

**PROCESS FOR PRODUCING THE PROFILE OF REFLECTORS FOR  
A CYLINDRICAL SOURCE OF LIGHT AND REFLECTORS  
OBTAINED ACCORDING TO THIS PROCESS**

**TECHNICAL FIELD**

5       The present invention relates to the process for the production of the profile of reflectors for a cylindrical source of light to illuminate a target surface with practically any desired illumination curve. The present invention also relates to the reflectors obtained according to the process.

**BACKGROUND ART**

10       The process for the production of reflector profiles for an extended flat source of light has been established by A. Rabl and J. M. Gordon [French patent no. 94 07809]. However, the process is restricted to virtual flat sources of light that are obtained from actual cylindrical sources of light, such as fluorescent tubes, with the aid a primary reflector having the shape of a developed circle. One of the drawbacks of the former process is that the  
15       desired target illumination curve cannot be obtained exactly when the primary reflector is modified to satisfy manufacturing specification such as a small gap between the reflector and the source of light. Another drawback is that the reflector for a cylindrical source of light according to the former process consists of two distinct shapes, thus incurring extra costs in manufacturing. The present invention overcomes these drawbacks with a process for  
20       producing reflectors directly for a cylindrical source of light that will achieve not only the desired target illumination but also, it is possible to produce reflectors that exhibit a smooth and continuous profile.

**DISCLOSURE OF INVENTION**

25       It is a primary object of the present invention to provide means for producing the profile of reflectors for an extended cylindrical source of light that will yield practically any

illumination curve so desired by the end-user and in particular, for achieving constant illumination at the target surface.

It is thus an object of the present invention to provide a process for the production of the profile of reflectors for a cylindrical source of light symmetrical relative to a vertical plane, of four cylindrical reflective elements, two on each side of the said plane consisting the inner and outer reflective elements, both of which combine to yield a continuous reflector profile on one side of the said plane, the other being symmetrical about the said plane. Each point (R) of the profile of the said outer element is defined by the length (r) of the segment representing the distance from a point of tangency on the left of the said source, located centrally relative to the symmetrical reflective elements, as seen from the said element on the right of the said plane, to the said point, and by the angle ( $\phi$ ) formed by the said segment with the said plane, the resultant ray of light from the said source forming, at the output, respective angles ( $\theta$ ) with the said plane, characterised in that it comprises the steps consisting:

in defining the inner reflective element on one side of the said plane, the other being symmetrical about the said plane, a modified revolution of a circle as obtained from the cross-section of the said source is chosen; defined by its starting point ( $I_d$ ) on the axis of the said plane, located at a vertical distance (g) of at least one source radius (t) measured from the said light source to the said starting point, and by its terminating end ( $I_e$ ) of the said inner element by the angle ( $\mu$ ) formed by said plane and the output of the ray of light that originates from a point of tangency on the right of the said source as seen by the left said inner element relative to the said plane, and also by the angle ( $\theta_d$ ) formed by the said plane and the segment from the said starting point to a point of tangency on the said source,

in defining the position of one end ( $R_b$ ) of the said outer element, from a desired distance ( $r_b$ ) separating said point of tangency on the left of the said source as seen from the said outer element located on the right of the said plane and, of which may either be equal to the terminating end ( $I_e$ ) of the said inner element or, be situated on the downstream of the

said outer element away from the terminating end ( $I_e$ ) of the said inner element, and also from an angle ( $\gamma$ ) subtended by the said source at the said end beyond which the continuation of the profile of the said outer element has to account for the diminishing contribution of the luminance from the said end, which depends on the said segment ( $r_b$ ).

- 5 in defining an illumination function  $E(\theta)$  corresponding to a desired target illumination curve, for  $|\theta| \leq \gamma$ , associated with a luminance  $L(\theta)$  by the formula:

$$E(\theta) = L(\theta) \cos^2(\theta) = \{ 2t \sin(\beta_L + \theta) - (t + g) \sin(\theta) + t \} \cos^2(\theta) + \\ \{ (r + t \tan(\alpha)) \sin 2(\alpha) \} \cos^2(\theta)$$

- 10 if the said end of the profile for the said outer element is the terminating end ( $I_e$ ) of the said inner element, and an illumination function, for  $|\theta| \leq \gamma$ :

$$E(\theta) = L(\theta) \cos^2(\theta) = \{ 3t + 2t \sin(\beta_L + \theta) + 2t \sin(\beta_R - \theta) - (t + g) \sin(\theta) \} \cos^2(\theta) \\ + \{ (r_b + t \tan(\alpha_b)) \sin 2(\alpha_b) - (r + t \tan(\alpha)) \sin 2(\alpha) \} \cos^2(\theta)$$

if the said end ( $R_b$ ) of the profile of the said outer element is at the downstream of the outer said element away from the said inner element.

