Sept. 12, 1933. H. W. WEINHART 1,926,889

GLOW DISCHARGE DEVICE

Filed June 26, 1929

FIG. 1.

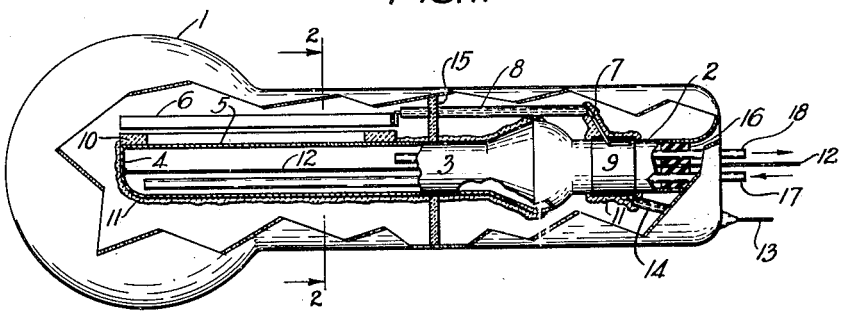


FIG. 2.

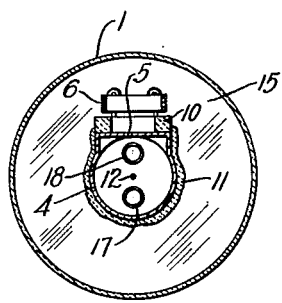
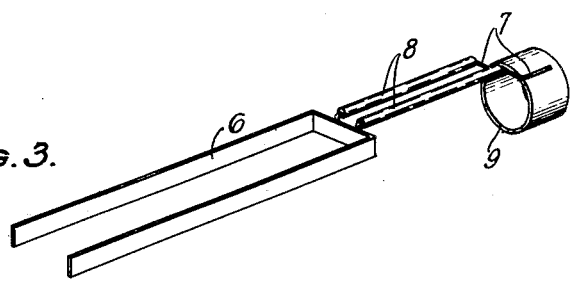


FIG. 3.



INVENTOR
H. W. WEINHART
BY J. P. Neille
ATTORNEY

Patented Sept. 12, 1933 1,926,889

UNITED STATES PATENT OFFICE

1,926,889

GLOW DISCHARGE DEVICE

Howard W. Weinhart, Elizabeth, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application June 26, 1929. Serial No. 373,818

8 Claims. (Cl. 176—122)

This invention relates to glow discharge devices and more particularly to devices of this type which constitute an especially efficient source of light.

In electro-optical systems, for example, picture transmission, television, sound recording systems, etc. a highly concentrated and very brilliant light of great intensity is most desirable.

It has heretofore been proposed to utilize glow discharge devices as a source of light in systems of the type described above and to give at least one of the electrodes such configuration that the light produced by the glow discharge is highly concentrated and of considerable brilliancy.

In an article entitled "Die Stromdichte des normalen Katodenfalles" by Gunther-Schulze, which appeared in Zeitschrift für Physik in 1923, it is explained on page 315 that in order to produce a cathode potential drop which is uniform with respect to the cathode surface of a glow lamp it is essential that the anode completely surround the cathode and be uniformly spaced therefrom.

An experimental apparatus for effecting the above result is shown in Fig. 1 on page 315. This apparatus comprises a platinum cathode constituting an elongated thimble with its upper end closed by a rubber stopper which carries an inlet tube and outlet tube through which water is supplied to the interior of the platinum cathode, an anode of iron wire netting positioned concentrically of the cathode and an enclosing bell jar of 5.5 liters capacity which is mounted on a brass base and sealed thereto with grease and mercury. In this construction the negative glow completely surrounds the cathode and extends from one end of the tube to the other and hence is of relatively large area.

An object of the present invention is to provide a glow lamp having an extended plane glow area which radiates light of uniform intensity throughout and the operation of which is stable.

Another object is to provide a light source of very high intensity and extreme brilliancy.

