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FLUORESCENT LIGHTING SYSTEM

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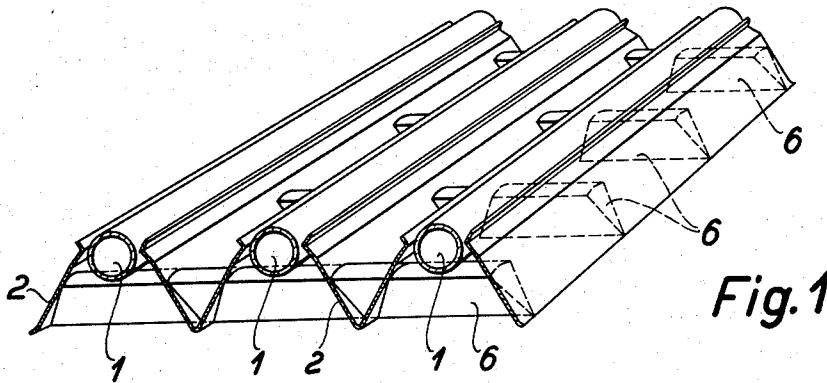


Fig. 1

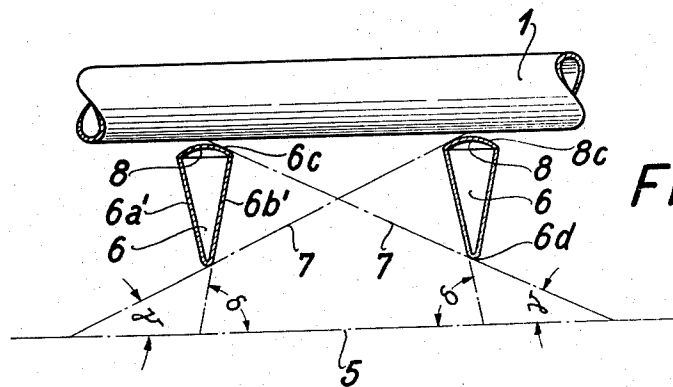


Fig. 3

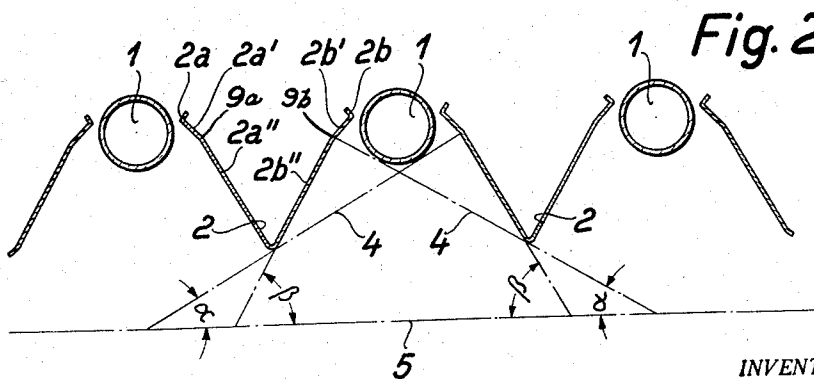


Fig. 2

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FLUORESCENT LIGHTING SYSTEM

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5 Claims. (Cl. 240—9)

The present invention relates to lighting equipment. More in particular, the present invention relates to elongated, tubular fluorescent lamps with preferably planar reflectors and accompanying means for shielding the eye of the observer from glare effects of the light source.

It is known in the art to equip fluorescent lamps of the commercial elongated tubular type with means designed to protect the unshielded eye of the observer from the glare effect of the lamp or its image. Since the conventional reflectors with which fluorescent lamps are generally equipped afford only a partial and an insufficient protection, protective devices have been developed consisting of an array of louvres, the latter being usually composed of an assembly of metal or plastic sheets. These anti-dazzle grids are usually vertically disposed relative to the longitudinal axis of the lamp tube, and are positioned either underneath the latter or underneath the reflectors, sometimes in a number of parallel rows, so as to form a grid shaped structure with the reflectors. Their size is so designed that only diffused light is spread outside of the pyramid defined by the undiffused light rays emitted by the lamp.

