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2,512,282

ELECTRIC DISCHARGE LAMP

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Inventor:
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My invention relates to gaseous electric discharge lamps and particularly to positive column lamps for operation from an alternating current supply.

A low voltage discharge in an elongated envelope between electrodes located adjacent the ends of the envelope exhibits a glow discharge at that electrode acting as the cathode and a diffused discharge extending from adjacent the cathode glow discharge to the other electrode acting as an anode. A non-emitting space between the cathode glow and the positive column glow is referred to as the Faraday dark space. In positive column lamps designed to be operated from an alternating current source, the electrodes are located at the ends of an elongated discharge space and are connected to the source of supply to function alternately as cathode and anode. Consequently, when one electrode is acting as a cathode, it is surrounded by a cathode glow and has a dark space adjacent to the cathode glow, whereas on the succeeding half cycle of alternating current, this same electrode has no cathode glow surrounding it and the space which was previously occupied by the Faraday dark space and the cathode glow now exhibits the positive column glow due to this electrode acting as an anode. It will be apparent therefore that adjacent each end of the tube there will be a variation of the intensity of the radiation at the period of the source of supply, whereas in that portion of the tube occupied by the positive column, the variation will have a frequency of twice the frequency of the source of supply.

Periodic fluctuations in the intensity of the light source render it objectionable as a source of illumination unless the frequency of fluctuations is high enough to render them unobjectionable due to the persistence of vision. Elongated tubular fluorescent lamps have in recent years gone into wide commercial use. These lamps consist of an elongated glass tube internally coated with a fluorescent powder, with electrodes adjacent the ends. They are provided with a filling of starting gas such as argon at a pressure of about 4 mm. of mercury and contain a drop of mercury. They are operated at a current density such that a very substantial proportion of the radiant energy produced by the discharge between the electrodes is in the 2537 Å. ultraviolet band. The tubes are coated throughout their length with a fluorescent powder whereby the ultraviolet radiation is converted to light and are provided with terminals at their ends. These lamps operate without objectionable flicker on 60-cycle alternating current. However, when operated with 25-cycle alternating current, those portions of the lamp adjacent the ends exhibit a very objectionable fluctuation in the intensity of the light at a frequency of the 25-cycle. The main central portion of the tube of the lamp which has a fluctuation of light intensity at a frequency of twice the source of supply, that is 50 cycles per second, is tolerable. The 25-cycle fluctuation at the ends, however, is so marked that it is found necessary to apply an opaque coating over several inches of the glass wall of each end of the tube. For example, the 40-watt lamp now in the market consists of a glass tube four feet long and \( \frac{1}{4}'' \) in diameter having thermionic electrodes with terminals permitting preheating thereof, operated on alternating current of 115 volts with a ballast on a 60-cycle source of supply. It is acceptable, but when operated on a 25-cycle source of supply, the flicker at the ends of the lamp is so objectionable that it is necessary to cover them with an opaque coating for a distance of \( \frac{3}{4}'' \) at each end to make them acceptable commercially. While this expedient removes the worst of the flicker, it cannot be removed entirely unless the opaque covering mentioned is carried along the length of the tube to a degree impracticable in commercial lamps.

In the commercial installation of tubular lamps, they are commonly mounted in elongated reflectors, and it is desirable that for a given length of reflector as great a proportion of its length as possible, be occupied by the luminous body. In such an installation the luminous tubes are of low light intensity, and it is common to mount a series of tubes end-to-end to get the required amount of light on the work surfaces to be illuminated. It is therefore apparent that it is desirable that as large proportion of the length of the lamps as possible contribute to the light output and to this end the lamps are made with their base as short as possible. It is obvious that covering up a portion of the tube to eliminate flicker is objectionable in these installations.

The object of my invention is to provide a tubular electric discharge lamp in which the full length of the tube is luminous and in which objectionable flicker effect at the ends are eliminated. For a complete understanding of my invention, reference is made to the accompanying drawings in which Fig. 1 is a perspective view of a positive column lamp of my invention mounted in a trough-shaped reflector; Fig. 2 is a sectional view on an enlarged scale of one end of the lamp; Fig. 3 is a section similar to Fig. 2 of a modific-
tion; Fig. 4 is a view taken on the line A–A of Fig. 3 looking in the direction of the arrows.

