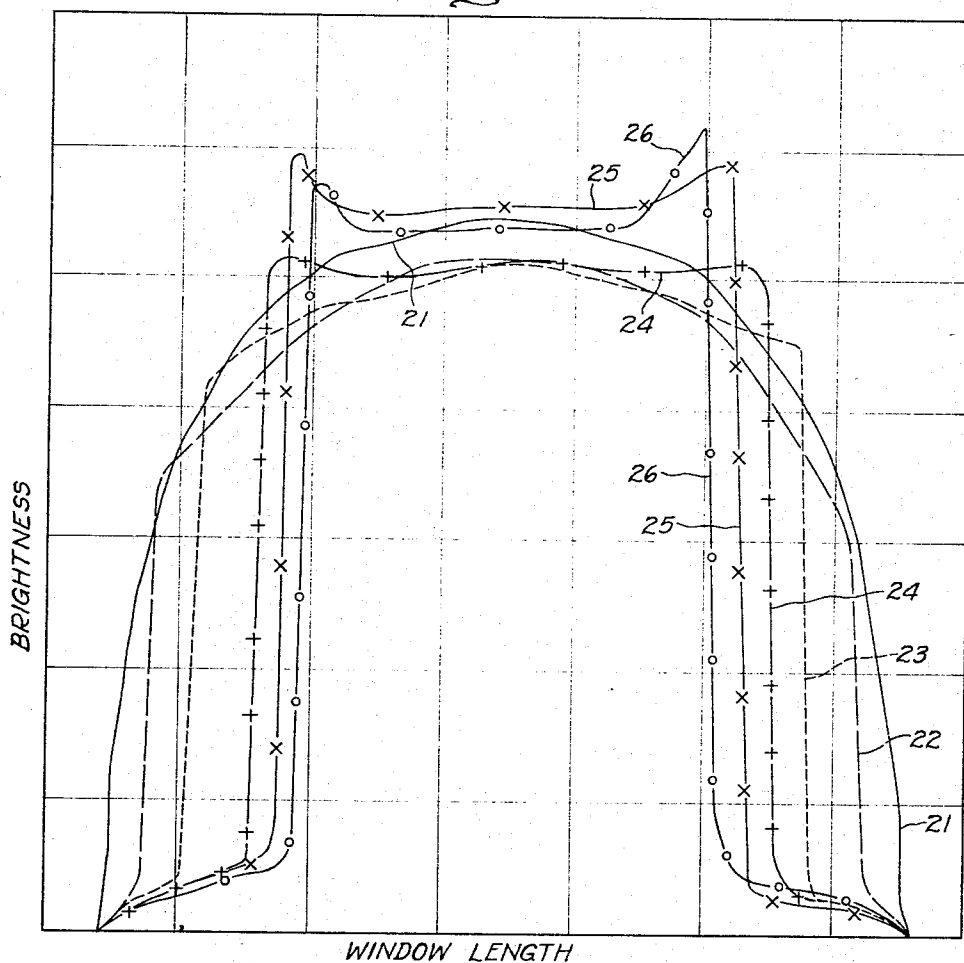
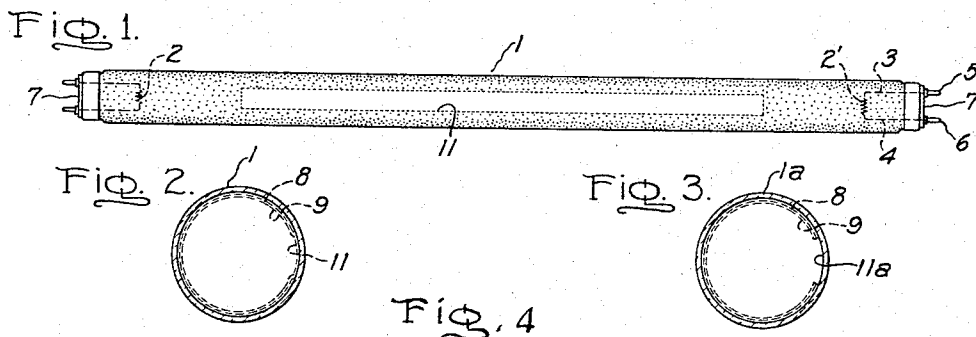


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M. A. CHERNIN ET AL
REFLECTOR FLUORESCENT LAMP

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LEGEND FOR FIG. 4:

— FULL LENGTH APERTURE.
— LIMITED LGTH STARTING FROM CATHODES.
— LIMITED LGTH STARTING FROM ANODES.
+ " " " 1" " "
x " " " 2" " "
o " " " 2 1/2" " "
o " " " 3" " "

Inventors:
Myron A. Chernin
Elton T. Leppelmeier
by *Ernest W. Hughes*
Their Attorney

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3,275,872

REFLECTOR FLUORESCENT LAMP

Myron A. Chernin, Shaker Heights, and Elton T. Leppelmeier, Highland Heights, Ohio, assignors to General Electric Company, a corporation of New York
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6 Claims. (Cl. 313-109)

This invention relates to reflector fluorescent lamps which contain a reflective layer over a portion of the periphery for increasing the candlepower or brightness in the opposite direction. The invention is concerned with controlling the candlepower and improving the uniformity of brightness along the length of such lamps.

