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GASEOUS DISCHARGE DEVICE
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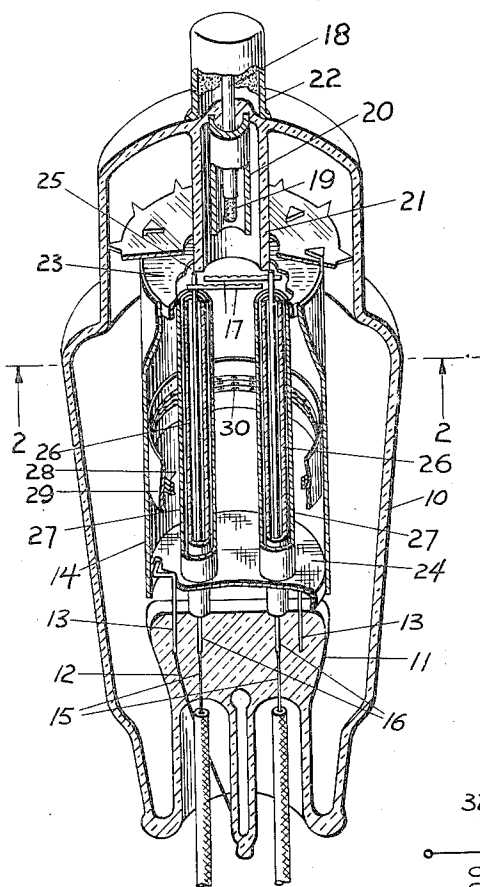


FIG. 1

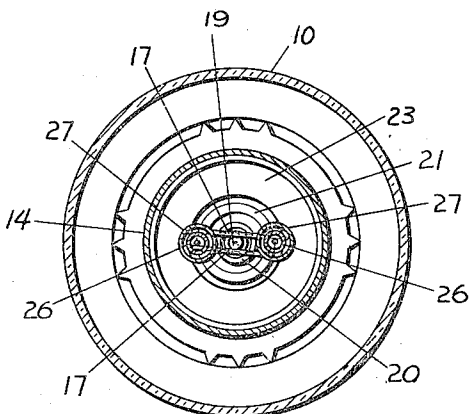


FIG. 2

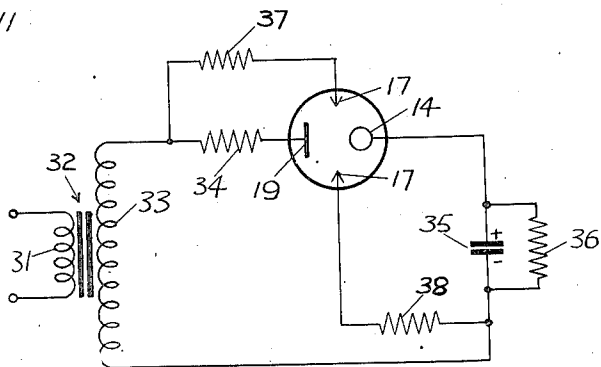


FIG. 3

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GASEOUS DISCHARGE DEVICE

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This invention relates to gaseous discharge devices, and more particularly to such devices employing a pair of starting electrodes between which a glow discharge is effected to initiate a discharge through the main cathode-anode circuit of the tube.

In my copending application, Serial No. 647,463, filed February 14, 1946, now United States Patent No. 2,435,246, issued February 3, 1948, a gaseous discharge device is disclosed having, beside the two main electrodes, a third electrode having a portion spaced a distance from the effective area of one of the said main electrodes substantially equal to the minimum breakdown-potential distance. A glow discharge initiated between the main electrode and the third electrode ionizes the gas in the space between the two main electrodes which are spaced at a distance substantially greater than the minimum breakdown-potential distance. Such a construction provides a tube which greatly facilitates the initiation of the main discharge.

The present invention is based upon the discovery that the starting glow discharge may be more readily initiated by providing a pair of starting electrodes between either of which and one of the main electrodes or between each other the glow discharge may be initiated. One of the two starting electrodes constitutes an auxiliary cathode and the other a starting anode. The construction provides a discharge device in which a minimum output is required to ionize the anode space.

The above and other objects and features of the invention will be made fully apparent to those skilled in the art from a consideration of the following detailed description taken in conjunction with the accompanying drawing, in which:

Fig. 1 shows a perspective view of a gaseous discharge device constructed in accordance with the invention and having parts broken away to show internal construction;

Fig. 2 is a section taken on the line 2—2 of Fig. 1; and

Fig. 3 is a schematic diagram of a rectifying circuit employing a discharge device of the present invention.

