

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
5 October 2006 (05.10.2006)

PCT

(10) International Publication Number
WO 2006/103600 A1

(51) International Patent Classification:
H05B 41/38 (2006.01) **H05B 37/02** (2006.01)

(21) International Application Number:
PCT/IB2006/050886

(22) International Filing Date: 22 March 2006 (22.03.2006)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
05102540.1 31 March 2005 (31.03.2005) EP

(71) Applicant (for all designated States except US): **KONINKLIJKE PHILIPS ELECTRONICS N.V.** [NL/NL]; Groenewoudseweg 1, NL-5621 BA Eindhoven (NL).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **BAAIJENS, Hans** [NL/NL]; C/o Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL). **POTZE, Willem** [NL/NL]; C/o Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL). **PAYNE, David, C.** [GB/GB]; C/o Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL). **THURSFIELD, Paul, P.** [GB/NL]; C/o Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).

(74) Agents: **BOSMA, Rudolphus, H., A.** et al.; Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

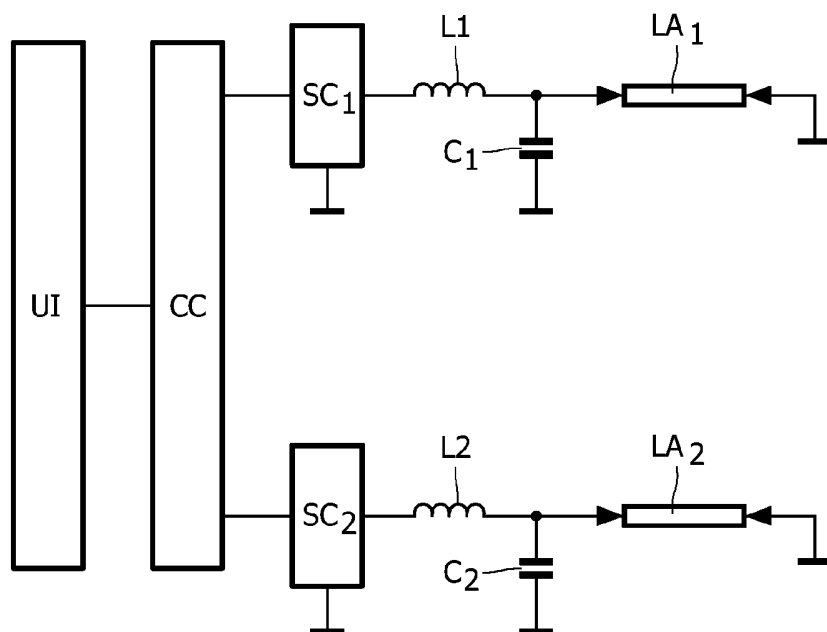
(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declaration under Rule 4.17:

— as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))

[Continued on next page]

(54) Title: LIGHTING UNIT



(57) Abstract: In a lighting unit for operating lamps (LA1, LA2) of a different color temperature, a number of predetermined color points can be adjusted. The color points are chosen so that the color difference calculated in the CIELAB space is the same for subsequent adjustable color points.

WO 2006/103600 A1



Published:

- with international search report
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Lighting unit

The invention relates to a lighting unit equipped with two light sources of a different color temperature and an operating circuit comprising

- a supply circuit for supplying currents to the two light sources,
- a control circuit for controlling the currents supplied by the supply circuit, and
- 5 - a user interface coupled to the control circuit for adjusting the color of the generated light at a number of predetermined color settings by means of adjusting the light outputs of the light sources.

10 Such a lighting unit is generally known. The light sources can for instance be fluorescent lamps of a different color temperature. The supply circuit may comprise one or more (dimmable) lamp ballasts, such as ballasts that supply a high frequency current to the lamps. Via the control circuit the currents supplied to the light sources are adjusted at a desired level. The current supplied to a light source determines the light output of the light
15 source. Different color settings are realized via the user interface by adjusting the ratio of the light outputs of the two light sources. In this way the color of the light generated by the lighting unit can be varied over a range. Preferably, the light outputs of the light sources are chosen so that the total light output of the lighting unit is maintained at the same level, when the color setting is changed.