Reflector fluorescent lamps utilize the basic structure of the common fluorescent lamp wherein the discharge takes place between thermionic electrodes in low pressure mercury vapor within an elongated glass tube. The discharge produces ultraviolet radiation at 2537 Å. which excites the phosphor coating on the envelope walls to emit visible light. In the reflector fluorescent lamp, a reflective coating is interposed between the glass wall and the phosphor coating over a major portion of the periphery in order to increase the candlepower issuing from the remaining portion or window. The window thus consists of a long slot, clear of the reflective coating, extending the length of the lamp and subtending a minor portion of the periphery. The window may be either phosphor coated or clear; when clear, such lamps are sometimes called aperture fluorescent lamps.

The light output of all fluorescent lamps decreases sharply from the center towards the ends. The foregoing applies to ordinary fluorescent lamps as well as to reflector fluorescent lamps. In certain types of lighting applications, it is desirable to have a greater uniformity of light output along the lighted length of the fluorescent lamp than normally occurs. This is particularly so in the case of reflector fluorescent lamps used in such applications as photoreproduction and photocopying service wherein substantial uniformity of brightness over the length of the slot is necessary for even reproduction of the subject matter across the width of the page.

The object of the invention is to provide, a lamp structure for controlling the candlepower along the length of a reflector fluorescent lamp including achieving a substantially uniform brightness over the length of the window when desired.

According to our invention, we have found that much greater uniformity can be obtained in a reflector fluorescent lamp by limiting the window, whether phosphor coated or clear, to a length which is less than that of the positive column. The ends of the window are located forward of the adjacent electrode; the forward distance required depends upon the angular width of the window and on the brightness pattern desired. The distance may conveniently be stated in terms of envelope diameters. Where a brightness pattern consisting of a vertical rise at each limit and a substantially uniform flat top in-between is desired, the end of the window may be located a distance of about 2 envelope diameters forward of the electrode in the case of a 45° window. For a narrower window opening, the forward distance required increases; for a wider window opening, it decreases. By making the forward distance yet greater, a saddle-shaped brightness pattern or distribution along the length of the window may be obtained, that is one wherein the brightness rises at the ends relative to the center.

For further objects and advantages and for a better understanding of the invention, attention is now directed to the following description of a preferred embodiment to be read in conjunction with the accompanying drawing.

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The feature of the invention believed to be novel will be more particularly pointed out in the appended claims.

In the drawing:

FIG. 1 shows a reflector fluorescent lamp with a shortened window embodying the invention.

FIG. 2 is a cross sectional view along line 2-2 of the lamp of FIG. 1 where a phosphor-coated window is provided.

FIG. 3 is a similar view where a clear window is provided.

FIG. 4 illustrates graphically candlepower patterns or brightness distribution along the length of the lamp for various window lengths.

The lamp illustrated in the drawing comprises an elongated glass tube 1 forming the envelope into the ends of which are sealed a pair of electrodes 2, 2'. By way of example, the electrodes are of the thermionic type, each comprising a tungsten filament coated with electron emitting material consisting of alkaline earth oxides and supported across inleads 3, 4 sealed through the usual stem press and connected to the terminal pins 5, 6 of a base 7. The envelope contains a filling of inert gas, for instance argon or a mixture of argon with another rare gas such as neon or helium at a pressure of a few millimeters of mercury with sufficient mercury to provide a vapor pressure of a few microns in operation. The example illustrated is designated 18T8, that is the envelope has an over-all nominal length of 18 inches and diameter of 1 inch.

