

(51) International Patent Classification:  
*F21S 8/06* (2006.01) *F21V 7/00* (2006.01)(21) International Application Number:  
PCT/EP2010/058150(22) International Filing Date:  
10 June 2010 (10.06.2010)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
09162466.8 10 June 2009 (10.06.2009) EP  
09164470.8 2 July 2009 (02.07.2009) EP  
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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

(54) Title: LIGHTING UNIT, LIGHTING NETWORK AND METHOD FOR LIGHTING AN INTERIOR

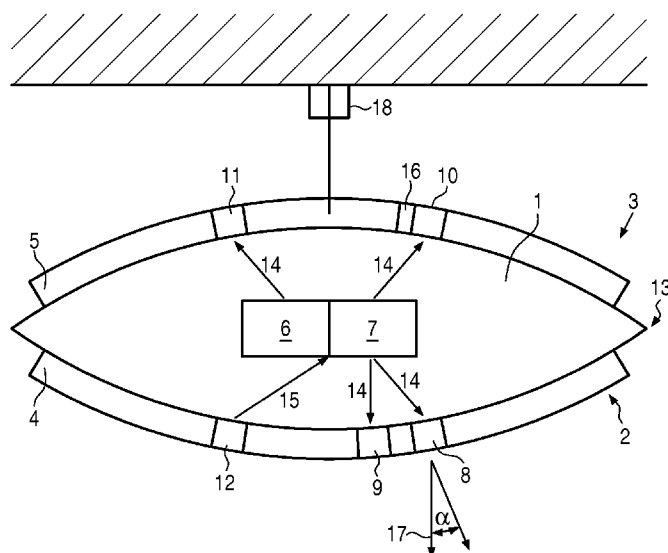


FIG. 1

(57) Abstract: The invention relates to a lighting unit (1) for illuminating an interior comprising a housing (13) with a bottom side (2) and a top side (3), a direct illumination lighting element (4) arranged at the bottom side with at least one warm light LED unit (8) providing white light with a first colour temperature and at least one cold light LED unit (9) providing white light with a second colour temperature, an indirect illumination lighting element (5) arranged at the top side comprising at least a first LED (10) and a second LED (16) having different colours and at least one amber coloured LED (11), a connection element for connecting the lighting unit to a control unit.

**Lighting unit, lighting network and method for lighting an interior**

The invention relates to a lighting unit for illuminating an interior, a network thereof and a method for lighting an interior using at least one lighting unit.

5 An effective bi-functional lighting unit provides light for working and other conditions in addition to light for situation dependent illumination of interiors. These lighting units creating the required light for a certain task on the one hand and a comfortable atmosphere on the other hand are currently discussed. In relation to effectiveness the use of LEDs (light emitting diodes) provides the possibility of a reduction of the power consumption.

0 It is therefore an object of the invention to provide a possibility for illuminating an interior effectively and situation dependent without a high power consumption.

This object is achieved by what is disclosed in the independent claims. In particular, according to the invention the power consumption and maintenance cost are reduced while increasing comfort, life time and functionalities.

Preferred embodiments are:

5 A lighting unit for illuminating an interior, which comprises a housing with a side, the predominant direction of which is towards the bottom and a top side, the predominant direction of which is towards not the bottom, i.e. the top or ceiling of an interior or the side walls of an interior. For providing a direct illumination, a direct illumination lighting element is arranged at the bottom side. Preferably, by the direct illumination element illumination is provided predominantly without any previous reflections at elements external to the lighting  
10 unit inside the interior.

The direct illumination lighting element comprises at least one warm light LED unit, from which light with a warm colour temperature, preferably in the range between 1,500 and 3,500 Kelvin is emitted. Further, the direct illumination lighting element comprises at least one cold  
15 light LED unit from which light with a temperature above 3,500 Kelvin is emitted. The LED unit may comprise one or more LED contained in one or more housings.

A direct illumination lighting element is e.g. used to provide a working light at a desk. By mixing the light from the warm light LED unit and the cold light LED unit the desired colour temperature can be achieved in addition to setting a desired intensity.

Further, at the top side an indirect illumination lighting element is provided from which light is emitted towards the ceiling or side walls in order to illuminate the interior as a whole. Preferably this is achieved by at least one reflection of the emitted light e.g. at the ceiling.

The LED light is a focused light and using only one sided light for the desk would provide a perfect working light but leaves the rest of the room in a darker situation than consumers are used to have which also causes problems with cleaning processes for buildings. With this combination of upper and lower light highest working light quality for the desk is achieved and the necessary room lightning is provided, so that additional light systems are not required.