20 The light output of each of the light sources can for instance be controlled by means of an adjustable digital number present in a memory comprised in the control circuit. The relation between the light output and the digital number can for instance be exponential (in case of the DALI standard) or linear (in case of the DMX standard). Subsequent predetermined color settings can in that case be realized by decreasing the digital number
25 controlling the light output of one of the light sources by a constant amount and increasing the digital number controlling the light output of the other light source by the same amount.

A problem associated with this approach is that subsequent predetermined color settings correspond in part with color points that are perceived by the human eye as almost identical, and in part with color points that are perceived by a user as very different.

To a user this is confusing and for this reason, a user cannot easily adjust the color of the light at a desired color.

5 The invention aims to provide a lighting unit that enables an untrained user to adjust the color of the light to a desired color in an easy way.

 A lighting unit as mentioned in the opening paragraph is for that purpose characterized in that the color difference calculated in the CIELAB color space between a first color point corresponding to a first color setting and the nearest color point
10 corresponding to a second color setting is the same for any first color point having the same value of the light output.

 When a user of a lighting unit according to the invention adjusts the color of the light by activating subsequent predetermined color settings (and leaving the total light output unchanged), the perceived change in color is equal over the entire range wherein the
15 color can be adjusted. As a consequence even an untrained user can easily find the predetermined color setting corresponding to the desired color.

 Preferably the user interface of a lighting unit according to the invention is further equipped with means for via the control circuit adjusting the total light output of the lighting unit at a number of predetermined levels. These levels can be chosen such that the
20 color difference calculated in the CIELAB space between color points corresponding to the same color setting and to successive levels of total light output is the same for each level of the light output.

 The user interface can be equipped with a first push button for adjusting the color of the generated light at the predetermined color setting having the next higher value of
25 the color temperature at every push and with a second push button for adjusting the color of the generated light at the predetermined color setting having the next lower value of the color temperature at every push. The user interface can be further equipped with a third push button for adjusting the total light output of the lighting unit at the next higher level at every push and with a fourth push button for adjusting the total light output of the lighting unit at
30 the next lower level at every push.

 Alternatively, the user interface can be equipped with a diamond shaped surface comprising a number of adjustment points where a user action is possible and wherein adjacent adjustment points in a first direction correspond to the same level of the light output and to different color settings and adjacent adjustment points in a second

direction correspond to the same color setting and different levels of light output. A user action at an adjustment point activates the corresponding color setting or level of the light output. The adjustment points can be formed by push buttons. The diamond shaped surface can alternatively be formed by a touch pad. The user performs a user action by touching the touch pad in somewhere at its surface. To provide further help to a user, the diamond shaped surface can be equipped with a mapping of the adjustable colors.

The light sources in a lighting unit according to the invention are preferably formed by fluorescent lamps.

Embodiments of the invention will be further explained making reference to a drawing. In the drawing,

Fig. 1 shows an embodiment of a lighting unit according to the present invention;

Fig. 2 shows an embodiment of a user interface for use in a lighting unit as shown in Fig. 1, and

Fig. 3 shows a further embodiment of a user interface for use in a lighting unit as shown in Fig. 1.

In Fig. 1, LA1 and LA2 are fluorescent lamps of a different color temperature forming two light sources. Circuit part SC1 together with inductor L1 and capacitor C1 form an electronic lamp driver for supplying a high frequency current to fluorescent lamp LA1. Circuit part SC2 together with inductor L2 and capacitor C2 form an electronic lamp driver for supplying a high frequency current to fluorescent lamp LA2. The two electronic lamp drivers together form a supply circuit for supplying currents to the two lamps. Respective output terminals of circuit part CC are connected to an input terminal of circuit part SC1 and circuit part SC2 respectively. Circuit part CC forms a control circuit for controlling the currents supplied by the supply circuit. An input terminal of control circuit CC is connected to an output terminal of circuit part UI. Circuit part UI forms a user interface for adjusting the color of the generated light by means of adjusting the light outputs of the light sources. Circuit part UI is equipped with means for adjusting the color of the generated light at a number of predetermined color settings.

The operation of the lighting unit shown in Fig. 1 is as follows.