- 15 in determining, from said end, the coordinates of each point ( $R$ ) of said profile of the said outer element satisfying the differential equation:

$$\frac{d\alpha}{d\theta} \left( 1 + \frac{2t \cos^2 \alpha}{p(\theta)} \right) = \sin(\alpha) \cos(\alpha) \frac{d(\ln\{p(\theta)\})}{d\theta} - \sin^2 \alpha + \frac{2t}{p(\theta)} \left( \frac{d\alpha}{d\theta} + \sin^2 \alpha \right)$$

where  $p(\theta)$  is equal to  $(r + t \tan(\alpha)) \sin 2(\alpha)$  and the angle  $\alpha$  is equal to  $(\phi - \theta)/2$ .

- 20 It is also an object of the present invention to provide a process for the production of the profile of reflectors for a cylindrical source of light symmetrical relative to a vertical plane, of four cylindrical reflective elements, two on each side of the said plane consisting the inner and outer reflective elements, both of which combine to yield a contiguous reflector profile on one side of the said plane, the other being symmetrical about the said

plane. Each point (R) of the profile of the said outer element is defined by the length (r) of the segment representing the distance from a point of tangency on the right of the said source, located centrally relative to the symmetrical reflective elements, as seen from the said element located on the right of the said plane, to the said point, and by the angle ( $\phi$ )  
5 formed by the said segment with the said plane, the resultant ray of light from the said source forming, at the output, respective angles ( $\theta$ ) with the said plane, characterized in that it comprises the steps consisting:

in defining the inner reflective element on one side of the said plane, the other being symmetrical about the said plane, a modified revolution of a circle as obtained from the  
10 cross-section of the said source is chosen; defined by its starting point ( $I_d$ ) on the axis of the said plane, located at a vertical distance (g) of at least one source radius (t) measured from the said light source to the said starting point, and by its terminating end ( $I_e$ ) of the said inner element by the angle ( $\mu$ ) formed by said plane and the output of the ray of light that originates from a point of tangency from the right of the said source as seen by the left said  
15 inner element relative to the said plane, and also by the angle ( $\theta_d$ ) formed by the said plane and the segment from the said starting point to a point of tangency on the said source,

in defining the position of one end ( $R_b$ ) of the said outer element, from a desired distance ( $r_b$ ) separating said point of tangency on the right of the said source as seen from the said outer element located on the right of the said plane and, of which may either be  
20 equal to the terminating end ( $I_e$ ) of the said inner element or, be situated on the downstream of the said outer element away from the terminating end ( $I_e$ ) of the said inner element, and also from an angle ( $\gamma$ ) subtended by the said source at the said end beyond which the continuation of the profile of the said outer element has to account for the diminishing contribution of the luminance from the said end ( $R_b$ ), which depends on the said segment  
25 ( $r_b$ ).

in defining an illumination function  $E(\theta)$  corresponding to a desired target illumination curve, for  $|\theta| \leq \gamma$ , associated with a luminance  $L(\theta)$  by the formula:

$$E(\theta) = L(\theta) \cos^2(\theta) = \{ 3t + 2t \sin(\beta_L + \theta) + 2t \sin(\beta_R - \theta) - (t + g) \sin(\theta) \} \cos^2(\theta) \\ + \left\{ \left( r + \frac{t}{\tan(\alpha)} \right) \sin 2(\alpha) - \left( r_b + \frac{t}{\tan(\alpha_b)} \right) \sin 2(\alpha_b) \right\} \cos^2(\theta)$$

if the said end of the profile for the said outer element is the terminating end ( $I_e$ ) of the said inner element, and an illumination function, for  $|\theta| \leq \gamma$ :

$$5 \quad E(\theta) = L(\theta) \cos^2(\theta) = \{ 3t + 2t \sin(\beta_L + \theta) + 2t \sin(\beta_R - \theta) - (t + g) \sin(\theta) \} \cos^2(\theta) \\ + \left\{ \left( r_b + \frac{t}{\tan(\alpha_b)} \right) \sin 2(\alpha_b) - \left( r + \frac{t}{\tan(\alpha)} \right) \sin 2(\alpha) \right\} \cos^2(\theta)$$

if the said end of the profile of the said outer element is at the downstream of the said element away from the said inner element.

