Feb. 7, 1939. G. E. INMAN 2,146,579

ELECTRIC DISCHARGE LAMP

Filed April 22, 1936

Fig. 1.

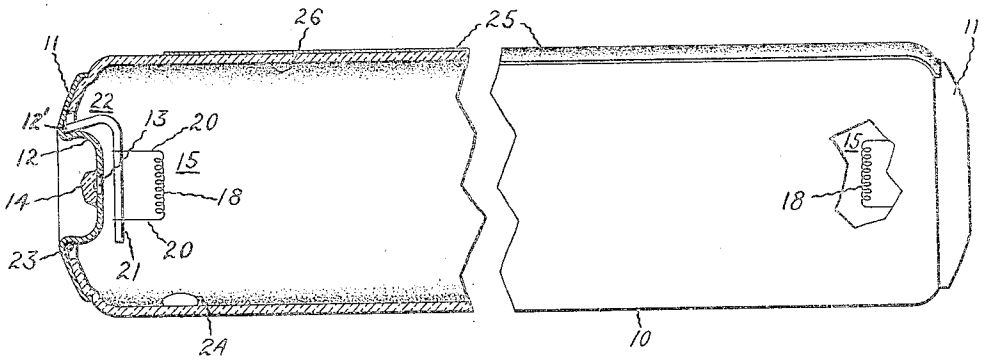


Fig. 3.

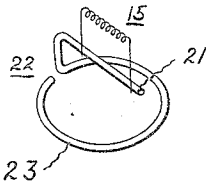


Fig. 2.

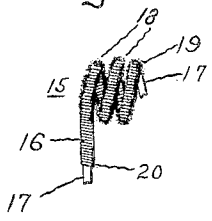
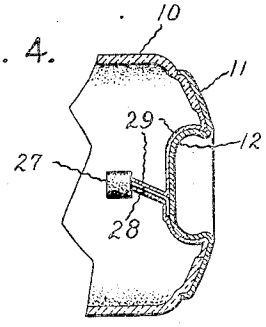


Fig. 4.



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UNITED STATES PATENT OFFICE

2,146,579

ELECTRIC DISCHARGE LAMP

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Application April 22, 1936, Serial No. 75,772

4 Claims. (Cl. 176—126)

My invention relates to gaseous electric discharge lamps and has for its object the provision of a lamp having novel and improved structural features.

According to my invention, the lamp comprises a tubular glass container having a metal disc sealed to each end thereof with an electrode mounted on each of said discs and electrically connected thereto. The discs are shaped to engage with suitable holders for mounting the lamp, thereby serving as engagement and contact means as well as end walls for the container. Moreover, the discs permit the lamp to be lighted substantially to its very ends which is particularly advantageous where the lamps are mounted end to end to form a line of light. Such a construction also makes easier the application of powdered materials such as luminescent materials to the inner surface of the container, since the powder may be readily applied to the tubular container before the end discs are sealed thereto. Further features and advantages of my invention will appear from the following detailed description of species thereof and from the drawing.

In the drawing, Fig. 1 is a side elevation, partly in section, of a lamp comprising my invention; Fig. 2 is an elevation showing in detail a portion of one of the electrodes; Fig. 3 is a detailed perspective view of the supporting structure for an electrode; and Fig. 4 is a side elevation, in section, of an end of a lamp having a modified electrode structure.

Referring to the drawing, the lamp comprises a tubular glass container 10 having a metal disc 11 sealed directly to each end thereof and serving as an end wall and contact. The discs 11 are of the type shown and claimed in the U. S. patent application to Harold D. Blake, Serial No. 3,344, filed January 24, 1935, and may be made of an iron alloy containing about twenty-nine per cent of chromium, such as an alloy marketed by the Allegheny Steel Company as "Allegheny 55." The discs are preferably concave or dish-shaped as shown so that they may be made of thin material and still be adequately strong. The said discs 11 each has an annular recess or depression 12 at the center, preferably of an inverted conoidal form, that is, it preferably increases in diameter inwardly from the edge or surface of the disc forming a circular groove 12' therein. The recesses 12 are adapted to be engaged by resilient portions of suitable holders which snap into the depressions in the manner of glove fasteners. One of the discs has an opening 13 at the center of the recess 12 through which the container 10 is exhausted and filled with a suitable gas or gases, the said opening 13 being subsequently sealed by fusion of the residue 14 of a glass exhaust tube.