During stationary operation, the supply circuit SC1, SC2 supplies a lamp current to each of the fluorescent lamps LA1 and LA2. In the embodiment shown in Fig.1, the light output of each of the fluorescent lamps can for instance be adjusted by adjusting the frequency of the current supplied to the lamp. In that case, each predetermined color setting is associated with two frequencies. These frequencies can for instance be stored in a memory. Circuit part UI can for instance be equipped with a microcontroller. When a user has selected one of the predetermined color settings, the microcontroller reads the corresponding frequencies from the memory and adjusts via circuit part CC the frequencies of the lamp currents at their proper value.

Every predetermined color setting corresponds to a color point in the CIELAB space. The CIELAB color space is described in detail in literature, e.g. "Principles of color technology" by R. Berns (2000). The CIELAB space is 3-dimensional and a color point is thus characterized by two parameters (such as hue and saturation) representing the color and a third parameter (such as brightness) representing the light level. These three parameters are the coordinates of the color point. To calculate these coordinates a reference color needs to be defined. This can for instance be the white color point at maximum light output. The color difference between two color points can be calculated as the Euclidean norm of the difference vector between the two color points in this space. The color settings are chosen such that the color differences between any color point and the color point(s) nearest to it in the CIELAB space is the same as long as these color points have the same level of light output. The important advantage of this is that a user can change the color of the light in a number of steps that are perceived as equidistant. In other words the change in color perceived by the user is identical for each step. This enables even an inexperienced user to easily find a desired color of the light.

It is noteworthy that apart from operating frequency, one or more other operational parameters can be used to adjust the light outputs of the lamps. It is for instance possible to modulate the amplitude of the lamp current with a square wave shape so that the amplitude of the current is zero during part of each modulation period and has a constant value differing from zero during the remaining part of each modulation period. The average light output of the lamp can be adjusted by adjusting the duty cycle of the modulation. Similarly, instead of fluorescent lamps, different light sources such as LEDs or HID lamps can be used.

Circuit part UI is further equipped with means for via the control circuit CC adjusting of the light output of the lighting unit at a number of predetermined levels. It is

remarked that the level of the light output can be adjusted by means of adjusting the same operational parameters as mentioned here-above for color adjustment, e.g. current frequencies, duty cycle of the modulations of the lamp currents. The predetermined levels of light output are chosen such that the color difference calculated in the CIELAB space
5 between color points corresponding to the same color setting and to successive levels of light output is the same for each level of the light output. As a consequence, a user adjusting the light output subsequently at successive levels, perceives a change in light output that is the same for each level of the light output. It has been found that also this makes it easier for an inexperienced user to adjust the desired color point.

10 It is remarked that the color difference calculated in the CIELAB space and thus the color change perceived by a user between two color settings can differ for different levels of the light output.

In Fig. 2, B1 to B9 are push buttons arranged in a diamond shape. Each push button is associated with a color point of the light generated by the lighting unit. Push buttons
15 that are on the same horizontal line (such as B1, B5 and B9; B3 and B8; B2 and B7) correspond to color points with same level of light output and thus provide means for changing the color of the light while the level of the light output remains the same. Similarly, push buttons that are on the same vertical line (such as B4, B5 and B6; B2 and B3; B7 and B8) correspond to color points with the same color setting but a different level of the light
20 output. They thus provide means for changing the level of the light output without changing the color of the light. The color points corresponding to the push buttons can for instance be chosen so that when adjacent push buttons are subsequently pushed moving from left to right, the color of the light changes from cool to warm, while the light level is increased when adjacent push buttons are subsequently pushed along the vertical direction. The push buttons
25 are mapped with colors representing the color points that can be adjusted. This mapping is indicated in Fig. 2 by means of different shades of gray.

Figure 3, shows a touch pad that has a diamond shape. A user can adjust a certain color point by touching the touch pad in a certain place. Also in this case the relation between the color points corresponding to the different positions on the touch pad can be
30 chosen so that touch points on a horizontal line correspond to color points with a different color setting but the same light output level, while touch points on a vertical line correspond to color points having the same color but a different light level. Also on this touch pad there is a mapping of colors representing the adjustable color points. This mapping is indicated in Fig. 3 by means of different shades of gray.

It be mentioned that other user interfaces can be used comprising a touch screen, a computer screen together with a mouse for selecting a color setting. The user interface can be coupled to the control circuit by means of wiring, but the coupling can also be by means of wireless communication by means of infrared radiation or RF. In the latter
5 case a mobile phone can be used as the user interface. The touch screen, computer screen or a screen that is comprised in the mobile phone may be equipped with a color mapping and/or a diamond shaped surface.

