Aug. 13, 1935. M. J. DRUYVESTEYN 2,010,852

GASEOUS ELECTRIC DISCHARGE DEVICE

Filed June 22, 1934

Fig. 1

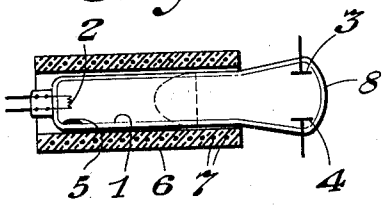



Fig. 2

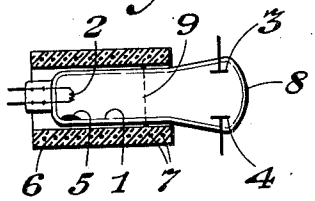
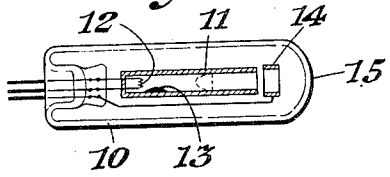



Fig. 3

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# UNITED STATES PATENT OFFICE

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## GASEOUS ELECTRIC DISCHARGE DEVICE

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4 Claims. (Cl. 176—122)

The present invention relates to gaseous electric discharge devices generally and more particularly the invention relates to such devices the gaseous atmosphere of which consists of or comprises a metal vapor.

Gaseous electric discharge lamp devices the gaseous atmosphere of which consists of a mixture of rare gas and a metal vapor are efficient light sources. Discharge lamp devices having a gaseous filling consisting of a rare gas and mercury vapor are useful not only as light sources but also as ultra-violet generators. Sodium vapor lamps are very efficient light sources. The vapors of certain other metals, such as magnesium, aluminum and silver, theoretically has value as a light giving element in gaseous electric discharge devices but have not been successfully used in such devices heretofore because no glass has been discovered which is chemically resistant to the hot vapor of such metal or which does not soften at the high temperature required for an effective metal vapor pressure in the lamp.

The object of the present invention is to provide a gaseous electric discharge lamp device of such structure that the vapor of the above enumerated metals among others can be successfully used therein as a light giving element. Still further objects and advantages attaching to the device and to its used and operation will be apparent to those skilled in the art from the following particular description.

In accordance with this object the invention comprises a gaseous electric discharge device having a tubular container and electrodes mounted at opposite ends of the container, one of said electrodes being a cathode. A window is provided in said container at the end thereof remote from the cathode. The vaporizable material is located adjacent said cathode and remote from said window. The container has a rare gas therein in which has a higher ionizing potential than the vapor of the vaporizable material. The tube current and the gas pressure are of such magnitude that a vapor discharge takes place in the region of the cathode and a gas discharge having a voltage drop along the length thereof, such as a positive column discharge, occurs in the anode part of the device.

A simple embodiment of the invention comprises a tubular container, a cathode and anodes mounted at opposite ends thereof and a window at the anode end of said container. The anodes are mounted between the window and the cathode. The anode is of such shape that the discharge between said electrodes is visible end on through said window. A ring shaped anode is suitable for this purpose. A quantity of vaporizable material is located in the vicinity of the cathode and a rare gas is present in said container. When the gas pressure and the current is of sufficient magnitude the spectrum of the light emitted by the discharge in the vicinity of the cathode is that of the vapor while the spectrum of the light emitted by the positive column discharge in the region of the anode is that of the gas. The gas at high pressure present in the container slows up the diffusion of the metal vapor atoms toward the anode end of the container and the metal vapor atoms are ionized in the positive column gas discharge and are attracted back toward the cathode. The positive column discharge which occurs in the anode part of the container thus acts as a barrier or stop to hold the metal vapor back from the anode part of the container and the hot metal vapor is prevented from coming into contact with the window at the anode end of the container while the light rays emitted by the vapor discharge pass freely through the window.

When the walls of the container consist of a material non-resistant to chemical attack by the metal vapor these walls become blackened and opaque when the metal vapor comes into contact therewith. This does not impair the efficiency of the device since the light rays are transmitted by the window which is protected from the metal vapor as pointed out above. When the mechanical strength of the container walls is apt to be weakened by the chemical attack of the metal vapor it is advantageous to mount in the container a tube surrounding the discharge path between the electrodes. This structure is also advantageous when the operating temperature of the device is above the softening temperature of the glass walls of the container in which case the tube surrounding the electrodes is of a material having a high melting point, such as porcelain, magnesium oxide, or aluminum oxide.