The indirect illumination lighting element comprises at least a first LED and at least second LED, which have different colours so that particularly a white colour can be produced. Further, the indirect illumination lighting element comprises at least one amber coloured LED in order to provide a natural colour in the interior as far as possible. Preferably, the first and the at least second LED may be contained together with the amber coloured LED in one common housing. Thus due to the small distances a good mixing can be achieved. Further, less space is required for the accommodation of the various LEDs.

Further, a connection element is provided for connecting the lighting unit to a control unit. This connection element may provide a wired connection or a wireless connection between lighting unit and control unit.

Particularly, for a wired connection the control data can be transformed directly over the existing current cables. This allows using an already fixed network infrastructure, which is available anyway at the lighting units as power has to be provided. According to an advantageous embodiment the control unit is positioned outside a housing of the lighting unit and the wired connection from the lighting unit to the control unit is realised by the power cable. Such systems would allow the central management of various light systems from a central control point in the building or be integrated in other existing building control systems.

The lighting unit provides an effective illumination of a room in the sense that e.g. working light on the one hand and an overall illumination of a room on the other hand can be provided with a satisfying consumption of power, considerable production costs, a wide range of possibilities to adapt to requirements of different interiors, and a long lifetime.

- 5 According to an advantageous embodiment the lighting unit further comprises a control unit by which the light intensity of the lighting unit is controlled. The control unit may be positioned inside the lighting unit, e.g. in or at the housing or, in the case of suspended lamps, at a point where the lighting unit is fixed at the ceiling or at a position at the cable providing electrical current to the lighting unit.
- 0 Preferably, the control unit controls the light intensity of the lighting unit by providing an internal control signal to the direct or indirect illumination element from which it is transmitted to a subunit such as warm light LED unit, cold light LED unit, first LED, second LED or amber LED. Alternatively or additionally, the control signal is directly provided to each of these LEDs or LED units. This allows an accurate control of brightness or intensity or
- 5 light colour.

- The bi-functional lighting unit offers all possible settings for different light situations which can be pre-defined based on customer needs or be adjusted in real time. One pre-defined setting as "standard" condition may be provided for. This would in this case be the setting used when turning on the light switch. The standard condition can be re-defined by customers
- 0 at any time and allows the usage of the lighting network comprising the lighting units like all existing systems by simply turning on and off the power switch in the wall. The lighting network does not require any additional installation works on the wall and will simply replace any existing lights connected with power cables.

- For this control the lighting unit may be equipped with an electrical circuit, which provides in
- 5 response to the internal control signal an adequate e.g. driving current. There may be provided one common electrical circuit for all LEDs or LED units.

Alternatively, a separate electrical circuit may be provided for individual LEDs or group of LEDs.

Instead or additionally to a wireless connection the connection element may provide a transmission interface for a connection to a DALI bus system or any other digital addressable lighting interface, across which the light intensity can be controlled.

According to further embodiments the connection element is either adapted for wireless or  
5 wired transmission or both. Particularly, for a wired transmission a power line communication might be used, where control signals are transferred across the power line.

According to another advantageous embodiment the lighting unit further comprises a movement detector which provides a signal to the connection element if a movement within a predetermined range of the lighting unit, e.g. a detection cone of the movement detector, a  
0 light cone defined by the lighting unit, is detected. This allows a further reduction of the energy consumption in that the light is switched off if no movement is detected or it is switched between different dimming levels. By placing a movement detector in or at the lighting unit, the movement is measured basically at the same position where the light is emitted. Thus, the measurement has a high relevance for controlling the light intensity.  
5 Further, a threshold may be applied to the movement detector, thus that e.g. flying insects or movement of curtains do not lead to the movement detector providing an output signal or that the output signal is not transmitted further, e.g. from the connection element or control unit.

Additionally, it allows a coordinated setting of intensity of at least two lighting units, if the movement detected by at least one lighting unit is communicated to the at least other lighting  
0 unit by use of the connection element. This information may be communicated either directly between the lighting units or via a central master control unit. The central master control unit may be a separate unit or part of a lighting unit, e.g. contained in its control unit.

A further advantageous embodiment is a lighting network comprising at least two lighting units which are controlled by a master control unit which sends an external control signal to at  
5 least one of the control units. Such a lighting network can be used to create a predetermined illumination for an interior by setting brightness and/or the temperature to a desired value.

The external control signal is preferably transmitted directly from the master control unit to the at least two lighting units. This allows a fast control.