Referring to the drawing, reference numeral 10 indicates an envelope of vitreous material containing an ionizable gas, for example, helium at a pressure of about fourteen millimeters of mercury. The tube is sealed at one end by an internal press 11 having a lead-in conductor 12 and supporting rods 13 for the cathode 14. Lead-

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in conductors 15 connected to metal rods 16 provide lead-in conductors and supports for a pair of auxiliary or starting electrodes 17.

The other end of the tube is provided with a central conductor 18 sealed through the wall of the tube and providing a lead-in conductor and support for an anode 19 preferably of carbon. A metal sleeve 20, embedded in the seal, surrounds the anode 19 leaving a short clearance space therebetween. A glass sleeve 21 surrounding the anode 19 and its metal shield 20 is fused with the glass or other vitreous material of the envelope 10 and projects downwardly for a short distance below the end of the anode 19 and its surrounding sleeve 20. An end cap 22 of metal cemented around the central conductor 18 and electrically connected thereto is provided to protect the seal at the upper end of the tube, and also permits the connection of the anode to a suitable source of current.

The cathode 14 comprises a hollow tubular member preferably of nickel closed at its upper and lower ends by end caps 23 and 24, respectively. An opening 25 is provided in the upper end cap 23 into which the sleeve 21 projects permitting a free discharge path between the anode 19 and the active interior surface of the cathode 14. The lower end cap 24 of the cathode 14 is provided with a pair of spaced openings through which the rods 16 project. The rods 16 extend upwardly through the cathode 14 to points adjacent to, but spaced from, the upper end cap 23. Glass sleeves 26 fused to the press 11 surround each of the rods 16 throughout the greater portion of their length terminating just below the upper ends thereof. Metal sleeves 27 surround the glass sleeves 26 throughout the portion of the length thereof within the cathode 14 and are rigidly secured to the cap 24 at the two openings therethrough. Preferably, a small clearance is provided between the metal sleeves 27 and the glass sleeves 26, and the upper ends of the metal sleeves 27 terminate flush with the ends of glass sleeves 26. Hollow iron wires 17 are welded to the projecting ends of the rods 16 and extend substantially at right angles thereto, projecting across the open end of sleeve 21. The exposed ends of the rods 16 and the projecting hollow iron wires 17 constitute auxiliary or starting electrodes having the iron wire portions 17 lying in or close to the same plane and extending approximately parallel, leaving a short gap between the parallel portions of the wires 17. The distance across the gap between the wires 17 is approximately equal to the minimum

breakdown-potential distance for the gas and the pressure used. The hollow wire electrodes 17 are filled with electron-emissive material which may be released through a plurality of spaced apertures in the wires during the operation of the tube.

The interior surface of the cathode 14 may be activated by providing a plurality of hollow iron wires 28 mounted upon a metal strip 29 as disclosed in the prior application previously mentioned. The hollow iron wires 28 are provided with regularly spaced apertures 30 through which the electron-emissive material is released.

A suitable circuit, in which the device disclosed in the foregoing may be applied, is shown in Fig. 3 in which the primary winding 31 of a transformer 32 is supplied with current from an alternating current source and stepped up to a voltage of the order of 1600 volts across the secondary winding 33. The anode 19 of the tube is connected to one end of the secondary winding 33 through a peak current limiting resistor 34 which may be of the order of 10,000 ohms. The cathode 14 is connected to the opposite end of the secondary winding 33 through a condenser 35 which may have a capacitance of the order of two microfarads. One of the starting electrodes 17 is connected to the anode through a resistor 37, the resistance of which is very high, for example, of the order of ten megohms. The other starting electrode 17 is connected to the conductor between the secondary winding 33 and the condenser 35 through a resistor 38 also of about ten megohms. A load resistor 36 which may be of the order of 200,000 ohms is connected across the condenser 35.