One embodiment, which will be hereinafter disclosed whereby the above mentioned and other objects are accomplished, involves a substantially cylindrical cathode having one end closed and the opposite end carried by a stem provided with a stopper carrying an inlet tube and outlet tube extending into the cathode through which a cooling fluid is supplied to circulate therein and having one face flattened to provide a plane surface; a fork-shaped anode with its tines parallel to the periphery of the cathode plane surface, cooperates with the cathode so that the whole of the plane surface is exposed to permit radiation of light rays therefrom, the electrodes being enclosed within a transparent bulb or container filled with neon, argon or other gas or mixture of gases.

For a complete understanding of the invention, together with its principles, organization and mode of operation, the following description should be read in conjunction with the attached drawing.

Fig. 1 is a side elevation of a structure which embodies the invention with a portion of the bulb broken away to show the relation of the parts of the device;

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

Fig. 3 is a perspective view illustrating the anode and its relation to the plane surface of the cathode.

Referring to Fig. 1 there is shown a glow discharge device comprising a transparent bulb or container 1 having integrally formed therewith a stem 2.

Mounted upon the stem 2 and sealed thereto is a cathode 3 of conductive material, preferably copper. The copper cathode 3 may be sealed to the stem 2 in any approved manner, for example, as disclosed in U. S. Patent 1,294,466, issued February 18, 1919 to Houskeeper.

Cathode 3 while substantially cylindrical and closed at one end 4 is either flattened or provided with a plane surface 5 extending axially thereof.

The anode 6, which may be fork-shaped, is supported parallel to the flattened or plane surface of the cathode 3. The tines of the fork shaped anode are preferably of the same length as the plane surface 5 and respectively lie in planes which define the periphery of that surface. The anode is supported from the stem 2 by conductors 7, each enclosed in a glass sleeve 8, having their opposite ends secured to a collar 9 mounted on the stem 2.

The plane surface 5 is surrounded by a rectangular insulating plate 10, which may be of lavite, and the remainder of the external surface of the cathode is covered with an insulating cement 11. In other words, the whole surface of the cathode, except the plane surface 5, is completely insulated, as is also the sleeve or collar to which the anode leads are connected.

The cathode 3 and anode 6 are provided with lead-in wires 12 and 13 respectively, which extend through the stem 2 and wall of the constainer

1 for connection to contacts mounted on a base (not shown) of the type now generally used in the manufacture of incandescent lamps. The portion of the anode lead-in wire between the collar 9 and the wall of the glass container is enclosed in a glass sleeve 14.

Intermediate between the stem and the electrically active surfaces of the anode and cathode is a mica disc 15 of the same diameter as the interior of the bulb 1.

The lavite plate 10 is provided with an opening which corresponds exactly in shape and size to the plane surface 5 of the cathode. The external dimensions of the lavite plate are such that, at the operating potentials applied to the device, the electric discharge from the anode to the cathode is confined to surface 5. The quartz cement 11, which is composed of powdered quartz and sodium silicate, and the glass sleeves 8 and 14 are provided to prevent the occurrence of electric discharges to or from the leads 7, 13 and collar 9.

As an additional precaution, to prevent electrical discharges through undesired paths within the bulb, the mica disc 15 is provided to divide the interior of the bulb into an active discharge area and an inactive section.

The stem 2, which is hollow, is closed by means of a rubber plug or stopper 16, through which extends an inlet tube 17 and an outlet tube 18. A cooling medium, for example, water is supplied to the interior of the cylindrical cathode 3 through the tube 17 and after traversing the surface of the cathode is discharged through the tube 18.

The cathode 3 is of copper, and the active surface 5 is plated with a material which tends to reduce sputtering. This material may be either nickel or beryllium.

After the structure described above is completed it is evacuated and then filled with a gas or mixture of gases of the noble group, for example, neon or argon, at the proper pressure. If desired the gas charge may include a small percentage of nitrogen, hydrogen, carbon dioxide or water vapor to reduce the operating voltage of the device.

All glow discharge devices hereinbefore produced have been subject to very definite operating limitations. One of the important limiting factors has been the fact that there is an optimum current density which may be used in any given device without causing overheating of the cathode, whereby undesirable gases may be released. Again overheating of the cathode may result in the production of an electronic discharge, which would provide a current conductive path across the dark space surrounding the cathode and result in a reduction of the intensity and brilliancy of the negative glow.

