode, and a control electrode including a wire ring immediately adjacent said one end and a tubular shell within said cathode and encompassing said insulating sleeve.

6. A glow discharge device comprising an enclosing vessel having a stem, a tubular cathode, an electrode having an annular portion adjacent one end of said cathode, means supporting said electrode from said stem, and other supporting means including a flexible ring connected to said electrode and engaging said enclosing vessel.

7. A glow discharge device comprising an enclosing vessel having a stem, a cylindrical cathode, an electrode including an annular member adjacent one end of said cathode and a member extending within said cathode, means supporting said cathode and said electrode from said stem, supporting members carried by said annular member, and an insulating ring carried by said supporting members and engaging said enclosing vessel.

8. A glow discharge device comprising an enclosing vessel having a stem and a dome opposite said stem, a cylindrical cathode above said stem, an anode in cooperative relation with said cathode, a control electrode including an annular member adjacent the end of said cathode remote from said stem and a tubular member within said cathode, means engaging said tubular member for supporting said control electrode from said stem, and bracing means for said control electrode including an insulating member connected to said annular member and engaging the inner wall of said dome.

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