Referring to Fig. 1, 10 indicates an elongated glass tube of a positive column low pressure mercury discharge lamp. The interior surface of the tube 10 is coated throughout its length with a fluorescent material. The electrodes for the lamp are mounted inside the tube 10 and which are coated with a fluorescent material. The side chambers 11 are provided with end caps 12 and terminals 13. The lamp is shown more or less diagrammatically mounted in the trough-shaped reflector 15, the reflector being shown in section along its apex. Any suitable socket, such as that shown in Fig. 5, will receive the terminals and retain the lamp in position. Fig. 1 illustrates an additional lamp 17 mounted in the reflector whereby an almost continuous line of light may be obtained.

Fig. 2 shows a larger scale than Fig. 1 the structure of one end of the tube. It is understood that the other end is of a similar construction. The side chamber 11, which is formed by an appendage to the main body of the tube 10 and which is shown as a glass tube of lesser diameter than the main tube 10, is sealed therewith. It extends from the side wall adjacent the end of the tube 10 for a substantial distance. An electron-emitting electrode 16 is sealed in a mount of known construction which mount is sealed to the end of the chamber 11. The electrode 16 is shown as the known type of coated filamentary electrode which is connected to a pair of leads 13 whereby it may be preheated to electron-emitting temperature on starting. The envelope of the lamp is filled with an inert gas such as argon at a pressure of about 4 millimeters of mercury and is provided with a drop of mercury to provide a mercury vapor atmosphere which carries the discharge in operation. In a 40 watt lamp for example, the tube is about 1/2" in diameter and about 4 feet long. When operated at 115 volts and at a low current density a large proportion of the energy dissipated in the lamp is converted into ultra-violet radiation primarily in the 2537Å band. A thin coating of fluorescent material 20 is applied to the inner wall of the tube 10, and covers the entire surface.

In operation on alternating current, when the electrode 16 is at one instant anode, as a cathode, a glow commonly referred to as the cathode glow, whose limits are indicated by the dotted line 18, surrounds it. During this half of the alternating current cycle, the positive column discharge occupies the whole of the tube 10 and extends to the other electrode at the remote end of the tube. The space indicated by reference character 26 lying between the dotted line 18 and the dotted line 19 which represents the beginning of the positive column discharge is relatively non-emitting. It is relatively deficient in both visible and ultra-violet radiation. The glow adjacent the cathode is of greater intensity in the visible band of radiation than the intensity of the positive column discharge in the visible band in the tube 10. On the other half of the alternating current cycle the positive column discharge again fills the tube 10 extending from the remote electrode, and extends into the side chamber 11 to the electrodes 16 which is now acting as an anode.

When operated on alternating current, it is thus apparent that the space within a chamber 11 is alternately occupied by cathode glow and its adjacent dark space, and with positive column radiation. The different intensity of the illumina-

nation occurring at the frequency of the supply, under these two conditions when the supply is of 25 cycles is marked and would be objectionable to the eye. However, in my construction this space is confined to the side chambers and it is hidden from direct view, when mounted in a reflector in the manner indicated in Fig. 1. The tube 10 of Fig. 3 having its complete surface subjected to the positive column discharge varying at twice the frequency of the source of supply. To further obscure the effect of the 25-cycle fluctuation in the tube 11 they may be coated with an opaque paint, tape, of the like as indicated in Fig. 1.

In Figs. 3 and 4 I have illustrated a modification. An opaque disc 22 is mounted in the mount of the side tube 11 and coaxial therewith. This disc is relatively thin and spaced from the wall of the tube 11 leaving an annular opening 23 from the tube 11 to the tube 10 of sufficient width that the discharge passes freely on all sides. The disc may be of metal and I have shown it held in position by a plurality of spring wires 23 extending from it and engaging the walls of the chamber 21. It is held in place by the two sides of the reflector 15. The disc 22 obscures a direct view of most of the interior of the side tube 11 when viewed from the side of the tube 10 and further reduces the flicker when the tube is mounted in a fixture in the manner shown in Fig. 1.