The present invention by providing means for dissipating the heat generated at the cathode increases the current carrying capacity of the tube and thereby causes the intensity and brilliancy of the negative glow to be materially increased. The degree to which the dissipation of the heat may be carried is limited solely by the capacity of the cooling medium to conduct away the heat and will be determined largely by the rate of flow of such medium through the cathode. Confining the current discharge from the anode to a plane surface, constituting a limited portion of the cathode area, results in the production of a negative glow area commensurate with the plane surface and having high current density. By the use of a fork-shaped anode it is possible to so position the glow discharge device that the whole surface of the negative glow area is viewed at a small angle with respect to the axis of the bulb, so that the light rays, emanating therefrom, may be concentrated in a small area corresponding to a rectangle bounded by the ends of the tines of the fork-like structure. Thus there is provided a high degree of concentration of the light rays emanating from the negative glow discharge area.

The bulb 1 is provided with a spherical portion, which is materially larger than its cylindrical portion, through which the negative glow is viewed. Two important results followed therefrom, namely, the field of vision along the length of the glow discharge is materially increased and loss of light intensity, due to the deposit of sputtered material on the inner surface of the spherical viewing portion of the bulb is avoided. This is due to the fact that the deposition of sputtered material occurs along the interior surface of the bulb which lies parallel to the plane surface of the cathode, rather than upon the extended spherical portion.

While one specific modification of the invention has been described and certain features have been set forth in detail, it is to be understood that the invention is not limited to the details herein given.

Obviously the ends of the tines of the fork-like anode could be connected together to provide an anode having an active surface which is rectangular. Again in small discharge devices the anode may be supported by a single lead wire, a portion of which may be wrapped around the stem to replace the collar 9.

What is claimed is:

1. A glow discharge device comprising a fork-shaped electrode, a hollow electrode having a plane surface parallel to the plane of said forked electrode, means for producing an electric discharge between said forked electrode and plane surfaces, and means for circulating a cooling medium through said hollow electrode.

2. A glow discharge device comprising a fork-shaped anode, a hollow cathode having a plane surface, means for producing an electric discharge between said anode and said plane surface, and means for circulating a cooling medium through said cathode.

3. A glow lamp comprising electrodes lying in parallel planes between which a discharge is maintained, and an enclosing bulb having a portion the wall of which surrounds said electrode and is substantially parallel therewith and an extension the wall of which is at an angle to the plane of said electrodes.

4. A glow lamp comprising a plurality of electrodes, means for mounting said electrodes parallel to each other, and an enclosing bulb having a portion the wall of which surrounds said electrodes and is substantially parallel therewith and a substantially spherical extension.

5. The combination with a containing vessel a portion at least of which is transparent, of a gas filling within said vessel, means for ionizing said gas to cause it to glow in a restricted region, all parts of which lie near to or in a plane, said means comprising two electrodes, one of which is hollow and has an extended plane surface and the other of which has two separated portions near to and substantially parallel to said plane surface, said region of ionized gas lying between said portions, and means for cir-

culating a cooling medium through said hollow electrode.

6. The combination with a containing vessel a portion at least of which is transparent, of a gas filling within said vessel, means for ionizing said gas to cause it to glow in a restricted region, all parts of which lie near to or in a plane, said means comprising two electrodes, one of which is hollow and has an extended plane surface and the other of which has two separated portions near to and substantially parallel to said plane surface, the distance between said portions being much greater than their effective length, said region of ionized gas lying between said portions, and means for circulating a cooling medium through said hollow electrode.

7. The combination with a containing vessel a portion at least of which is transparent, of a gas filling within said vessel, means for ionizing said gas to cause it to glow in a restricted region, all parts of which lie near to or in a plane, said means comprising two electrodes one of which is hollow and has an extended plane surface and the other of which is adjacent thereto and has an opening defining said region, and means for circulating a cooling medium through said hollow electrode.

8. The combination with a containing vessel a portion at least of which is transparent, of a gas filling within said vessel, means for ionizing said gas to cause it to glow in a restricted region, all parts of which lie near to or in a plane, said means comprising two electrodes one of which has an extended plane discharge portion and the other of which has a discharge portion closely adjacent the periphery of said plane discharge portion, and an enclosure within said vessel, opening externally thereto, for the circulation of a cooling medium to cool said plane discharge portion.

HOWARD W. WEINHART.