It is also known to provide the louvres with a non-specular surface. In this case the space free from glare effects can be kept within a certain angular sector in the direction of the tube depending upon the distance and the size of the metal or plastic sheets of the louvres. However, the light rays are diffusely reflected by the non-specular surface of the metal or plastic sheets and are therefore lost for lighting purposes. On the other hand, if the surfaces of the louvres are specular, the space free from dazzle effects cannot be determined at will. The product of the entrance aperture and the size of the entrance opening is equal to the product of the exit aperture and the size of the entrance opening. Where the louver sheets are arranged parallel to each other and the entrance opening is equal to the exit opening, and where the entrance aperture is 180° due to the longitudinal extension of the tube the exit aperture will also be 180° , i.e. there will be a radiation in an angular section of 180° . An unconcentrated radiation of this kind is, of course, undesirable for practically all lighting purposes.

It is therefore an object of the present invention to provide a lighting equipment comprising tubular fluorescent lamps which assures a uniform and angular distribution of light within the desired area of illumination and which eliminates undesirable and disturbing glare effects.

It is another object of the present invention to provide a lighting equipment comprising tubular fluorescent lamps and reflectors associated therewith in which undesirable glare effects can be eliminated within a predetermined accurately defined area and which simultaneously utilizes the light rays emitted by the lamp tube to the greatest possible extent for the purpose of illuminating a desired area.

These objects are achieved by the novel construction

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of my invention which is based on my discovery that a particular shape and position of the reflectors relative to the position of the tubular fluorescent lamp is sufficient to assure the elimination of undesirable glare and dazzle effects without requiring special anti-dazzle devices and arrangements, while utilizing to the fullest possible extent the light rays emitted by the lamp for the illumination of the desired area.

According to my invention the fluorescent lamp construction is so designed that reflector walls situated on both sides of and parallel to the lamp tube contact with their respective lower edges planes constituting the boundaries between light and shadow. Furthermore, these planes are tilted relative to the horizontal plane at an angle α corresponding to the desired range of absence of glare or dazzle effects and the planes are finally tangential to that part of the lamp tube which faces the floor. In addition, the walls of the reflectors must form with the horizontal plane an angle β which is equal to or smaller than $90^\circ - \alpha$.

According to another embodiment of the present invention there are provided reflector means which are transversely disposed relative to the longitudinal axes of the lamp tubes and which have a V-shaped cross section seen in transverse direction towards the longitudinal extension of the tube. V-shaped reflectors are known but it was considered impossible to provide V-shaped reflectors transversely to the tube as it was assumed that such a large area of the tubes was covered that the resulting loss of useful light would outweigh any advantage of such an arrangement. The present invention has overcome this prejudice. Because of the V-shaped construction of these transverse reflectors the exit opening is greater than the entrance opening and the range of radiation is smaller than 180° .

The invention will be better understood upon the following description of the accompanying drawings, wherein.

Figure 1 is a perspective view of the lighting equipment of the present invention;

Figure 2 is a somewhat schematic, cross sectional view of the fluorescent lamp tubes and the longitudinally extending reflectors in the lighting equipment of the present invention;

Figure 3 is another somewhat schematic view, partly in longitudinal section of the arrangement of the transverse reflectors of the invention;

Figure 4 is a diagram illustrating the relation of the angles γ and δ ;

Figure 5 is a cross sectional view of a transverse reflector of the invention;

Figure 6 is a cross sectional view of a transverse reflector of the invention having a cover.

Turning now to the drawings more in detail the lamp tubes 1 have associated reflectors 2. The respective lower edges of the walls 2a and 2b of these reflectors 2 contact imaginary planes 4 which constitute the boundaries between the light and shadow regions. The planes 4 are inclined relative to the horizontal plane 5 at an angle α and they are arranged tangentially relative to the lower portions of the tubes 1 facing the floor. The angle α defines the range free from dazzle or glare effects and it is chosen in correspondance with the desired extension of that range. In the example shown in Figure 1 the angle α is 30° . The walls 2a and 2b of the reflectors have an inclination relative to the horizontal plane 5 defined by an angle β . The ratio of the angles α and β is so chosen that the virtual image of the tube remains always above the tangential plane 4 limiting the space free from glare or dazzle effects. The angle β has a maximum value of $90^\circ - \alpha$ or a value inferior to $90^\circ - \alpha$. As a result, if the eye of the observer looks in the direc-

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tion of the fluorescent tubes at an angle smaller than β , neither the tube nor a reflected image of the tube can be seen. In the example shown in Figure 2, the angle β defining the inclination of the walls 2a and 2b of the reflectors 2 relative to the horizontal plane 5 has a value of 60° ($90^\circ - \alpha$, i.e. $90^\circ - 30^\circ = 60^\circ$).