in determining, from said end, the coordinates of each point (R) of said profile of the  
10 said outer element satisfying the differential equation:

$$\frac{d\alpha}{d\theta} \left( 1 - \frac{2t \cos^2 \alpha}{p(\theta)} \right) = \sin(\alpha) \cos(\alpha) \frac{d(\ln\{p(\theta)\})}{d\theta} - \sin^2 \alpha$$

where  $p(\theta)$  is equal to  $\left( r + \frac{t}{\tan(\alpha)} \right) \sin 2(\alpha)$  and the value of the angle  $\alpha$  is equal to  $(\phi - \theta)/2$ .

The invention thus permits controlling the illumination supplied to the target surface. Such  
15 illumination can be symmetrical or otherwise relative to the said plane of symmetry of the source, the profiles of the reflector being adapted in such an instance.

The present invention is particularly superior for producing reflectors for a cylindrical source of light such that a desired constant illumination curve can be achieved at the target surface. The invention is also particularly advantageous for producing constant illumination  
20 at the target surface for the case, for example for illuminating a finite-space target where several sources have to be utilized, by means of overlapping the output illumination from adjacent reflectors to achieve the desired constant target illumination.

**BRIEF DESCRIPTION OF THE DRAWINGS**

The accompanying drawings which are incorporated into and constitute the reflectors that can be obtained by the said process, serve to illustrate the embodiments of the invention, and not as a definition of the limits of the invention for which reference should be made to the  
5 claims appearing at the end of the description.

Figure 1 is a schematic cross-sectional view of a type of reflector of the invention illuminating a target surface in which the desired illumination curve is constant, as obtained according to the invention.

Figure 2 is a cross-sectional view, on a larger scale, of a type of reflector obtained  
10 according to the invention.

Figure 3 is a cross-sectional view, on a larger scale, of the inner reflective element as part of the embodiment of the invention.

Figure 4 is a cross-sectional view, on a larger scale, of a type of reflector obtained according to the invention and of an embodiment of practicing the invention shown in  
15 Figure 2.

Figure 5 is a cross-sectional view, on a larger scale, as part of an embodiment of the invention of the inner reflective element for practicing the invention.

Figure 6 is a schematic drawing to illustrate an embodiment of the invention for the practice of the invention as shown in Figure 2.

Figure 7 is a cross-sectional view, on a larger scale, of another type of reflector  
20 obtained according to the invention.

Figure 8 is a cross-sectional view, on a larger scale, of also another type of reflector obtained according to the invention.

**BEST MODE FOR CARRYING OUT THE INVENTION**

There is as shown in Figures 1, 2, 4, 7 and 8 a reflector 1 consisting of a cylindrical source of light 3 and four cylindrical reflective elements 5, 5' and 7, 7' whose cross sections, or profiles, are symmetrical relative to a plane P of the source 3. This reflector 1 is adapted according to the invention to illuminate a target surface 15, located at a distance comparable to at least 10 times the aperture of reflector 1.

This reflector 1 is adapted according to the invention to illuminate the target surface 15 with an illumination curve that is constant in shape as shown in Figure 1, in the transverse plane relative to reflector 1 constituting of a central plateau 9 and 9' between 2 sloping shoulders 11 and 11'. The illumination curve shows that the illumination receive at 10 the target surface 15 is constant between the points C and C', and diminishes eventually to zero at end points G and G'. As shown in Figure 1, the sloping shoulders 11 and 11' on each end of the plane P permit easy association of the illumination from two adjacent reflectors, so as to produce an overall constant illumination by summing individual reflector's 15 luminance contributions as illustrated by the dashed illumination curves 13 and 13'.

