Oct. 29, 1935. R. C. HYDE 2,018,957

ELECTRODE FOR GASEOUS DISCHARGE LAMPS

Filed Dec. 5, 1933

Fig. 1.

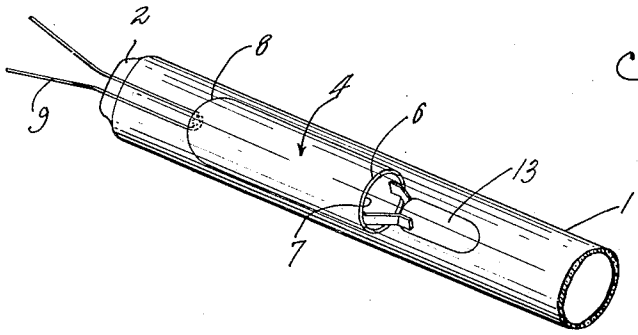


Fig. 2.

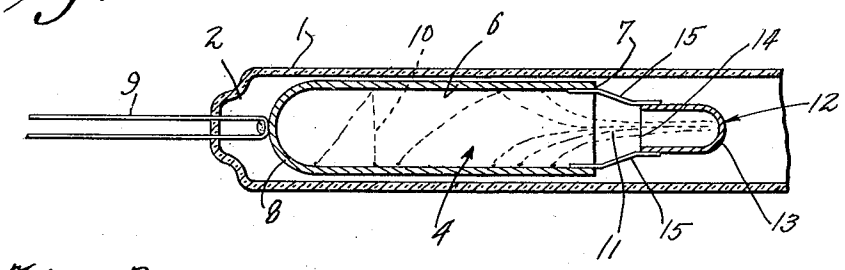


Fig. 3.

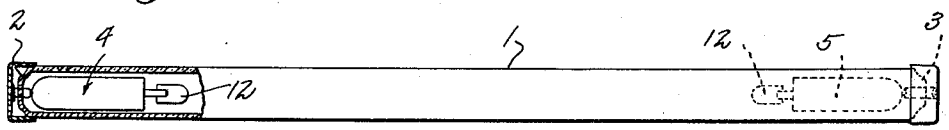
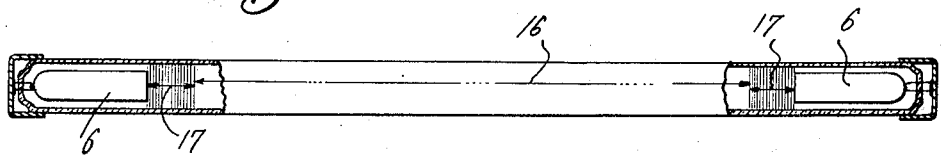


Fig. 4.



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ELECTRODE FOR GASEOUS DISCHARGE LAMPS

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Application December 5, 1933, Serial No. 700,977

2 Claims. (Cl. 176—126)

My invention relates to electrodes for use in gaseous discharge lamps, such as are commonly employed for illuminating purposes, particularly lamps of the type employing neon or other rare gases for producing a positive column glow, and more particularly lamps of this type which employ a small quantity of mercury.

In gaseous discharge lamps, such as are commonly employed for the production of positive column illumination, considerable difficulty is encountered due to "sputtering" of the electrode, accompanied by a deterioration of the gas employed in the tube with the resultant shortening of the life of the tube, and more particularly a deposition of metallic particles upon the glass walls of the tube or envelope, tending to darken the tube. Various methods have been suggested for overcoming these difficulties, such as the coating of the electrodes with various rare earths or the construction of the electrode in some peculiar form which tends to reduce the amount of "sputtering" which will occur.

It has been found that an electrode which is formed as a hollow tube, the outer walls of which are in close proximity to the walls of the enclosing envelope, and particularly if mica or similar material is interposed between the outer walls of the electrode and the inner walls of the envelope, that the "sputtering" is materially reduced, apparently, due to the fact that the electrical discharge occurs only from the interior of the tubular electrode and any metallic particles which would be thrown off from the electrode would be thrown to the interior of the electrode. However, considerable quantities of material will be discharged from the electrodes, which will come out of the open end thereof and be projected into the tube, either depositing upon the walls of the tube or combining with the gases contained within the tube. However, although various expedients, such as those noted above, have been employed, the difficulties due to the "sputtering" still exist and are particularly apparent in tubes which employ not only a rare gas but also mercury as a part of the contents of the tube. It appears that the metal sprayed off the electrode combines with the water in the mercury (it has been found that mercury, as employed in the tubes, always contains a certain amount of occluded moisture), or combines with the mercury itself to form an opaque deposit which quickly darkens the tube and materially reduces its illuminating value.