As best seen in FIG. 2, reflective coating 8 is applied to the inside surface of the glass envelope 1 over the major portion of the periphery and the phosphor coating 9 is applied thereover. It is preferred to use for the reflective coating a material which is an efficient reflector of visible light in preference to being an efficient reflector of ultraviolet 2537 Å. radiation, and to rely upon the fluorescent phosphor layer to absorb substantially the entire ultraviolet radiation produced by the discharge, as proposed in U.S. Patent 2,854,600 Van de Weijer. A preferred material for the reflective layer in view of these considerations is titanium dioxide having a particle size less than one micron, for instance centering on about 0.3 micron which is about half the median wavelength of the visible spectrum. An alternative reflective material is zirconia. A suitable method for applying the reflective coating is the upflush method wherein the titania is applied as a suspension in a solution of ethyl cellulose or nitrocellulose in an organic solvent to serve as a binder. The suspension is drawn up into the tube supported vertically and then allowed to drain out. Thereafter the tube is lehrd in order to decompose and drive out the organic binder, leaving only a thin layer of titania adhering to the glass wall.

If a reflector lamp with a phosphor coated window is desired as illustrated in FIG. 2, a window 11 is now provided by scraping out the reflective coating over a minor portion of the interior periphery, for instance over an arc of 45° as illustrated. The phosphor coating 9 consisting for example of calcium halophosphate activated with manganese and antimony or any other suitable fluorescent lamp phosphor is then applied over the entire interior periphery of the glass tube or envelope. The phosphor may be applied as a suspension in a water soluble binder or alternatively in an organic binder such as previously mentioned. The upflush method may again be used; preferably the suspension is twice drawn up into the tube and allowed to drain out. The tube is reversed end for end after the first occurrence in order to compensate for drainage characteristics and obtain an even thickness of coating over the entire length. The envelope is then lehrd again in order to decompose and drive out

the binder and the lamp is thereafter processed to complete in the usual fashion.

Alternatively, if a clear window reflector fluorescent lamp 1a as illustrated in FIG. 3 is desired wherein the reflector and phosphor coatings are co-extensive, the phosphor coating may be applied following the reflective coating and then both coatings scraped out or brushed off at the same time to provide a clear window 11a. Other methods of forming the window may of course be used. A clear window is preferred for some applications where a narrower light pattern of higher brightness is desired. A reflective coating different in kind from the phosphor coating is not absolutely essential; a reflector fluorescent lamp may also be made by providing over the major portion of the periphery a phosphor coating thick enough that substantially no visible light is transmitted through it while over the minor portion forming the window, the phosphor coating is either thin or absent in order to transmit the trapped light.

The common practice with reflector fluorescent lamps of both the phosphor-coated window and the clear window types up to the present time has been to extend the window or aperture the entire length of the lamp. A typical pattern of the relative brightness measured at the aperture along the length of such a lamp is illustrated in FIG. 4 by curve 21. The measurements were taken on an 18T8 lamp as described with reference to FIG. 1, having a nominal length and diameter of 18" and 1" respectively. The abscissa or window length scale in FIG. 4 matches the lamp in FIG. 1. The lamp had a 45° clear window. With reference to brightness curve 21, it is mound-shaped, the intensity decreasing gradually from the center towards the ends. With a full length window, even of one utilizes only the central $\frac{2}{3}$ portion of the lamp, there is still a substantial variation in brightness between the center and the $\frac{2}{3}$ limits; in a photoreproduction application, this may cause unsatisfactory reproduction. If now the window is limited in length to the region forward of the electrodes, that is if the reflective coating is retained over the entire periphery at the ends of the lamps to the rear of the electrodes so that the window extends only from one electrode to the other, the brightness pattern indicated by curve 22 is obtained. The pattern now shows a substantially vertical rise at each limit and the variation in brightness within the limits is reduced. As the length of the window is described while that of the reflectively coated ends is increased, the brightness patterns indicated by curves 23 to 26 are successively obtained wherein the shoulders are gradually squared off. When the fully coated ends extend forward of the electrodes a distance of approximately two diameters, a substantially flat top results, as seen in curve 24. With further increase in length of the fully coated ends, the shoulders of the curve rise above the middle portion resulting in what may be described as a saddle-shaped brightness pattern, as in curves 25 and 26.

For most photo reproduction applications, a flat top brightness pattern is desirable. This is achieved by providing reflectively coated ends extending forward of the electrodes a length from 1 to 3 diameters. With a narrower window opening, a longer coated length is required: for instance approximately $2\frac{1}{4}$ diameters in the case of a 30° window. As the window opening angle is increased, the coated length required for a flat top brightness pattern decreases: for instance approximately $1\frac{1}{4}$ diameters for a 60° window.