Alternatively, the externally control signal is transmitted from the master control unit to a neighboured lighting unit and there from to the next neighboured lighting unit. This allows in the case of wireless transmission a further reduction of sending power. In the case of wired transmission, a simple protocol can be used without excessive overhead data defining the modus of the transmission, i.e. the data to be transferred are essentially the load data used for the control. The wired transmission of the external control signal can be particularly via the power line.

Thus in general, the external control signal may be transmitted either wireless or wire-bound. For special applications a parallel transmission via a wireless connection and via a wired connection is desirable. A wire-bound transmission of the control signal can be realised particularly across the power lines, thus using already existing transmission structures.

According to another embodiment an external control signal may be provided to the control unit of a lighting unit which then provides an internal control signal to at least one of direct or/and indirect illumination lighting element or individual or groups of LEDs, such as first LED, at least second LED and amber LED. Thus the light intensity and light temperature for the direct illumination lighting element can be set on basis of the internal control signal.

The internal control signal may be transmitted either wirelessly or wire-bound.

Further, the colour of the indirect illumination lighting element can be adjusted by adjusting the intensity of the first LED, second LED and/or amber LED separately. Thereby, also the brightness of light emitted by the indirect illumination may be adjusted together with the colour.

According to another embodiment an overall control signal may be provided to a master control unit, which contains information on the overall illumination of an interior, e.g. a lighting scenario such as conference or desktop work. In the master control unit then an external control signal is created by using this overall control signal and the external control signal is provided to at least one of the lighting units.

According to another embodiment the internal control signal or the external control signal is created using in addition or only the movement detector signal, such that an interior is illuminated only when actually a person is inside the interior.

Advantageous embodiments are described in the dependent claims.

Further aspects and advantages of the invention are disclosed in relation with the accompanying drawings of which show:

Figure 1: an individual lighting unit;

5 Figure 2: a lighting network comprising several lighting units;

Figure 3: a processing of a movement detector signal;

Figure 4: an embodiment of a lighting unit as a suspended lamp;

Figure 5: a cross section of the lighting unit of Figure 4;

Figure 6: a top view on an embodiment of a bottom side PCB; and

0 Figure 7: a top view on a top side PCB 50.

In Figure 1 a lighting unit 1 is depicted which is formed as a suspended lamp fixed on a ceiling. A housing 13 of the lighting unit 1 has a bottom side 2 directing towards the floor of an interior and a top side 3 directing towards the ceiling of an interior.

Alternatively the lighting unit 1 may be formed as a lamp standing on a surface. In particular  
5 the suspended lamp of Figure 4 may be equipped with a foot element on one end, which can be placed on a surface. Thus one side corresponding to a top side 3 of the lamp may be directed towards a wall of the interior, the other side corresponding to the bottom side may be directed towards the interior.

Due to the setup of the lighting unit 1 or/and the form of the housing 13 the bottom side and  
10 the top side are defined such that the predominant direction is top or bottom, but parts of the side may be directed under an angle  $\alpha$  in relation to the vertical line 17, thus that also light is not only emitted in vertical direction, even if a spreading of light cones is neglected.

According to another embodiment, not shown, the bottom side is defined by the direction, where a direct illumination is to be achieved and the top side by the direction where no direct  
25 illumination is to be achieved. This may e.g. required for concert halls, where the orchestra is positioned at some elevated position.

On the bottom side 2 a direct illumination lighting element 4 is positioned. This direct illumination lighting element 4 may be positioned at one or various distinct areas or may be distributed over the whole bottom side. The design of the direct illumination lighting element 4 depends on the desired purpose, e.g. whether a desk is to be illuminated for computer work or e.g. a larger conference room is to be illuminated for a meeting.

Further, an indirect illumination lighting element 5 is positioned on the top side 3 of the lighting unit 1. The indirect illumination lighting element 5 may be positioned at one or various distinct positions or be distributed over the whole top side. The design of the indirect illumination lighting element depends on the desired illumination, e.g. brightness, the size and also the form of the interior. The latter influences the way the light is reflected. Therefore according to an advantageous embodiment at least the indirect illumination lighting element 5 is formed such, that a major part of the emitted light hits the ceiling of side walls in a predetermined angle, preferably perpendicularly.

Further, a connection element 6 is provided for establishing a connection between the lighting unit 1 and a control unit 7. The connection element is preferably a wireless sending and transmitting unit or a wired connection.

According to a further embodiment for a wired connection the connection element is adapted for power line communication. Thus a wired connection is established to the power line cable and the control signals are sent across the power line cable.

According to a further advantageous embodiment the connection element 6 provides a connection to the control unit 7 of another lighting unit 1 or a central control unit.