CLAIMS:

1. A lighting unit equipped with two light sources of a different color temperature and an operating circuit comprising

- a supply circuit for supplying currents to the two light sources,
- a control circuit for controlling the currents supplied by the supply circuit, and
- 5 - a user interface coupled to the control circuit for adjusting the color of the generated light at a number of predetermined color settings by means of adjusting the light outputs of the light sources,

characterized in that the color difference calculated in the CIELAB color space between a first color point corresponding to a first color setting and the nearest color point
10 corresponding to a second color setting is the same for any first color point having the same value of the total light output.

2. A lighting unit as claimed in claim 1, wherein the user interface is further equipped with means for via the control circuit adjusting the total light output of the lighting
15 unit at a number of predetermined levels.

3. A lighting unit as claimed in claim 2, wherein the color difference calculated in the CIELAB space between color points corresponding to the same color setting and to successive levels of total light output is the same for each level of the total light output.

20

4. A lighting unit as claimed in claim 1, 2 or 3, wherein the user interface is equipped with a first push button for adjusting the color of the generated light at the predetermined color setting having the next higher value of the color temperature at every push and with a second push button for adjusting the color of the generated light at the
25 predetermined color setting having the next lower value of the color temperature at every push.

5. A lighting unit as claimed in claim 4, wherein the user interface is equipped with a third push button for adjusting the total light output of the generated light at the next

higher level at every push and with a fourth push button for adjusting the total light output of the generated light at the next lower level at every push.

6. A lighting unit as claimed in claim 1, 2 or 3, wherein the user interface is
5 equipped with a diamond shaped surface comprising a number of adjustment points where a user action is possible and wherein adjacent adjustment points in a first direction correspond to the same level of the total light output and to different color settings and adjacent adjustment points in a second direction correspond to the same color setting and different levels of total light output.

10

7. A lighting unit as claimed in claim 6, wherein the adjustment points are formed by push buttons.

8. A lighting unit as claimed in claim 6, wherein the diamond shaped surface is
15 formed by a touch pad.

9. A lighting unit as claimed in claim 6, wherein the diamond shaped surface is equipped with a mapping of the adjustable colors.

20 10. An operating circuit for use in a lighting unit according to one or more of the previous claims.

