

Dec. 24, 1963

D. E. SPENCER ET AL
APERTURE FLUORESCENT LAMP

3,115,309

Filed July 9, 1959

2 Sheets-Sheet 1

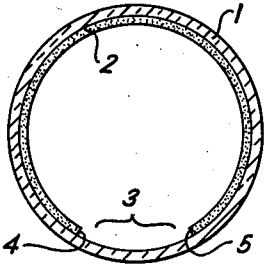


FIG. 1

FIG. 2

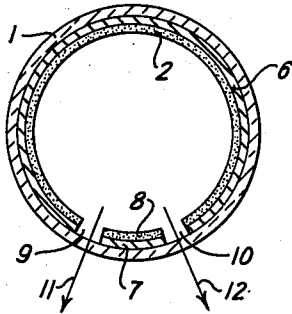
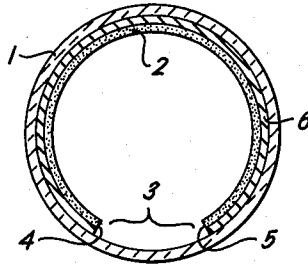
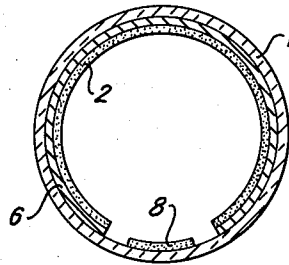


FIG. 3

FIG. 4



INVENTORS
DOMINA E. SPENCER
BY SANDFORD C. PEEK, JR.
Lauren Bunn
ATTORNEY

Dec. 24, 1963

D. E. SPENCER ET AL
APERTURE FLUORESCENT LAMP

3,115,309

Filed July 9, 1959

2 Sheets-Sheet 2

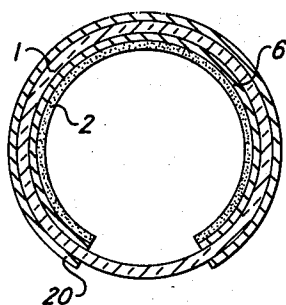


Fig. 6

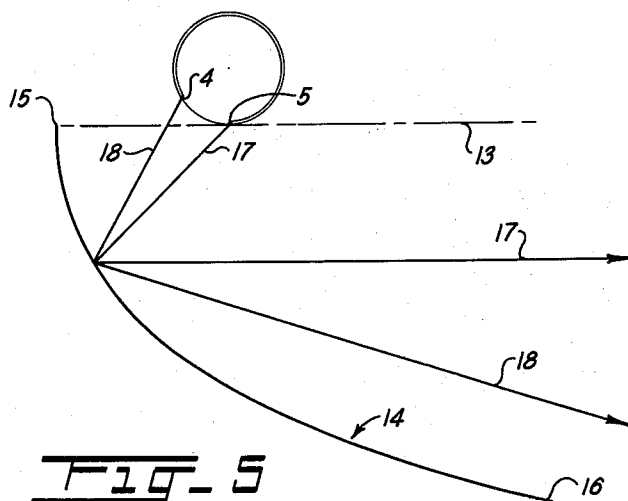


Fig. 5

INVENTORS
DOMINA E. SPENCER
SANDFORD C. PEEK, JR.
BY *Lawrence B. Burre*
ATTORNEY

1

3,115,309

APERTURE FLUORESCENT LAMP

Domina Eberle Spencer, Cambridge, and Sandford Christopher Peek, Jr., Hamilton, Mass., assignors to Sylvania Electric Products Inc., a corporation of Delaware

Filed July 9, 1959, Ser. No. 825,915

2 Claims. (Cl. 240—41.35)

This invention relates to fluorescent lamps and similar devices, and equipment in which said lamps are operated.

For many applications for fluorescent lamps, a higher brightness than presently obtainable is required. The brightness of the lamps can be increased by increasing the power input while keeping the mercury vapor pressure at a suitable value, but even the brightness obtained by this means is smaller than that required for certain types of applications, and in any event, the total light output of the lamp is increased, which is not always desirable.