The wireless transmission unit is a transmission unit which works in the regime around 2.4 GHz and uses an encryption of at least 8 bit. Alternatively, other frequency bands are used which are suitable in respect to range, interferences, allowed frequency bands and radiation exposure.

According to another embodiment a transmission unit for wired transmission is particularly adapted for a power line transmission.



According to a further embodiment the transmission unit is adapted for wireless and wired transmission. This allows a high flexibility in regard to the surroundings the light unit 1 is used.

Further, the lighting unit comprises a not shown electrical circuit for driving the LEDs or groups of LEDs. This circuit is designed to run alternatively on either DC or AC power. In case of AC power input the circuit includes an AC-DC converter following by a constant current source which can comprise an electronic component for controlling the operating current of a LED or a group of LEDs by using a signal with bit angle modulation other than the pulse width modulation. This signal is e.g. the internal control signal. In case of DC power input the AC-DC converter will be by-passed. This enables the light units to be able to use both DC and AC power for example by using solar and/or wind power in parallel to the generally AC network.

It is possible that AC power is not needed at all when lighting units are planned to run on DC power networks. In this case there will be no need for the AC-DC converter. The solar or wind power plant may be positioned at the outside of the interior, e.g. a roof.

In this case according to an embodiment wherein the transmission unit is suited for wired transmission the DC power lines might be used for transmission of control signals.

When using bit angle modulation, the LED is driven by a pulse train that is the binary word defining the value of a required intensity. Each bit of the pulse train is stretched by a ratio defined by the binary significance of each bit. Each bit of the binary word is effectively allocated a fixed range of phase angles within the drive cycle. The advantage of bit angle modulation is a simple implementation, and, as the drive signal is a multiple of the modulation frequency, a reducing of potential flicker. Also, because the LED drive signal contains a digital code of the intensity value, other devices may recover the data.

According to an advantageous embodiment a bit angle modulated internal control signal is provided to one or more electrical circuits which provides in response thereon a driving current to one or more LEDs.

The control unit 7 provides internal control signals 14 to a warm light LED unit 8 and a cold light LED unit 9 or the at least one electrical circuit for providing their driving current. The

control unit is, as depicted in Figure 1, positioned within the housing 13 of the lighting unit 1. The connection element 6 provides then a wired connection to the control unit 7.

Alternatively, the control unit 7 is positioned at the fixing point 18, where the lighting unit 1 is suspended at the ceiling. In this case, the connection element 6 may either provide a wired  
5 connection to the control unit 7 or transmit a signal to the control unit 7 wirelessly.

According to another embodiment, the control unit 7 is positioned at a predetermined position inside or outside the exterior. This allows a control of illumination e.g. from a central position for several rooms.

The warm light LED unit 8 comprises at least one LED providing a warm light, preferably  
0 corresponding to a temperature range between about 1500 and about 3500 Kelvin. Further, the direct illumination lighting element 4 comprises a cold light LED unit 9 with at least one LED providing cold light that is preferably in a temperature range above about 3500 Kelvin.

According to an embodiment, the warm light LED unit 8 comprises at least one blue LED, which is covered with a coloured element having a colour in the orange or red range. For the  
5 cold light LED unit 9 at least one blue LED is used, which is covered with a coloured element in the yellow range.

Alternatively, other luminescent material is used to cover an LED which can excite the luminescent material.

On the top side a first LED 10 is positioned as a part of the indirect illumination lighting  
0 element, closely together with at least a second LED 16. Therefore preferably an array of at least two LEDs with colours is formed such that white light can be produced. This may be a combination of a red, green and blue LED or a combination of a blue and yellow LED. By the use of a combination of a red, green and blue LED, different colours can be produced dependent on the situation for which the illumination is desired.

15 In addition, an amber coloured LED 11, possibly as a part of a multicolour LED 10, is positioned on the top side. As amber is the predominant colour of the human skin, by using amber, that is a colour between yellow and orange, the room illumination may be defined as comfortable and showing the people in an approximately natural light.

The LEDs of the warm light LED unit 8, the cold light LED unit 9, the first LED 10 and the amber LED 11 may be put into separate glass, plastic or other transparent housings. This allows to use cheap custom LEDs, so that the whole lighting unit 1 can be produced cheaply.

Alternatively, two or more LEDs may be put into a common housing, so that so called  
5 multicolour LEDs are formed. Thus, the various LED chips are contained in one component so that on the one hand less space is needed on a printed circuit board, and on the other hand a very good mixing of various colours can be achieved. Particularly a red, green and blue LED may be contained in a common housing.