By providing fully reflectively coated ends in accordance with the invention, the utilizable length of the lamp is actually increased. This is readily confirmed by comparison of curves 21 and 24 in FIG. 4. Assuming for instance a variation in brightness of 3% as a maximum permissible in order to achieve satisfactory photo reproduction, only the central 6 diameter portion could be utilized in the case of the full length window lamp corresponding to curve 21. By limiting the length of the

window, the utilizable portion of the lamp becomes the entire window length consisting of approximately 10.5 diameters as indicated by curve 24. Thus the utilizable length of the lamp has been increased from 6 to 10.5 diameters, a full 75%. This means of course, that a commensurately shorter lamp may be used for the same function with resultant savings in lamp cost, energy consumption and size of the equipment required.

The unexpected improvement in uniformity of brightness achieved by the invention appears to be explainable as follows. The usual decrease in fluorescent lamp brightness from the center towards the ends is due in part to lack of exciting energy from the region around and to the rear of the cathodes, and in part to the diminishing contributions of multiple internal light reflections. By enveloping the ends with a reflective coating, the multiple internal light reflections are reinforced to the point where the usual decrease is completely offset, resulting in substantially uniform brightness from end to end of the window.

While a certain specific embodiment of the invention has been illustrated and described in detail, it is intended as exemplary only, and the scope of the invention is to be determined by the appended claims:

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

1. A fluorescent reflector lamp comprising a tubular elongated glass envelope having electrodes sealed into opposite ends and containing an ionizable medium including mercury vapor and an inert gas at a low pressure, a reflective coating and a phosphor coating thereover responsive to the ultraviolet radiation produced by an electric discharge through said medium, said reflective coating extending over the entire interior of said envelope except for a window extending in width over a minor portion of the periphery and in length less than the full length of the lamp.

2. A fluorescent reflector lamp comprising a tubular elongated glass envelope having electrodes sealed into opposite ends and containing an ionizable medium including mercury vapor and an inert gas at a low pressure, a reflective coating and phosphor coating thereover responsive to the ultraviolet radiation produced by an electric discharge through said medium, said reflective coating extending over the entire interior of said envelope except for a window extending in width over a minor portion of the periphery and in length from points forward of the electrodes in order to achieve a controlled light distribution pattern with a substantially vertical rise at each limit.

3. A fluorescent reflector lamp comprising a tubular elongated glass envelope having electrodes sealed into opposite ends and containing an ionizable medium including mercury vapor and an inert gas at a low pressure, a reflective coating and phosphor coating thereover responsive to the ultraviolet radiation produced by an electric discharge through said medium, said reflective coating extending over the entire interior of said envelope except for a window extending in width over a minor portion of the periphery and in length a distance in the range of 1 to 3 envelope diameters forward of the electrodes in order to achieve a controlled light distribution pattern with a substantially vertical rise at each limit.

4. A fluorescent reflector lamp comprising a tubular elongated glass envelope having electrodes sealed into opposite ends and containing an ionizable medium including mercury vapor and an inert gas at a low pressure, a reflective coating on the interior of the envelope wall and a phosphor coating thereover responsive to ultraviolet radiation produced by a electric discharge through said medium, said reflective coating being applied over the entire interior of the envelope except for a window extending in width over a peripheral angle between approximately 20° to 90° and in length between points forward of the electrodes a distance of one to three diam-

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eters in order to achieve a controlled light distribution pattern having a generally flat top with a substantially vertical rise at each limit.

5. A fluorescent reflector lamp comprising a tubular elongated glass envelope having electrodes sealed into opposite ends and containing an ionizable medium including mercury vapor and an inert gas at a low pressure, a reflective coating on the interior of the envelope wall and a phosphor coating thereover and co-extensive therewith, said phosphor being responsive to ultraviolet radiation produced by an electric discharge through said medium, said coatings being applied over the entire interior of the envelope except for a clear window extending in width over a peripheral angle between approximately 20° to 90° and in length between points forward of the electrodes a distance of one to three diameters in order to achieve a controlled light distribution pattern having a generally flat top with a substantially vertical rise at each limit.

6. A fluorescent reflector lamp comprising a tubular elongated glass envelope having electrodes sealed into opposite ends and containing an ionizable medium in-

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cluding mercury vapor and an inert gas at a low pressure, a reflective coating on the interior of the envelope wall and a phosphor coating thereover responsive to ultraviolet radiation produced by an electric discharge through said medium, said reflective coating being applied over the entire interior of the envelope except for a window extending in width over a peripheral angle between approximately 30° to 60° and in length between points forward of the electrodes a distance of approximately $2\frac{1}{4}$ to $1\frac{3}{4}$ envelope diameters in order to achieve a controlled light distribution pattern having a generally flat top with a substantially vertical rise at each limit.

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JOHN W. HUCKERT, *Primary Examiner*.

J. R. SHEWMAKER, *Assistant Examiner*.