A pair of electrodes 15 are located at the ends of the container 10, each of said electrodes consisting of a filament 16 of refractory metal, preferably tungsten, coiled around a mandrel 17, also preferably of tungsten, the coil on mandrel being again coiled as shown at 18. The portion 18 of the electrode is covered with a coating, indicated by the dots at 19, of an electron emissive material such as barium oxide. The straight end portions 20 of the electrode are attached, preferably by welding, to the transversely extending end portion 21 of a support member or wire 22, the other end 23 of which is in the form of a resilient split ring encircling the boss or shoulder formed at the inside of the disc 11 by the recess 12 and lying in the groove 12'. The electrodes 15 are thereby electrically connected to the discs 11 through the supports 22.

The container 10 has a starting gas therein such as argon at a pressure of about 4 mm. and a quantity 24 of vaporizable metal, preferably .002 to .003 c. c. of mercury. During the operation of the device the electrically excited mercury vapor emits visible and ultra-violet light. For ease of starting, a strip 25 of conductive material such as a metallic paint or graphite mixed with potassium silicate is applied to the container 10 and is in contact with one disc 11 and extends to a position adjacent the electrode 15 at the opposite end of the container. The said strip 25 is of high resistance, preferably about 50,000 ohms or more.

The inner surface of the container 10 has applied thereto a coating 26 of luminescent material such for example as zinc silicate, cadmium silicate, cadmium tungstate, or some specially prepared materials such as a mixture described and claimed in the U. S. patent application Serial No. 75,783, Willard A. Roberts, of even date, and consisting of about sixty parts of CdO, forty parts of SiO_2 and a small amount of manganese, or another mixture described and claimed in the U. S. patent application Serial No. 75,780, Willard A. Roberts, of even date, and consisting of about sixty parts of ZnO, forty parts of SiO_2 and a small amount of manganese, or still another mixture described and claimed in the U. S. patent application Serial No. 75,782, Willard A. Roberts, of even date, and consisting of CaO and WO_3 in such proportions that there is from one to ten per cent more calcium oxide than is required by the chemical formula $CaWO_4$, with or without a small amount of lead. The coating 26 of luminescent material may be applied to the surface of the container 10 by means of a binder, or it may be embedded in the glass itself by heating the glass to its softening point or, if the powdered material is fine enough, it will adhere by merely dusting it into the container. The powder may also be mixed with a binder and sprayed on the container. Among the various binders which may be used are glycerin; glycerin and twenty per cent of boric acid; phosphoric acid alone or diluted with ace-

tone or alcohol; potassium silicate; an ester of glycerin with boric acid; castor oil or mineral oil; or an inorganic resin such as that sold under the name of Stacol by the Glyco Products Company, Inc., of Brooklyn, N. Y.

The luminescent powder may be applied to the container 10 before the discs 11 are sealed thereto in the following manner:

A cork or stopper is inserted in one end of the container, an excess of binder (such as a mixture of 5 c. c. of eighty-five per cent H_3PO_4 and 40 c. c. of methyl alcohol) is poured in, a cork is inserted in the other end of the container and the container is shaken to distribute the binder over the inner surface thereof. The excess binder is then poured out and the container is set vertically and allowed to stand for about fifteen minutes. Next a dry sponge covered with a double layer of fine mesh cheesecloth is drawn back and forth through the container to remove the excess binder. This operation may be repeated with clean cloths to obtain minimum streaking and yet leave sufficient binder for the proper coating thickness. The container may then be set at an angle of about thirty to sixty degrees with a clean receptacle at the lower end thereof and the luminescent powder poured in at the top while the container is being rotated. The ends of the container may then be reversed and this operation repeated. The container may then be held vertically and jarred at the ends to remove the excess powder. The container is then heated for about fifteen minutes at a temperature of about 425° to 450° C. to remove the volatilizable portion of the binder and fuse the remainder. The containers are now ready for the sealing of the discs 11 thereto with the electrodes attached.