In operation, during the initial portion of the positive half-wave of applied potential and before the initiation of conduction through the tube, one of the starting electrodes 17 will be at the same potential as the anode 19. The other starting electrode will be at the same potential as the negative side of the condenser 35. At this instant, the glow discharge may be initiated between the two auxiliary electrodes 17. The gas in the space immediately adjacent the anode 19 becomes highly ionized. Upon the initiation of the discharge between the two starting electrodes 17, the potential difference between these two electrodes drops sharply relative to the anode-cathode potential due to the resistors 37 and 38. The potential upon the anode 19 being higher than the potential on electrode 17 and the gas in the space between the anode 19 and the cathode 14 being highly ionized, a glow discharge is now initiated between the anode 19 and the cathode 14. Upon conduction through the anode-cathode circuit of the tube, the potential between the two starting electrodes drops to a value incapable of supporting a discharge therebetween.

The spacing and arrangement of the two starting electrodes insure that the starting discharge across the gap between these two electrodes will occur, at least in part, in the region adjacent the open end of the sleeve 21. The gas in the region of the anode, as well as the gas in the interior of the cathode, is highly ionized by the starting discharge, thus insuring an immediate discharge through the main electrodes.

While there has been herein described a preferred embodiment of the invention, other embodiments within the scope of the appended claims will be apparent to those skilled in the art from a consideration of the form shown and the teachings hereof.

What is claimed is:

1. A gaseous discharge device comprising an envelope containing an ionizable gas, a plurality of electrodes within said envelope, said electrodes including an anode, hollow cathode, and two starting electrodes, said anode being disposed exteriorly of said cathode and said cathode having an opening providing a discharge path between said anode and the interior of said cathode, said starting electrodes being mounted within said cathode and projecting across said opening, one of said starting electrodes being an auxiliary cathode and the other a starting anode.

2. A gaseous discharge device comprising an envelope containing an ionizable gas, a plurality of electrodes within said envelope, said electrodes including an anode, a cathode, and two starting electrodes, said starting electrodes being mounted in the discharge path between said cathode and anode, said starting electrodes each including a hollow wire portion filled with electron emissive material and having spaced apertures, said wire portions being substantially parallel and spaced a distance from each other substantially equal to the minimum breakdown-potential distance.

3. A gaseous discharge device comprising an envelope containing an ionizable gas, a plurality of electrodes within said envelope, said electrodes including an anode, a relatively large, hollow, metallic cathode, and two starting electrodes, said cathode having an opening providing a discharge path between said anode and the interior of said cathode, said starting electrodes being mounted within said cathode and projecting across said opening, said starting electrodes including substantially parallel portions spaced a distance from each other substantially equal to the minimum breakdown-potential distance.

4. A gaseous discharge device comprising an envelope containing an ionizable gas, a plurality of electrodes within said envelope, said electrodes including an anode, a relatively large, hollow, metallic cathode, and two starting electrodes, said cathode having an opening providing a discharge path between said anode and the interior of said cathode, said starting electrodes being mounted within said cathode and projecting across said opening, said starting electrodes each including transversely projecting wire portions, said wire portions being substantially parallel and spaced a distance from each other substantially equal to the minimum breakdown-potential distance.

5. A gaseous discharge device comprising an envelope containing an ionizable gas, a plurality of electrodes within said envelope, said electrodes including an anode, a relatively large, hollow, metallic cathode, and two starting electrodes, said cathode having an opening providing a discharge path between said anode and the interior of said cathode, said starting electrodes being mounted within said cathode and projecting across said opening, said starting electrodes each including a hollow wire portion filled with electron emissive material and having spaced apertures, said wire portions being substantially parallel and spaced a distance from each other substantially equal to the minimum breakdown-potential distance.

6. A gaseous discharge device comprising an envelope containing an ionizable gas, a plurality of electrodes within said envelope, said electrodes including an anode, a relatively large, hollow, metallic cathode, and two starting electrodes, said cathode having an opening providing a discharge path between said anode and the interior of said

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cathode, an insulating sleeve surrounding said anode and having an open end projecting into said opening of said cathode, said starting electrodes being mounted within said cathode and projecting across said opening, said starting electrodes including substantially parallel portions spaced a distance from each other substantially equal to the minimum breakdown-potential distance.

7. A gaseous discharge device comprising an envelope containing an ionizable gas, a plurality of electrodes within said envelope, said electrodes including an anode, a relatively large, hollow, metallic cathode, and two starting electrodes, said cathode having an opening providing a discharge path between said anode and the interior of said cathode, an insulating sleeve surrounding said anode and having an open end projecting into

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said opening of said cathode, said starting electrodes being mounted within said cathode and including substantially parallel portions spaced a distance from each other substantially equal to the minimum breakdown-potential distance and providing a discharge gap adjacent said opening.

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The following references are of record in the file of this patent:

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