As shown in Figure 2, the reflector 1 consists of two symmetrical reflective profiles relative to a plane of source 3 constituting of symmetrical inner reflective elements 7 and 7' in the shape of a modified revolution of a circle as obtained from the cross section of the source 3 with a sizable displacement of its starting point ( $I_d$ ) above the source 3 along the 20 plane P, and symmetrical outer reflective elements 5 and 5', whose construction begins according to the invention in determining the coordinates of an end edge  $R_b$  of each of the elements 5, 5' and terminates according to the process stated hereinafter. There are as shown in Figures 2 and 8 termination points  $R_e$  and  $R'_e$  of the reflective elements 5 and 5' which are synonymous to the terminating ends  $I_e$  and  $I'_e$  of the inner reflective element 7 and 7'. 25 There are as shown in Figure 7 end edges  $R_b$  and  $R'_b$  of the reflective elements 5 and 5' which are synonymous to the terminating ends  $I_e$  and  $I'_e$  of the inner reflective element 7 and 7'. Construction of the outer element 5, of which the element 5' is symmetrical about the

plane P of the source 3, from its said end  $R_b$  can continue provided the output angle  $\theta$  does not exceed the angle  $\gamma$  as shown in Figure 6 subtended by the source 3 at the said end. As each successive point along the outer element 5 is determined, so is the contribution of the other tangential ray from the source 3 to the total luminance as depicted in Figures 2, 7 and 8 with the intermediate point  $R_T$  along the reflective element 5. Construction of the outer element for  $|\theta| > \gamma$  depends essentially on this pre-condition.

In determining the inner reflective element 7, of which the element 7' is symmetrical about the plane P of the source 3, a vertical gap  $g$  is introduced as shown in Figure 3, from the source 3 to the starting point  $I_d$  of the said elements located along the plane P. Varying the distance  $g$  yields different shapes of revolution of a circle. It is essential according to the invention that the said distance  $g$  is at least one source radius  $t$  so that the ray B cannot point away from the aperture plane  $I_e$  and  $I'_e$  of the inner elements 7 and 7' to ensure that the same ray B exits the reflector 1 unobstructed. Also according to the invention, and also by practice of the invention, it is essential that the ray C as denoted in Figures 3, 4, 7 and 8 exits the reflector 1 directly dictating a minimum gap  $g$  of two source radii in some instance. By practice of the invention, it is obvious that between the angles  $-\theta_d$  and  $\theta_d$  (up to ray A as shown in Figure 3), the starting point  $I_d$  is not visible at  $\theta = 0$ , rather, two images of the source 3 can be seen in both symmetrical elements 7 and 7'. As one moves from the left to right relative to the plane P of the source 3, the perceived images in the elements 7 and 7' move in the opposite direction. Point  $I_d$  becomes visible beyond the angle  $\theta_d$  denoted by the ray A and at the angle denoted by the ray marked B, the image of the source 3 in the element 7 disappears at  $I_d$ . The image of the source 3 in element 7' disappears totally at the angle denoted by the ray marked C.

By practice of the invention, the termination end  $R_e$  of the element 5, of which the element 5' is symmetrical about the plane P of the source 3, of the type shown in Figure 2 is contiguous and continuous, meaning they meet with the same slope, with the terminating end  $I_e$  of the inner element 7. In contrast, but as obtained from the practice of the invention,

the types shown in Figures 7 and 8 illustrate distinct profiles between the outer elements 5 and the inner elements 7, that is, where the inner element 7 ends, the outer element 5 commences with the associated abrupt change in slope.

The illumination curve at the target surface 15 is defined between the angles  $\theta_c$  and  $\theta_{c'}$  corresponding to the end points C and C' as shown in Figure 1. The contribution of the total luminance  $L(\theta)$  to a point on the target surface 15 corresponding to a given angle  $\theta$ , as illustrated in Figure 2, is equal to the sum of the incident luminance  $L_1$  from the image of the source 3 in the element 7', luminance  $L_2$  from the source 3 and the image of the source 3 in the element 7 and from the contribution of luminance  $L_3$  from the image in the outer element 5, i.e.,  $L(\theta) = L_1 + L_2 + L_3$ .