During the operation of the lamp the ultra-violet rays striking the luminescent material are transformed thereby into visible light rays which complement and supplement the spectrum of the visible light emitted by the electrically excited gaseous atmosphere. A 15 watt lamp of the type shown having a container about one inch in diameter and about eighteen inches long requires a starting voltage of about 250 volts. The lamp operates at about 65 volts and one-quarter ampere. The lamp therefore operates at a current density of about .05 ampere per square centimeter of cross section and with an energy consumption of about .04 watt per square centimeter of container surface. The lamp may be operated simply by a leakage transformer by connecting the discs 11 to the secondary thereof.

The low pressure mercury arc in the lamp described produces short ultra-violet radiation with very high efficiency, about fifty per cent of the wattage input to the lamp being converted into radiations of 2537 angstroms. These radiations are very efficient in exciting fluorescent light from phosphors such as zinc silicate, cadmium silicate and calcium tungstate. Efficiencies of 74 lumens per watt have been obtained in lamps of the type described using the special zinc-silicon-manganese phosphor described above, 26 lumens per watt with the special cadmium-silicon-manganese phosphor and 22 lumens per watt with the special calcium-tungsten-lead phosphor.

Fig. 4 shows a modified end and electrode structure. The electrode 27 may be of the type described and claimed in U. S. Patent application Serial No. 16,614, Eugene Lemmers et al., filed April 16, 1935, and consisting of a porous body of refractory metal, such as tungsten, impregnated with an electron emissive material such as barium oxide. The said electrode 27 is mounted on one end of a support wire 28, the other end of which is secured, preferably by welding, to the disc 11. The inner surface of the disc 11, and the support wire 28, may also be covered by insulating material 29, such as a glaze.

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 device illustrated and in its use and operation may be made by those skilled in the art without departing from the broad spirit and scope of my invention. For example, the ends 20 of the electrode 15 in Fig. 1 may be spot welded directly to the disc 11, thus eliminating the supporting member 22, and the inner surfaces of the discs 11 in the lamp shown in said Fig. 1 may be coated with insulating material.

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

1. A gaseous electric discharge lamp comprising a tubular glass container, a metal disc sealed directly to each end of said container as an end wall and contact, each of said discs having a depression therein for engagement with a holding means forming a peripherally grooved boss at the inside thereof, a conductive support member encircling the said boss on each of said discs and lying in said groove and extending a short distance therefrom, and an electron emissive electrode mounted on each of said support members in front of the adjacent disc and electrically connected through said support member to the said adjacent disc.

2. A gaseous electric discharge lamp comprising a tubular glass container, a metal disc sealed directly to each end of said container as an end wall and contact, each of said discs having a depression therein for engagement with a holding means forming a boss peripherally grooved at the inside thereof, a conductive support member encircling the said boss on each of said discs and lying in said groove and extending a short distance therefrom transversely of the container, and an electrode at each end of said container comprising a coil of refractory wire having its ends secured to the transversely extending portion of said support member and electrically connected therethrough to the adjacent disc.

3. A gaseous electric discharge lamp comprising an elongated tubular glass container having a filling of inert gas and metallic vapor and having sealed across each of its ends a metal closure disc, a support wire secured to said disc and extending forwardly thereof, a thermionic electrode supported from said wire, and a coating of insulating material over the interior surface of the disc and over the wire, said coating insulating said disc and wire from the gas filling inside the lamp.

4. A gaseous electric discharge lamp comprising an elongated tubular glass container having a filling of inert gas and metallic vapor and having sealed across each of its ends a metal closure disc with an inward peripherally grooved boss, a wire encircling said boss and lying in said groove, a thermionic electrode supported from said wire, and a coating of insulating material over the interior surface of the disc insulating said disc from the gas filling in the lamp.

GEORGE E. INMAN.