We have discovered that the brightness can be increased without increasing either the power input, or the total light output, by the use of a small aperture in the lamp coating. In other words, instead of being coated with phosphor entirely around its circumferential surface, the lamp will be coated around only a portion of its circumferential surface; that is, it will be coated over an angle somewhat less than the full 360 degrees of circumference. This will leave a narrow uncoated strip extending lengthwise along the lamp generally parallel to the longitudinal lamp axis. The brightness of the light coming through said aperture or uncoated portion will be much greater than the light emerging through the coated portion of the lamp.

We have discovered that the brightness can be still further improved if a reflector, for example, in the form of a reflective coating, be placed on the inside surface of the glass tube between the glass and the fluorescent phosphor, said reflecting coating being omitted from the aperture; that is, from the portion of the lamp which has no fluorescent coating.

The coating can be of a reflecting powder for example, titanium dioxide, or of a metal, for example, aluminum or silver. The use of aluminum has the additional advantage of increasing not only the visible reflection but also the ultraviolet reflection. A coating of aluminum oxide will also reflect ultraviolet light.

The reflector or reflecting coating can be put on the outside of the surface of the glass tube, but will then be less effective because of the absorption of light in the glass between the phosphor coating and the reflecting material.

In a fluorescent coating for the usual type of lamp in which the entire circumferential surface is coated with phosphor, the particle size of the phosphor should ordinarily be between three and thirty microns to reduce the reflection back into the tube.

In the present type of lamp however, the transmission of light through the coating is not desired and hence a smaller particle size, below three microns, for example, about 1/2 micron, is most effective.

We have found that in lamps having a portion of their inside surface coated with phosphor and a portion uncoated, the mercury generally present in such devices will attack the uncoated portion of the glass tube, blackening it and thereby decreasing the light output. To prevent or reduce such blackening a light-transmitting protective coating can be applied to the inner surface of the glass tube, or at least to the portion not coated with phosphor. A thin coating of antimony oxide can be used, or a very thin coating of the phosphor itself, much thinner than the main phosphor coating, can be applied over the un-

2

coated portion of the tube. In the latter case, the protective phosphor coating can be of a thickness less than half that of the main phosphor coating, and it is desirable to make it of an average particle size of greater than about 3 microns, in order to minimize reflection and increase transmission of light through it.

The discoloration can also be reduced by making the lamp tube of a special glass, for example, lead glass, instead of the lime glass commonly used.

In some cases it may even be desirable to make the phosphor coating on the aperture of a phosphor of a type emitting a different color than does the main phosphor coating, and a phosphor may even be used which will transform some of the radiation from the main phosphor coating into radiation of a different wavelength.

In some cases where the lamp is used for illuminating the street and is placed transverse to the axis of the street it may be desirable to use two apertures in the lamp, the two being spaced slightly apart so that the light coming from them will be directed along the street in opposite directions. If necessary, a linear lens can be used around the lamp to further direct the light in order to get a proper distribution on the street, and a phosphor coating without a reflector used between the apertures to direct some light onto the street directly below the lamp. The lamp of the present invention is especially useful in the illumination of highways and airport runways in which it is desired to project a beam of light in which substantially all rays are horizontal or at angles below the horizontal, that is, so that there will be no upward component of the light from the lamp. A lamp of high brightness is especially needed in such installations because the brightness at the center of the runway will depend on the brightness of the light source. We have discovered that for such purposes a lamp can be very effectively used with a parabolic reflector, with the edge of the aperture farthest from the apex of the parabola being along the axis of the parabola and at its focus, with the other edge of the aperture being above the axis of the parabola. The lamp is then off the axis of the parabola, whereas in ordinary use of the parabolic reflector the center of the lamp would be at the focus of the parabola; that is, in cross-section, the center of the lamp would be on the axis of the parabola.

We have found that the smaller the aperture is made, that is, the smaller the angle it subtends at the center of the tube, the nearer the light source becomes to a linear source in effect, although the light is not actually emitted from the aperture but rather through it from the inside surface of the lamp.