As shown in Figures 5 and 6, this luminance  $L(\theta)$  is given by, for  $|\theta| \leq \gamma$ :

$$L(\theta) = \{ 3t + 2t \sin(\beta_L + \theta) + 2t \sin(\beta_R - \theta) - (t + g) \sin(\theta) \} \\ + \{ (r_b + t \tan(\alpha_b)) \sin 2(\alpha_b) - (r + t \tan(\alpha)) \sin 2(\alpha) \}$$

As to the illumination  $E(\theta)$  received at a point on the target surface 15 comprised between the points C and C' at an angle  $\theta$  with the plane P of the source 3, this is given by:

$$E(\theta) = L(\theta) \cos^2(\theta)$$

therefore  $E(\theta)$  can be equated to:

$$E(\theta) = \{ 3t + 2t \sin(\beta_L + \theta) + 2t \sin(\beta_R - \theta) - (t + g) \sin(\theta) \} \cos^2(\theta) \\ + \{ (r_b + t \tan(\alpha_b)) \sin 2(\alpha_b) - (r + t \tan(\alpha)) \sin 2(\alpha) \} \cos^2(\theta).$$

Given that  $p(\theta) = (r + t \tan(\alpha)) \sin 2(\alpha)$  and  $\phi = 2\alpha + \theta$ , one can derive the following differential equation:

$$\frac{d\alpha}{d\theta} \left( 1 + \frac{2t \cos^2 \alpha}{p(\theta)} \right) = \sin(\alpha) \cos(\alpha) \frac{d(\ln\{p(\theta)\})}{d\theta} - \sin^2 \alpha + \frac{2t}{p(\theta)} \left( \frac{d\alpha}{d\theta} + \sin^2 \alpha \right).$$

Such a first order differential equation can be solved by giving a limit condition according to which a beam from a point of tangency originating from the left of the source 3 as seen from the element 5 to the end  $R_b$  as mentioned above, is reflected parallel to the plane P of the source 3 such that at this point  $\theta = 0$ . In one embodiment of the invention, the luminance  $L(\theta)$  must be attributed accurately should for example local conditions like  $|\theta| > \gamma$  occur. The latter condition(s) become(s) apparent with the practice of the invention.

Similar equations can be obtained for example for the type shown in Figure 7 for  $|\theta| \leq \gamma$ , one obtains

$$E(\theta) = L(\theta) \cos^2(\theta) = (3t + 2t \sin(\beta_L + \theta) + 2t \sin(\beta_R - \theta) - (t + g) \sin(\theta)) \cos^2(\theta) + \left\{ \left( r + \frac{t}{\tan(\alpha)} \right) \sin 2(\alpha) - \left( r_b + \frac{t}{\tan(\alpha_b)} \right) \sin 2(\alpha_b) \right\} \cos^2(\theta)$$

where in this case,  $p(\theta) = \left( r + \frac{t}{\tan(\alpha)} \right) \sin 2(\alpha)$  and  $\phi = 2\alpha + \theta$ , one then derives the differential equation:

$$\frac{d\alpha}{d\theta} \left( 1 - \frac{2t \cos^2 \alpha}{p(\theta)} \right) = \sin(\alpha) \cos(\alpha) \frac{d(\ln\{p(\theta)\})}{d\theta} - \sin^2 \alpha$$

Such a first order differential equation can be solved by giving a limit condition according to which a beam from a point of tangency originating from the right of the source 3 as seen from the element 5 to the end  $R_b$  as mentioned above, is reflected parallel to the plane P of the source 3 such that at this point  $\theta = 0$ . In one embodiment of the invention, the luminance  $L(\theta)$  must be attributed accurately should for example local conditions like  $|\theta| > \gamma$  occur. The latter condition(s) become(s) apparent with the practice of the invention.

The present invention permits obtaining illumination curves of substantially any appearance by inputting the desired illuminance function denoted by  $E(\theta)$  above. For example, for a constant illumination curve as that shown in Figure 1,  $E(\theta)$  is given by  $L(0)$ , whereas one can also input a function  $E(\theta) = L(0) * (1 + \tan(\theta))$  to obtain another desired illumination curve.

**INDUSTRIAL APPLICABILITY**

The present invention is primarily applicable in the lighting industry where most commercial, industrial and residential illumination systems are reflector-based wherein the primary source of light is a linear fluorescent lamp. In this instance, the invention is particularly superior in the control of light distribution (in the form of the desired illumination curve on the target surface) within a space or target area while ensuring zero or minimum (considering material losses) light loss within the reflectors. The present invention is also highly applicable in industries; for example, in semi-conductor manufacturing processes where energy from an linear infrared (IR) cylindrical source must be distributed uniformly over the wafers. The examples cited serve to explain the invention and should not be taken to limit the applicability of the invention.