It is, therefore, the object of my invention to provide an electrode for gaseous discharge tubes, in which the "sputtering" of the electrode is substantially eliminated.

Another object of my invention is to provide an electrode for gaseous discharge tubes, in which a main electrode is employed having a relatively tubular shape, closed at one end, and having an auxiliary electrode in the tube in the path of the discharge emanating from the main electrode.

Another object of my invention is to provide a main and auxiliary electrode, as set forth in the preceding paragraph, in which the auxiliary electrode is mechanically connected to the main electrode.

Another object of my invention is to provide an electrode construction, as set forth in the preceding paragraphs, in which the auxiliary electrode is electrically connected to the main electrode.

Further objects of my invention will be apparent from a study of the drawing read in connection with the following specification, wherein

Figure 1 is a perspective view of a portion of the gaseous discharge tube showing my electrode mounted therein;

Figure 2 is a vertical sectional view through the tube and electrode, shown in Figure 1;

Figure 3 is a diagrammatic view illustrating a complete discharge tube employing my electrode; and

Figure 4 is a diagrammatic view of a complete discharge tube employing one of the well-known forms of electrodes.

Referring to the drawing, there is illustrated herein a gaseous discharge tube, comprising a glass or quartz envelope 1, preferably having the form of an elongated tube, each end of which is closed as indicated at 2 and 3 and having in each end thereof an electrode 4 and 5.

The electrode 4 is illustrated as being formed of a section of metal tube 6, one end 7 of which is open while the opposite end 8 is closed, preferably such electrode being punched out of a solid sheet of metal so as to form a cup-like electrode, the side walls of which are elongated. At the closed end 8 of the tubular electrode 6 a conducting wire 9 may be attached to constitute both a lead-in conductor permitting electric current to be applied directly to the electrode 6, and may also be employed for the purpose of supporting and fixing the electrode in the end of the tube 1. The electrode 6 thus far described is similar in all respects to the common type of electrode employed in gaseous discharge tubes well known in the art for the purpose of sign illumination. However, such electrodes, al-

though carefully processed for the purpose of eliminating occluded gases therein, may and usually do contain some occluded gas which during the operation of the tube breaks out and passes into the interior of the envelope 1. This discharge of gas is usually accompanied by a spraying or breaking away of a portion of the metal of which the electrode is formed, such metal being sprayed out into the envelope 1, as is particularly illustrated in Figure 2. The normal electrical field within the electrode when the tube is in operation is such that the particles of metal which are broken off from the electrode will be attracted and will pass in a direction perpendicular to the major axis of the electrode tube 6, such path being illustrated at 10, so that considerable amounts of such sprayed metal may travel back and forth across the interior of the electrode tube 6 without entering into the discharge space of the envelope 1, and as long as such sprayed metal travels in the path indicated at 10 it will cause no appreciable damage since the metal sprayed from one side of the electrode will be deposited upon the opposite side without having the opportunity to pass out of the confines of the electrode tube 6.

However, near the front end 7 of the electrode tube 6 particles which are sprayed off the electrode enter into an electric field, the lines of force of which tend to travel parallel to the major axis of the electrode tube 6, and such particles instead of traveling diametrically across the electrode tube 6 are drawn into an arcuate path tending to spray them out of the confines of the electrode 6 and into the interior of the tube 1, and it is these particles which cause the damage known as "sputtering".

While the exact nature of the field which causes such particles to travel out into the tube 1 is not definitely known, it appears that there is a definite focusing of the lines of force, indicated in Figure 2 at 11, the bending of the path of travel of the sputtered particles causing a convergence of these paths into a cross-section considerably smaller than the cross-section of the interior of the electrode tube 6. Moreover, it may be observed in the operation of such tubes that a cathode ray emanates from the electrode tube 6, which apparently focuses or comes to a point at a short distance outside the end 7 of the tube 6.