It should be kept in mind that the angle of inclination shown in the example of Figure 1 must be regarded as a marginal value constituting the minimum inclination of the reflector walls 2a and 2b towards the horizontal plane 5, defined by a maximum angle β . In this marginal case, the reflector surfaces have the smallest possible extension and the total height of the lamp construction attains a minimum value. If the angle of inclination of the reflectors towards the horizontal is made smaller (which can be done to a certain marginal value) the light yield can be increased. There will be, however, as an accompanying result, an undesirable influence upon the size of the reflecting surface and of the lamp construction which are both increased, since both the reflector surface and the lamp construction will have a greater extension.

It has been discovered that the best overall results are obtained if a compromise is chosen between the greatest light yield and the minimum size of the reflector surfaces and the lamp construction. According to this solution only a certain portion of the reflector walls is arranged at an angle of inclination, smaller than the aforementioned maximum value of the angle β . For example, the reflector walls 2a and 2b can be bent in the area neighboring the lamp tubes and preferably or respectively starting from the points of intersection 9a and 9b with the tangential planes 4 limiting the space free from glare so as to have upper portions 2a', 2b', and lower, inwardly bent portions 2a'', 2b'', with the upper portions 2a' and 2b' being inclined towards the horizontal plane 5 at an angle β which is inferior to $90^\circ - \alpha$ whereas the lower portions 2a'' and 2b'' are inclined towards the horizontal plane 5 at an angle having the maximum value of $90^\circ - \alpha$ (in the example shown in Figure 2, 60°).

In order to keep the total width of the lamp as small as possible it is further advisable to have the upper edges of the reflector walls approach the tube as much as possible, at a height corresponding approximately to the longitudinal center line of the lamp. In doing so that region of the lamp tube which is ordinarily prevented from spreading useful light rays by the own shadow of the lamp is fully utilized for illuminating the ceiling, from where the light may again be more or less perfectly reflected to the lower parts of the respective room, according to the condition of the ceiling.

According to a further advantageous feature of the present invention an assembly of tubular fluorescent lamps comprising at least two tubes is provided with combined reflectors composed of one single V-shaped piece 2 and disposed between two neighboring tubes. The single V-shaped piece thus provides one reflector wall 2a for each of the two adjoining tubes, and, another reflector wall 2b for the other of the two adjoining lamp tubes. Furthermore, there is provided a second set of reflectors 6 (Figure 3) vertically and transversely arranged relative to the longitudinal axis of the lamp tube replacing the conventional louvres or anti-dazzle grid structures. These vertical reflectors fulfill the double function of preventing a glare or dazzle effect and at the same time reflect the light rays emitted by the light source, i.e. with the fluorescent lamp tube thus contributing to a better utilization of the light rays emanating from the latter. To accomplish these ends the vertically and transversely arranged reflectors 6 are so positioned that the light rays emitted by the light source and reaching the reflecting surface of the transverse reflectors are reflected against the floor, thereby avoiding any glare or dazzle effect undesirable and unpleasant to the eye of the observer. The transverse reflectors 6 are arranged

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out of contact but very close to the lower side of the lamp tube 1. The upper edges 6c of each of the transverse reflectors as well as the lower edges 6d of each neighboring transverse reflector contact imaginary planes 7 which are inclined towards the horizontal plane 5 at an angle γ which corresponds to the desired extension of the space which is free from glare or dazzle effects.

In addition, the transverse reflectors are V-shaped and their lateral sides 6a' and 6b' form with the horizontal plane 5 and angle δ which is

$$\leq 90^\circ - \frac{\delta}{2}$$

In the example shown in Figure 3, the imaginary planes 7 are inclined towards the horizontal plane 5 at an angle $\gamma = 25^\circ$, and the sides 6a and 6b of the transverse reflectors 6 are inclined towards the horizontal plane 5 at an angle $\delta = 77^\circ 30'$.

An angle γ of 30° has proved to be of particular advantage since in that case a maximum light yield is obtained while the overall size of the lighting equipment is as small as possible. However, good results are also obtained if the angle is a little smaller or wider by an amount of 10° , i.e. up to 40° and down to 20° .