The smaller the aperture, the greater the brightness becomes, as long as the aperture is finite and greater than zero in dimension. With extremely small apertures and high reflectivity around the remainder of the lamp surface, the brightness increase can be tremendous, far more than 50 times the normal brightness of a lamp without an aperture.

The total light output, however, will be less for very small apertures than for some intermediate sizes of apertures. With a reflectivity of about 0.9 for the reflecting material used, the maximum light output will occur at an aperture extending over only 60° of the 360° surface of the tube.

The aperture lamp of this invention with a suitable reflector or a refractor is especially suitable as a headlight for an automobile, because it gives a wide beam in which the upward component can be made as small or as large as desired, a type of beam which has been long sought in the automobile industry.

3

Other objects, advantages and features of the invention will be apparent from the following specification taken in connection with the accompanying drawings in which:

FIGURE 1 is a cross-sectional view of a lamp having an aperture in a fluorescent coating;

FIGURE 2 is a cross-sectional view of such a lamp having a reflector coating under the fluorescent coating;

FIGURE 3 is a cross-sectional view of a lamp with two spaced apertures;

FIGURE 4 is a cross-sectional view of a lamp with two apertures spaced apart, with a fluorescent coating without a reflecting coating between apertures;

FIGURE 5 is a schematic view of a lamp with an external reflector to direct the light from the aperture; and

FIGURE 6 is a cross-sectional view of a lamp having an opaque coating over the lamp except at the aperture.

In FIGURE 1, the glass tube 1 has the coating 2 of phosphor particles on its inside surface, the coating 2 having a gap 3 between its two ends 4, 5 in order to provide an aperture through which light from the inside surface of the coating 2 can be directly emitted, or emitted after internal reflection, without passing through the coating 2 itself.

The fluorescent coating should be thick enough to reflect into the tube 1 a large portion of the light emitted in the coating 2. The phosphor particles of the coating 2 are preferably of a small size, averaging less than about 3 microns, to enhance the reflection. The coating can be applied in the customary manner for coating fluorescent lamps, over the entire surface if desired, and then scraped off the portion or gap 3 which is to be free of coating.

The brightness of the light emitted through the aperture can be greatly increased by adding a reflecting coating 6 between glass tube 1 and phosphor coating 2, as shown in FIGURE 2. The reflecting coating 6 can be of powdered materials of good reflectivity, such as magnesium oxide, zinc oxide, or titanium dioxide. The particle size can be small, for example an average size of .1 micron is quite effective. The reflector coating can be applied in the same manner as the phosphor coating, or in some other manner, if desired, and the phosphor coating then applied over it in the manner previously mentioned.

The brightness obtained through the gap or aperture 3 will be greater if a metal surface, preferably a specular reflecting surface, is used for the reflecting coating 6. The metal coating can be applied in any manner customary in the art, for example as shown in U.S. Patent 2,064,369 to O. H. Biggs. Aluminum and silver are especially effective as reflecting materials, and can be applied by evaporation. Silver can also be applied chemically, by the usual mirror deposition methods, if desired.

Although the reflector coating has been shown inside the bulb, it can also be placed on the outside of the bulb if desired, although then there will be additional losses in the glass between the phosphor and the reflector, with a smaller increase in brightness.

In some cases, more than one aperture may be present, as shown in FIGURE 3. In the case, the glass tube 1 and the coatings 2 and 6 can be the same as before, but part of the gap 3 between them will be covered by the additional reflecting coating 7 and the additional phosphor coat 8, thereby in effect producing two apertures 9, 10. Such a lamp is especially useful as a street-light, mounted several feet, perhaps as high even as twenty feet, above the street, the axis of the lamp being perpendicular to the street or the center line thereof.

As shown by the arrows 11, 12, light would then emerge from the apertures 9, 10 in two different directions, part being directed toward the street on one side of the lamp, and part toward the street on the other side.

A refractor or series of longitudinal or linear lenses, parallel to the axis of the tube can be used on each side of the tube 1 to direct the light wherever desired.