When desired the inside wall of the tube has a reflecting surface which increases the intensity of the light emitted by the device through the window thereof. A hollow cylinder of chromium steel polished on the inside surface thereof and inserted in the tube is suitable for this purpose. It is also advantageous to polish the outside of said tube to reduce the emission of heat therefrom. When the tube is made of a high melting point material, such as porcelain, magnesium oxide or aluminum oxide a thin metal sheath, such as a hollow, molybdenum cylinder polished

on the outside, surrounding the tube is advantageous for this purpose. Such a sheath increases the mechanical strength of the tube and effects a more even temperature distribution over the walls of said tube. The radiation of heat from the walls of the container of the device can be reduced by surrounding the container with a reflecting or heat-insulating jacket. Asbestos is a suitable material for a heat insulating jacket. A heating element connected in series with said device is mounted on said jacket, when desired.

The boundary between the vapor discharge and the gas discharge in said device is not, as a rule, a flat plane, but rather is convex on the cathode side thereof and concave on the anode side thereof. For this reason it is desirable that the distance between the anode and the rim of the boundary be large enough to permit the formation of a gas discharge having a voltage drop along the length thereof sufficient to enable the discharge to successfully perform the function of acting as a barrier for the metal vapor. The concavo-convex boundary can be flattened somewhat, when desired, by providing a circular protuberance at that part of the element of the device surrounding the boundary. The concavo-convex shape of the boundary can be avoided entirely, when desired, by mounting a grid, such as a metal screen, transverse to the longitudinal axis of the element surrounding the discharge path between the electrodes and between the vapor discharge and the gas discharge therein which makes said boundary a flat plane. A large voltage drop takes place at the anode side of the grid and the distance between the anode and boundary can thus be made shorter than in the case where no grid is used.

In the drawing accompanying and forming part of this specification several embodiments of the invention are shown in which

Fig. 1 is a front elevational, partly sectional view of one embodiment of the invention,

Fig. 2 is a similar view of another embodiment, and

Fig. 3 is a similar view of still another embodiment of the invention.

Referring to Fig. 1 of the drawing, the new and novel gaseous electric discharge lamp device comprises a tubular container 1 flared at one end and having electrodes 2, 3, and 4 sealed therein. Said electrode 2 is the cathode and is electron emitting when heated. Said cathode 2 consists of a metal filament, such as a tungsten filament, coated or impregnated with an electron emitting material, such as barium oxide, and is sealed into one end of said container 1. Said electrodes 3 and 4 are plate anodes and are sealed into said container 1 at the end thereof opposite that end into which said cathode 2 is sealed. Said container 1 is surrounded over part of its length adjacent the cathode by a sleeve 6 of heat insulation material, such as asbestos, in which a heating coil 7 is embedded. The heating coil 7 is connected in series with the discharge in said container 1 during the operation of the device and acts as a series resistance, when desired. I prefer to operate the new and novel lamp device as a rectifier, it will be understood, of course that the device can be operated on direct current, when desired, in which case one of the anodes 3 or 4 is omitted. I have obtained good results with a lamp device wherein the distance between the cathode 2 and the anodes 3 and 4 was approximately 20 cm.; the diameter of the container 1 was approximately 27 mm.; the gaseous filling of neon was at a pressure of 6 mm., and a quantity 5 of vaporizable material, such as magnesium, was mounted adjacent the cathode 2. The above described device was operated on a current of approximately 6 or 7 amperes.

During the operation of the lamp device the container 1 surrounded by jacket 6 is at a temperature of approximately 320 to 480° C. The magnesium vapor concentrates in the region of the anodes 3 and 4. The discharge in the region of the anodes takes place in the neon and is of the positive column type. The boundary between the two discharges is indicated by dotted lines in Fig. 1 of the drawing. The flared end of the container 1 has a weaker neon discharge therein. The neon discharge in the region of the anode acts as a kind of stop which closes off the anode part of the container 1 from the magnesium vapor to prevent the magnesium vapor from coming into contact with the end wall 8 of said container 1. The wall 8 thus remains transparent during the operating life of the lamp device even though the other walls of said container 1 are attacked and blackened by the metal vapor. Magnesium vapor emits ultra-violet radiations when excited by the passage of an electric discharge therethrough and it is desirable that at least the window 8 in the container 1 be made of a material which transmits such rays, such as quartz.

The container 1 can be made shorter in length, when desired, by mounting a screen 9 therein transverse to the longitudinal axis of said container 1 as shown in Fig. 2 of the drawing. The boundary between the vapor discharge and the gas discharge is a flat plane in this embodiment of the invention. The metal vapor discharge is between the screen 9 and the cathode 2 and the gas discharge is between the screen 9 and the anodes 3 and 4. A high voltage drop takes place at the anode side of the screen 9 which performs the same function as the positive column discharge in the neon in the embodiment of the invention illustrated in Fig. 1 of the drawing.