The width of the angle δ should be smaller than

$$90^\circ - \frac{\delta}{2} \text{ as } \delta = 90^\circ - \frac{\delta}{2}$$

constitutes the marginal width of the angle δ in which there is no dazzling effect and in which the reflected rays are utilized to their fullest extent in the desired area which is to be illuminated. If the angle δ is smaller than

$$90^\circ - \frac{\delta}{2}$$

the intensity of the illumination is increased whereas the extension of the illuminated area is reduced.

The angles γ and δ will become apparent upon regarding Figure 4. The marginal light ray A runs parallel to the longitudinal extension of lamp tubes 1 and is reflected by the reflector 6a so as to be tangential to the lower edge of reflector 6b and thus passing reflector 6b, since the reflector surface B of reflector 6a is vertically disposed relative to the angle by sector C of the angles γ' and γ with γ' being equal to γ . If the angle between the light ray A and the reflector surface B of the reflector 6a is designated as ϵ the following equations are valid:

$$\delta = \delta' = 180^\circ - \epsilon$$

$$\epsilon = 90^\circ + \frac{\gamma}{2}$$

$$\delta = 180^\circ - \left(90^\circ + \frac{\gamma}{2} \right) = 90^\circ - \frac{\gamma}{2}$$

The transverse reflectors 6 can be provided with a cover 8 protecting the reflector from dust. The cover can be bulged in outward direction so as to have a convex configuration as shown in Figure 3 and may have a specular surface 8c so as to undiffusely reflect the light rays emitted from the fluorescent tube 1.

The cover can also have an angular configuration 8b as shown in Figure 6.

The reflector walls 2a, 2b and 6a, 6b can be composed of a perfectly or partly specular material. The respective upper ends 2c, 2d of the reflector walls 2a and 2b can be flanged to give sufficient stability to the reflector walls.

It will be understood that this invention is susceptible to modification in order to adapt it to different usages and conditions, and, accordingly, it is desired to comprehend such modifications within this invention as may fall within the scope of the appended claims.

What I claim is:

1. In a lighting equipment comprising a plurality of

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fluorescent lamp tubes; longitudinal reflector means comprising a plurality of longitudinally extending walls disposed on both longitudinal sides of each of said lamp tubes and parallel thereto, every two of said walls intermediate two of said lamp tubes being composed of one V-shaped piece, said reflector walls having lower edges adjoining an imaginary plane defining the boundaries between light and shadow, said imaginary plane being inclined towards the horizontal plane at a predetermined angle α corresponding to the desired extension of space free from glare effects and being tangential with the lower downwardly extending portion of said lamp, said reflector walls being bent at their point of intersection with said imaginary plane so as to have an upper and a lower portion above and below said bend, respectively, the respective lower portions of said reflector walls being inclined towards the horizontal plane at an angle inferior to $90^\circ - \alpha$, and a plurality of transverse reflectors having reflector walls vertically extending relative to the longitudinal axes of said lamp tubes, the respective upper edges of said transverse reflectors and the respective lower edges of the neighboring vertically extending reflectors adjoining an imaginary plane which is inclined towards the horizontal plane at a predetermined angle γ corresponding to the desired extension of space free from glare effects.

2. A lighting equipment as described in claim 1 wherein said transverse reflectors are V-shaped and have two lateral surfaces which are inclined towards the horizontal plane at a predetermined angle δ that is less than

$$90^\circ - \frac{\gamma}{2}$$

3. A lighting equipment as described in claim 2, fur-

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ther comprising an outwardly bulged cover placed on top of said V-shaped vertically extending reflectors.

4. A lighting equipment as described in claim 2, further comprising an outwardly bulged cover placed on top of said V-shaped vertically extending reflectors, said cover having a specular surface.

5. A reflector arrangement for use with a lighting fixture having at least one elongated light source, said arrangement comprising, in combination, longitudinal reflector means arranged on both longitudinal sides of said light source and being parallel thereto, said longitudinal reflector means flaring downwardly from said light source and having upper edges which are at substantially the same level as the middle of said light source; and transverse reflector means arranged between said longitudinal reflector means and extending upwardly to the region of the lowermost edge of said light source, said reflector means being in the form of wedge-shaped members which in a vertical plane of said light source have a downwardly tapering V-shaped cross-section, each member being closed by an upwardly bulging cover element which is near said lowermost edge of said light source and which has a specular outer surface.

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