1/2

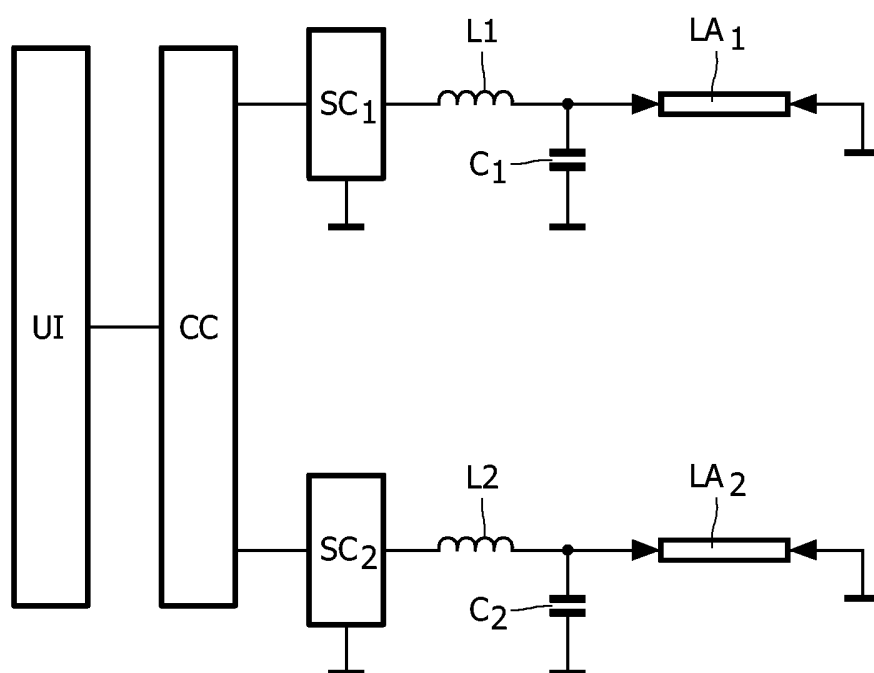


FIG. 1

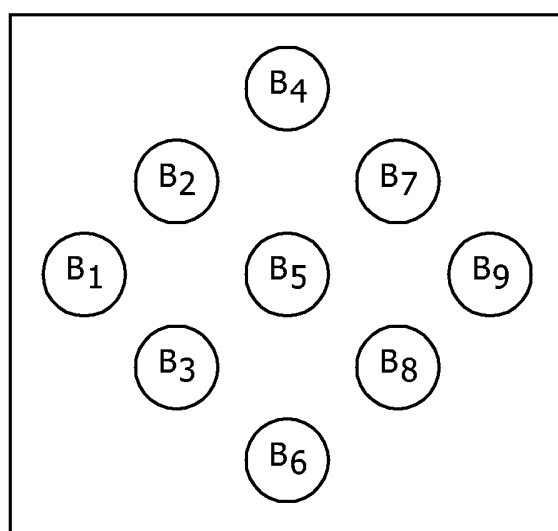


FIG. 2

2/2

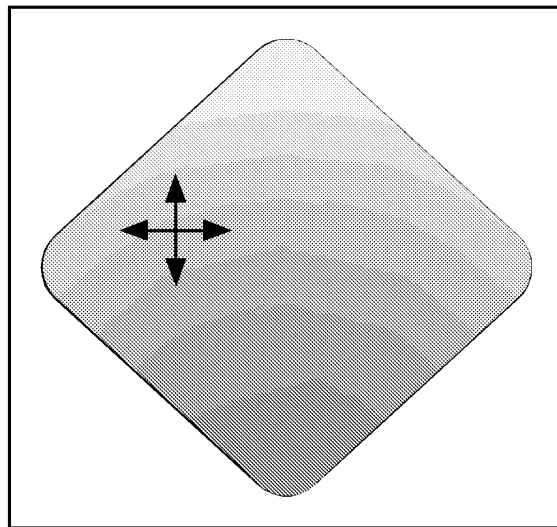


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2006/050886

A. CLASSIFICATION OF SUBJECT MATTER INV. H05B41/38 H05B37/02		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) H05B		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used) EPO-Internal		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 00/44205 A (NOH, SHI, YOUL) 27 July 2000 (2000-07-27) page 4, line 15 - page 5, line 4 page 2, line 19 - page 3, line 8 page 3, line 6 - line 8 page 5, line 16 - line 21 page 6, line 6 - line 22; figure 3 page 6, line 1 - line 5 page 7, line 1 - line 4	1-10
Y	US 2002/047647 A1 (NOH SHI-YOUL) 25 April 2002 (2002-04-25) paragraphs [0011], [0022]	1-10
A	EP 0 574 993 A (MATSUSHITA ELECTRIC WORKS, LTD) 22 December 1993 (1993-12-22) the whole document	1
☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents : *A* document defining the general state of the art which is not considered to be of particular relevance *E* earlier document but published on or after the international filing date *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) *O* document referring to an oral disclosure, use, exhibition or other means *P* document published prior to the international filing date but later than the priority date claimed *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. *Z* document member of the same patent family		
Date of the actual completion of the international search 16 August 2006		Date of mailing of the international search report 01/09/2006
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016		Authorized officer Heiner, C

INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2006/050886

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
WO 0044205	A	27-07-2000	AU 1080200 A	07-08-2000
			CN 1293886 A	02-05-2001
			DE 69920004 D1	14-10-2004
			DE 69920004 T2	15-09-2005
			EP 1078556 A1	28-02-2001
			KR 164907 Y1	15-02-2000
US 2002047647	A1	25-04-2002	NONE	
EP 0574993	A	22-12-1993	CA 2098247 A1	16-12-1993
			CN 1083572 A	09-03-1994
			DE 69305002 D1	31-10-1996
			DE 69305002 T2	03-04-1997
			JP 2578455 Y2	13-08-1998
			JP 6002597 U	14-01-1994
			KR 9711554 B1	11-07-1997
			US 5350977 A	27-09-1994