I have discovered that if a second or auxiliary electrode 12 is mounted in the tube a short distance in advance of the main electrode 6 that the deposition of metal or salts upon the walls of the envelope 1 is reduced to a minimum, if not completely eliminated. I prefer to form the electrode 12 as a small cup-like member having a diameter considerably less than the diameter of the main tubular electrode 6, and I also prefer to form such auxiliary electrode with a closed end 13 approximating in shape the shape of the main electrode 6 to thereby achieve whatever benefits may occur from a focusing of an auxiliary cathode ray discharge which may, and apparently does, emanate from the auxiliary electrode 13. The auxiliary electrode 13 has an open end 14 directed toward the open end 7 of the main electrode 6, and being of smaller diameter than the main electrode 6 does not completely obstruct the passage of the discharge from the main electrode 6 to the interior of the tube 1. However, the employment of the auxiliary electrode 12 positively stops the deposition of opaque material upon the walls of the tube 1 either by acting as a source of auxiliary cathode ray, which repels the sputtered particles or creates an electrical condition within the interior of the main electrode 6 which counteracts or obliterates the electrical effects which start the "sputtering" phenomena, or by mechanically interposing a shield located within the area of those lines of force which draw the sputtered particles so as to constitute a mechanical shield against which the sputtered particles may strike and be deposited without passing to the envelope walls.

I also prefer to support the auxiliary electrode 12 with its major axis parallel with and in alignment with the major axis of the main electrode 6, which may be conveniently done by mounting the same upon a pair of strips of metal 15, which may be secured in any suitable manner to both the main electrode and the auxiliary electrode, such method of support not only mechanically but electrically connecting the main and auxiliary electrodes.

I have observed from practice that the employment of the main or auxiliary electrodes, as set forth herein, not only reduces or eliminates the "sputtering" effects, but also appears to have the effect of eliminating the Crookes dark space from the tube so that the positive column approaches to a position directly in contact with the main electrode 6.

I have illustrated in Figure 4 a tubular lamp employing one of the common well-known types of electrodes, such as the main electrode 6, without the auxiliary electrode 12, and in such tubes it may be observed that the positive column discharge, indicated by the reference character 16 and constituting the luminous portion of the tube, extends through the envelope 1 to a point considerably spaced from the electrode 6, leaving a dark area, indicated by the arrow 17, at each end of the tube, such phenomena being designated as "Crookes dark space", while as illustrated in Figure 3 the employment of my electrode 6 with the auxiliary electrode 12 shows the positive column 16 extending entirely throughout the length of the envelope 1.

The employment of my main and auxiliary electrode construction materially lengthens the effective life of tubes which employ mercury either for the purpose of producing a blue color in the tube or for the purpose of producing ultra-violet emanations, since it is in this type of tube that the undesirable "sputtering" effects occur most frequently and to the greatest degree. Actual tests with my electrode show that after long periods of operation the envelope walls show no effect of deposition of metal or salts thereon. This is of great advantage in this art since heretofore it has been the practice to employ specially constructed electrodes or electrodes made of specially selected materials coated with rare earths or oxides thereof to reduce the "sputtering" effects, while with my electrode no coating is required nor is it essential that any particular metal be used, the ordinary copper or iron employed for the common types of electrodes being used with the desired results.

While I have shown and described a preferred embodiment of the invention, I do not desire to be limited to any of the details shown or described herein, except as defined in the appended claims.

I claim:

1. In a gaseous discharge lamp, an envelope, a tubular main electrode in said envelope having one end thereof closed and having the open end

thereof directed toward the interior of said envelope, an auxiliary electrode smaller in lateral dimensions than said main electrode, and means mounting said auxiliary electrode in spaced relation in front of said main electrode and in axial alignment with the major axis of said main electrode, all parts of said auxiliary electrode being positioned forwardly of said main electrode.

2. In a gaseous discharge lamp, an envelope, a tubular electrode in said envelope having one end thereof closed and having the open end thereof directed toward the interior of said envelope, an auxiliary cup-like electrode spaced from said main electrode and having a cross-sectional area less than the cross-sectional area of said tubular electrode, and means mounting said auxiliary electrode in axial alignment with the major axis of said main electrode with the open end of said cup-like auxiliary electrode directed toward the open end of said main electrode.

RALPH C. HYDE.