In some cases, some direct light from the lamp may be desired on the street directly below tube 1, and that may

4

be achieved by omitting the reflecting coating 7 between the two apertures 9, 10, as shown in FIGURE 4, so that some direct light from the outside surface of phosphor coating 8 will fall on the roadway.

One type of fixture which is effective with an aperture lamp is shown in FIGURE 5. In this the phosphor coating 2 is shown schematically, with its ends 4, 5 shown as dots for emphasis. A reflecting parabola, which can be of specular metal, is placed with its axis tangent to the circle of coating 2 at one end 5 thereof, with the other end 4 of the coating 2 off the axis 13 of the parabola 14. Only one side 15—16 of the parabola is present in the actual reflector, and the lamp is on the other side of the axis 13 than the portion 15—16 of the parabola 14. One edge 5 of the coating 2 is tangent to the axis of the parabola, as previously stated, and at the focus of the parabola. The other edge 4 of coating 2 is off the axis of the parabola and nearer to the apex 15 thereof.

As shown by the schematic ray of light 17, all rays from edge 5 will be reflected parallel to the axis 13, and all other rays, for example a ray 18 from edge 4, will be reflected below ray 18 in the figure, that is, in a direction nearer to the parabola 14 itself.

This reflector-lamp combination is therefore especially effective where it is desired to place the longitudinal axis of the lamp horizontally and to insure that all rays emanating from the fixture will be directed at or below the horizontal. If it is desired to have all rays below the horizontal, for example to have them just slightly below the horizontal when illuminating a runway or roadway from a region vertically close to the edge of the runway or roadway, then the whole unit, lamp plus reflector, can be tilted the desired amount.

If a glass or plastic window is used in front of the unit, then a non-reflecting black region can be used between the forward end 16 of reflector 14 and the window, as shown in co-pending U.S. patent application Serial No. 712,203, filed January 30, 1958, by Biggs, Spencer and Peek.

Because the lamp used with the reflector has an aperture, the fixture of the present invention can be made much smaller than that shown in the application mentioned above.

In the fixture of FIGURE 4, an opaque coating can be used over the reflecting portion of the bulb in order to prevent any stray light passing through the reflector from reaching the reflector or the object to be eliminated. In that way, a sharp cut-off of the beam will be achieved.

A lamp having such an opaque coating 20 is shown in FIGURE 6.

The width of the beam can be adjusted by varying the distance 15—5, that is, the distance along the axis 13 between points 15 and 5.

In the foregoing description only the new features in the lamps were described, and the old features were not. However, it is clear that the tube 1 is a sealed envelope, containing a filling of inert gas and a small amount of mercury vapor, with an electrode, preferably of the thermionic type, at each end of the lamp, in the manner customary in the art. These features can be the same as in the so-called "Very High Output" lamps, with an input of about 25 watts or more, such as shown in U.S. patent application Serial No. 742,928, filed June 18, 1958, by Waymouth et al.

What we claim is:

1. A lighting unit comprising a parabolic reflector, a tubular fluorescent lamp having a phosphor coating with a longitudinal aperture therein, one edge of said aperture being placed at the focus of said parabolic reflector, the lamp being tangent to the axis of the parabola at said focus, the other edge of said aperture being placed off the axis of, and nearer to, the apex of said parabola.

2. The lighting unit of claim 1, in which the reflecting parabolic surface is mainly confined to the side of the

axis opposite to that on which the second-mentioned edge of the aperture is placed.

References Cited in the file of this patent

UNITED STATES PATENTS

2,407,379	Morehouse	Sept. 10, 1946
2,436,635	De Bishop	Feb. 24, 1948
2,724,047	Zurawski	Nov. 15, 1955

5

2,753,444
2,854,600
2,892,956
2,906,905

603,326
838,796
1,085,509

Zurawski	July 3, 1956
Van De Weyer et al.	Sept. 30, 1958
Vodicka	June 30, 1959
Wares	Sept. 29, 1959

FOREIGN PATENTS

Great Britain	June 14, 1948
Germany	May 12, 1952
France	July 28, 1954