I have shown the disc 22 metallically connected to one of the lead wires of the electron emitting cathode 16 by a wire 24, which is an extension of one of the spring fingers 23. This facilitates the assembly and support of the disc in the lamp. The disc is of thin metal and does not reach electron emitting temperature during operation of the lamp. The disc acts as an anode during the half cycles when the thermionic member 16 is positive and shields the member 16 from excessive positive ion bombardment. The disc acts as a positive ion collector and when located in accordance with the teachings of U. S. Patent No. 2,351,616, Karash and Lemmers, assigned to the same assignee as the present invention, it suppresses to some degree the Faraday dark space and extends correspondingly the positive column discharge. The side chamber 11 can therefore be of some length. The tube is shown in Fig. 1, 50 which is used as a cathode in Fig. 3, when using the disc 22 connected to the cathode than with the modification of Fig. 2.

While I have shown and described a particular embodiment of my invention, it will be obvious to those skilled in the art that changes and modifications may be made without departing from my invention in its broader aspects and I therefore aim in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

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

1. A positive column electric discharge lamp of the low pressure mercury vapor type adapted to operate on alternating current comprising an elongated glass tube constituting the useful light emitting portion of the lamp, a tubular chamber extending transversely from the tube adjacent each end thereof, a thermionic member mounted in the bottom of each chamber, an opaque shield supported by said electrode and mounted in the mouth of each chamber spaced from the internal surface of said tube providing a communicating path between said chamber and the other electrode, the thermionic electrodes mounted in said chambers at such a distance from the mouth
thereof that the cathode glow and adjacent dark space present when an electrode is functioning as a cathode is confined to the side chamber behind the shield and the whole length of the tube is occupied by the positive column of the discharge.

2. A positive column electric discharge lamp of the low pressure mercury vapor type adapted to operate at alternating current comprising an elongated glass tube constituting the useful light emitting portion of the lamp, a tubular chamber extending transversely from the tube adjacent each end thereof, a thermionic electrode sealed in the bottom of each chamber, a thin metal disc mounted centrally in the mouth of the chamber to obscure the view of the electrode and to provide a discharge passage around the disc from the chamber to the tube, the thermionic electrodes mounted in said chambers at such a distance from the mouth thereof that the cathode glow and adjacent dark space present when an electrode is functioning as a cathode is confined to the side chamber behind the disc and the whole length of the tube is occupied by the positive column of the discharge.

3. A positive column electric discharge lamp of the low pressure mercury vapor type adapted to operate at alternating current comprising an elongated glass tube constituting the useful light emitting portion of the lamp, a tubular chamber extending transversely from the tube adjacent each end thereof, a thermionic electrode sealed in the bottom of each chamber, a thin metal disc mounted centrally in the mouth of the chamber to obscure the view of the electrode and to provide a discharge passage around the disc from the chamber to the tube, said disc being electrically connected to the electrode, the thermionic electrodes mounted in said chambers at such a distance from the mouth thereof that the cathode glow and adjacent dark space present when an electrode is functioning as a cathode is confined to the side chamber behind the disc and the whole length of the tube is occupied by the positive column of the discharge.

4. A positive column electric discharge lamp of the low pressure mercury vapor type adapted to operate at alternating current comprising an elongated glass tube constituting the useful light emitting portion of the lamp, a tubular chamber extending transversely from the tube adjacent each end thereof, an electrode structure sealed in the bottom of each chamber and comprising a supporting conductor therefor, an opaque shield connected to said conductor and mounted in the mouth of said chamber and provided with spring biased fingers in engagement with the internal surface of an appendage to said tube forming said tubular chamber, said shield being spaced from the internal surface of said appendage for providing a discharge path between said chamber and the other electrode, the electrodes being mounted in the chambers at such a distance from the mouth thereof that the cathode glow and adjacent dark space present when an electrode is functioning as a cathode are confined to the side chamber behind the shield and the whole length of the tube is occupied by the positive column of the discharge.

5. A positive column electric discharge lamp of the low pressure mercury vapor type adapted to operate on alternating current comprising an elongated glass tube constituting the useful light emitting portion of the lamp, a tubular chamber extending transversely from the tube adjacent each end thereof, an electrode structure sealed in the bottom of each chamber and comprising a supporting conductor therefor, an opaque shield connected to said conductor and mounted in the mouth of said chamber and lying in the plane of the juncture of the tube and the appendage forming said tubular chamber, said shield being spaced from the internal surface of said appendage for providing a discharge path between said chamber and the other electrode, the electrodes being mounted in the chambers at such a distance from the mouth thereof that the cathode glow and adjacent dark space present when an electrode is functioning as a cathode are confined to the side chamber behind the shield and the whole length of the tube is occupied by the positive column of the discharge.

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