**CLAIMS**

- (1). A process for the production of the profile of reflectors for a cylindrical source of light (3) symmetrical relative to a vertical plane (P), of four cylindrical reflective elements (5, 5') and (7, 7'), two on each side of the said plane (P) consisting the inner reflective elements (7, 7') and the outer reflective elements (5, 5'), both of which combine to yield a continuous reflector profile (5, 7) on one side of the said plane (P), with the other (5', 7') being symmetrical about the said plane (P). Each point (R) of the profile of the said outer element (5) is defined by the length (r) of the segment representing the distance from a point of tangency on the left of the said source (3), as seen from the said element (5) on the right of the said plane (P), to the said point (R), and by the angle ( $\phi$ ) formed by the said segment with the said plane (P), the resultant ray of light from the said source (3) forming, at the output, respective angles ( $\theta$ ) with the said plane (P), characterized in that it comprises the steps consisting of:
- defining the inner reflective element (7) on one side of the said plane (P), the other element (7') being symmetrical about the said plane (P), which is a modified revolution of a circle as obtained from the cross-section of the said source (3); defined by its starting point ( $I_d$ ) on the axis of the said plane (P), located at a vertical distance (g) of at least one source radius (t) measured from the said light source (3) to the said starting point ( $I_d$ ) and defined also, by its terminating end ( $I_e$ ) of the said inner element (7) by the angle ( $\mu$ ) formed by said plane (P) and the output of the ray of light that originates from a point of tangency on the right of the said source (P) as seen by the left inner element (7') relative to the said plane, and also by the angle ( $\theta_d$ ) formed by the said plane (P) and the segment from the said starting point ( $I_d$ ) to a point of tangency on the said source,
  - defining the position of one end ( $R_b$ ) of the said outer element (5), from a desired distance ( $r_b$ ) separating said point of tangency on the left of the said source (3) as



seen from the right outer element (5) relative to the said plane (P) and, from which may either be equal to the terminating end ( $I_e$ ) of the said inner element (7) or be situated on the downstream of the said outer element (5) away from the terminating end ( $I_e$ ) of the said inner element (7), and also from an angle ( $\gamma$ ) beyond which the continuation of the profile of the said outer element (5) has to account for the diminishing contribution of the luminance from the said end ( $R_b$ ), and which depends on the said segment ( $r_b$ ).

- defining an illumination function  $E(\theta)$  corresponding to a desired target illumination curve, for  $|\theta| \leq \gamma$ , associated with a luminance  $L(\theta)$  by the formula:

$$E(\theta) = L(\theta) \cos^2(\theta) = \{ 2t \sin(\beta_L + \theta) - (t + g) \sin(\theta) + t \} \cos^2(\theta) + \{ (r + t \tan(\alpha)) \sin 2(\alpha) \} \cos^2(\theta)$$

if the said end ( $R_b$ ) of the profile for the said outer element (5) is the terminating end ( $I_e$ ) of the said inner element (7), and an illumination function, for  $|\theta| \leq \gamma$ :

$$E(\theta) = L(\theta) \cos^2(\theta) = \{ 3t + 2t \sin(\beta_L + \theta) + 2t \sin(\beta_R - \theta) - (t + g) \sin(\theta) \} \cos^2(\theta) + \{ (r_b + t \tan(\alpha_b)) \sin 2(\alpha_b) - (r + t \tan(\alpha)) \sin 2(\alpha) \} \cos^2(\theta)$$

if the said end ( $R_b$ ) of the profile of the said outer element (5) is at the downstream of the said element (5) away from the said inner element (7);

- determining, from said end ( $R_b$ ), the coordinates of each point (R) of said profile of the said outer element (5) satisfying the differential equation:

$$\frac{d\alpha}{d\theta} \left( 1 + \frac{2t \cos^2 \alpha}{p(\theta)} \right) = \sin(\alpha) \cos(\alpha) \frac{d(\ln\{p(\theta)\})}{d\theta} - \sin^2 \alpha + \frac{2t}{p(\theta)} \left( \frac{d\alpha}{d\theta} + \sin^2 \alpha \right)$$

where  $p(\theta)$  is equal to  $(r + t \tan(\alpha)) \sin 2(\alpha)$  and the value of the angle  $\alpha$  is equal to  $(\phi - \theta)/2$ .