The embodiment of the invention illustrated in Fig. 3 of the drawing comprises a tubular container 10 having mounted therein a tube 11 of heat resisting material, such as aluminum oxide, surrounding the cathode 12 and extending along the longitudinal axis of said container 10. Said tube 11 is closed at the end thereof located between the cathode 12 and the stem of said container 1 and is open at the other end thereof. A body 13 of vaporizable material, such as aluminium, is located in said tube 11 adjacent said cathode 12. A ring-shaped anode 14 is mounted adjacent the open end of said tube 11. The container 10 has a gaseous atmosphere therein consisting of neon or helium. Said tube 11 is surrounded by a hollow cylinder open at both ends, such as a molybdenum cylinder, to evenly distribute the heat thereover, when desired, and the container 10 is surrounded except for the window 15 by a sheet metal jacket polished on the inside to decrease the radiation of heat therefrom, when desired. Take, for example, a lamp device filled with neon at 6 mm. pressure and having the above structure and in which the diameter of the container 10 is 5 cms., the diameter of the tube 11 is 8 mm. and the length thereof 10 cm., the distance between the cathode 12 and the closed end of the tube 11 is 8 mm. and the distance between the anode 14 and the open end of the tube 11 is a few mm.

When the above described device is operated

on a current of approximately 8 to 10 amperes the discharge space within the tube 11 is at a temperature of approximately 650° C. during the operation of the device. The aluminum vapor discharge takes place in the region of the cathode 12 and the neon gas discharge in the region of the anode 14. The boundary between the two discharges is indicated by the dotted lines in Fig. 3 of the drawing. The positive column discharge in the neon acts as a kind of cork or stopper which closes the open end of the tube 11 to the aluminum vapor and prevents said vapor from coming into contact with the window 15. The device can also be used as an ultra-violet generator in which case the window 15 is made of a material which transmits ultraviolet rays. When desired a screen similar to that illustrated in Fig. 2 of the drawing is mounted in said tube 11 transverse to the longitudinal axis thereof. The tube 11 is of conical shape to increase the angle at which the light is emitted, when desired.

While I have shown and described and have pointed out in the annexed claims certain novel features of the invention, it will be understood that various omissions, substitutions and changes in the forms and details of the devices illustrated and in their use and operation may be made by those skilled in the art without departing from the broad spirit and scope of the invention, for example, other types of electron emitting cathodes, such as an indirectly heated cathode of the Hull type, or a cathode consisting of a body of electron emitting material having a metal heater in operative relation thereto, is used in said devices, when desired.

What I claim as new and desire to secure by Letters Patent of the United States is:—

1. A gaseous electric discharge device comprising a container, electrodes sealed therein. a gaseous atmosphere therein comprising a gas and a metal vapor, said gas having a higher ionizing potential than said metal vapor, at least one of said electrodes being a cathode, said cathode being electron emitting when heated, another of said electrodes being an anode, and a window in said container, said anode being eccentrically mounted between said cathode and said window, and a body of vaporizable material mounted adjacent said cathode the smallest diameter of the discharge path between said electrodes being at said cathode.

2. A gaseous electric discharge device comprising a container, electrodes sealed therein, a gaseous atmosphere therein comprising a gas and a metal vapor, said gas having a higher ionizing potential than said metal vapor, at least one of said electrodes being a cathode, said cathode being electron emitting when heated, another of said electrodes being an anode, a grid and a window in said container, said anode being eccentrically mounted between said cathode and said window, said grid being interposed between said anode and said cathode and transverse to the discharge path therebetween, and a body of vaporizable material mounted adjacent said cathode the smallest diameter of the discharge path between said electrodes being at said cathode.

3. A gaseous electric discharge device comprising a container, electrodes sealed therein, a gaseous atmosphere therein comprising a gas and a metal vapor, said gas having a higher ionizing potential than said metal vapor, at least one of said electrodes being a cathode, electron emitting when heated, another of said electrodes being an anode, a tube in said container, said tube surrounding said cathode and extending toward said anode, a window in the walls of said container, said anode being eccentrically mounted between said cathode and said window, and a body of vaporizable material mounted adjacent said cathode the smallest diameter of the discharge path between said electrodes being at said cathode.

4. A gaseous electric discharge device comprising a container, electrodes sealed therein, a gaseous atmosphere therein comprising a gas and a metal vapor, said gas having a higher ionizing potential than said metal vapor, at least one of said electrodes being a cathode, said cathode being electron emitting when heated, another of said electrodes being an anode and a window in said container, said anode being eccentrically mounted between said cathode and said window, and a body of difficultly vaporizable material mounted adjacent said cathode the smallest diameter of the discharge path between said electrodes being at said cathode.

MARI J. DRUYVESTEYN.