- (2). A process for the production of the profile of reflectors for a cylindrical source of light (3) symmetrical relative to a vertical plane (P), of four cylindrical reflective elements (5, 5') and (7, 7'), two on each side of the said plane (P) consisting the inner reflective elements (7, 7') and the outer reflective elements (5, 5'), both of which combine to yield a contiguous reflector profile (5, 7) on one side of the said plane (P), the other profile (5', 7') being symmetrical about the said plane (P). Each point (R) of the profile of the said outer element (5) is defined by the length (r) of the segment representing the distance from a point of tangency on the right of the said source (3), as seen from the said element (5) on the right of the said plane (P), to the said point (R), and by the angle ( $\phi$ ) formed by the said segment with the said plane (P), the resultant ray of light from the said source (3) forming, at the output, respective angles ( $\theta$ ) with the said plane (P), characterized in that it comprises the steps consisting of:
- defining the inner reflective element (7) on one side of the said plane (P), the other element (7') being symmetrical about the said plane (P), which is a modified revolution of a circle as obtained from the cross-section of the said source (3); defined by its starting point ( $I_d$ ) on the axis of the said plane (P), located at a vertical distance (g) of at least one source radius (t) measured from the said light source (3) to the said starting point ( $I_d$ ) and defined also, by its terminating end ( $I_e$ ) of the said inner element (7) by the angle ( $\mu$ ) formed by said plane (P) and the output of the ray of light that originates from a point of tangency from the right of the said source (3) as seen by the left said inner element (7') relative to the said plane (P), and also by the angle ( $\theta_d$ ) formed by the said plane (P) and the segment from the said starting point ( $I_d$ ) to a point of tangency on the said source (3),
  - defining the position of one end ( $R_b$ ) of the said outer element, from a desired distance ( $r_b$ ) separating said point of tangency on the right of the said source (3) as seen from the right of the said outer element (5) relative to the said plane (P) and,



from which may either be equal to the terminating end ( $I_e$ ) of the said inner elements (7) or be situated on the downstream of the said outer element (5) away from the terminating end ( $I_e$ ) of the said inner element (7), and also from an angle ( $\gamma$ ) beyond which the continuation of the profile of the said outer element (5) has to account for the diminishing contribution of the luminance from the said end ( $R_b$ ), and which depends on the said segment ( $r_b$ ).

- defining an illumination function  $E(\theta)$  corresponding to a desired target illumination curve, for  $|\theta| \leq \gamma$ , associated with a luminance  $L(\theta)$  by the formula:

$$E(\theta) = L(\theta) \cos^2(\theta) = \{ 3t + 2t \sin(\beta_L + \theta) + 2t \sin(\beta_R - \theta) - (t + g) \sin(\theta) \} \cos^2(\theta) + \left\{ \left( r + \frac{t}{\tan(\alpha)} \right) \sin 2(\alpha) - \left( r_b + \frac{t}{\tan(\alpha_b)} \right) \sin 2(\alpha_b) \right\} \cos^2(\theta)$$

if the said end ( $R_b$ ) of the profile for the said outer element (5) is the terminating end ( $I_e$ ) of the said inner element (7), and an illumination function, for  $|\theta| \leq \gamma$ :

$$E(\theta) = L(\theta) \cos^2(\theta) = \{ 3t + 2t \sin(\beta_L + \theta) + 2t \sin(\beta_R - \theta) - (t + g) \sin(\theta) \} \cos^2(\theta) + \left\{ \left( r_b + \frac{t}{\tan(\alpha_b)} \right) \sin 2(\alpha_b) - \left( r + \frac{t}{\tan(\alpha)} \right) \sin 2(\alpha) \right\} \cos^2(\theta)$$

if the said end ( $R_b$ ) of the profile of the said outer element (5) is at the downstream of the said element (5) away from the said inner element (7);

- determining, from said end ( $R_b$ ), the coordinates of each point ( $R$ ) of said profile of the said outer element (5) satisfying the differential equation:

$$\frac{d\alpha}{d\theta} \left( 1 - \frac{2t \cos^2 \alpha}{p(\theta)} \right) = \sin(\alpha) \cos(\alpha) \frac{d(\ln\{p(\theta)\})}{d\theta} - \sin^2 \alpha$$

where  $p(\theta)$  is equal to  $\left( r + \frac{t}{\tan(\alpha)} \right) \sin 2(\alpha)$  and the value of the angle  $\alpha$  is equal to  $(\phi - \theta)/2$ .