Additionally, a movement detector 12 may be installed on the bottom side 2 of the lighting  
0 unit 1. If a movement is determined within the sensitive area of the movement detector, e.g. a predetermined cone extending from the lighting unit 1, a movement detector signal 15 is provided to the control unit 7 via the connection element 6 or directly.

An internal control signal 14 for controlling the brightness of the illumination provided by the  
5 lighting unit may be sent either via the connection element 6 or directly to at least one or all of the following: the warm light LED unit 8, cold light LED unit 9, first LED 10 and amber LED 11. Thus, a desired brightness and colour of the illumination can be achieved.

The first LED 10 may therefore comprise at least a second LED 16, e.g. in that the at least  
first LED 10 is formed by an LED group or array comprising several LEDs. Particularly, the first LED 10 is a blue LED and the second LED is a yellow LED. Alternatively the at least  
10 first LED 10 and at least second LED 16 may be formed by a group of at least one red, green and blue LED. Further, the above set-ups with blue and yellow LEDs and red, green and blue LED may be used both for the indirect illumination unit, e.g. alternating. Thus the lighting unit can be optimised in regard to its function, e.g. achievable brightness, colours, life time etc, and costs.

15 In Figure 2 a lighting network 20 is depicted which comprises several lighting units 1. The control unit 7 is positioned either inside of the housing 13 of a lighting unit 1, at the fixing point 18 of a lighting unit 1 or at a position in between, e.g. along the cable for providing electrical power to the lighting unit. The connection element 6, which is not depicted in Figure 2, is adapted either for wireless transmission, so that signals are transferred wirelessly  
20 between the connection element 6 and the control unit 7. This allows to position the control

units arbitrarily or user-defined. Alternatively or additionally the connection element 6 are adapted for wired transmission. Then power line communication can be used for transmitting control signals, which is particularly advantageous, if the control unit 7 is positioned along the power line.

5 An external control signal 23 for setting the light to a required value for a predetermined scenario, such as meeting, press conference, presentation, computer work, or cleaning the computer, is transmitted from a master control unit 21 to each lighting unit 1, e.g. to the connection unit 6, where it is received and further transferred to the control unit 7. Thus, the light intensity of each lighting unit 1 can be adapted to the required value.

10 The external control signal 23 may be transmitted across a wired connection or wireless.

According to an embodiment the power line is used as wired connection and the external control signal 23 is transferred across the power line.

According to another embodiment the external control signal is transmitted to at least one control unit by using a WLAN technology.

15 The master control unit may be a mobile remote control unit or fixed at a certain position, e.g. at a wall of the interior, or being realised by e.g. a web server which accesses one or more lighting units e.g. via the internet as access network. Alternatively, a fixed or mobile master control unit may be accessed via the internet by a web server.

20 The external control signal 23 may therefore contain information on the brightness or light intensity of each LED or group of LEDs. According to an embodiment this is realised by prescribing the driving current for a LED or group of LEDs. Alternatively or additionally the external control signal may contain information on the brightness or light intensity or colour direct lighting element 4 or indirect lighting element 5. The control unit 7 of each lighting unit may then assign the individual values for a LED or group of LEDs.

25 The transmission of the external control signal 23 can be either performed in a wired or a wireless mode. The master control unit 21 may be positioned at a central position inside the interior, e.g. given at a switch unit positioned at an entry or at a switch unit also used for other purposes such as teleconference etc., or outside, e.g. at a control room.

An overall control signal 22, defining the light situation, such as a press conference, discussion, meeting, presentation, computer work or cleaning, is provided as the overall control signal 22 to the master control unit 21 which then splits the information such that each lamp or lighting unit adapts the required intensity and colour such that as a whole, in the interior, the desired lighting situation is created. This overall control signal may be provided by a control program, user input or e.g. by a web server or other remote control entity, e.g. by using a transmission over the internet. In general, also the overall control signal may be transmitted in a wired or wireless mode. According to an embodiment, for the wired transmission power line communication is used.

Further in the master control unit 21 the external control signal 23 may be created on basis of the overall control signal 22. Therefore, the master control unit may use also further information, such as time or already existing brightness, e.g. due to sunshine, in the room to be illuminated. Alternatively or additionally the master control unit may use movement information as set out below:

The master control unit 21 or/and at least one of the lighting units 1 is connected to the movement detector 12. The movement detector signal 15, see Figure 3, may be combined in the master control unit 21 in order to adapt the external control signal 23.

Alternatively, the movement detector signal 15 may be combined in a lighting unit 1 with the internal control signal 14 such that the intensity or/and colour of the illumination is changed when a person 24 enters the detection cone 25 of a movement detector 12 positioned in or at a lighting unit 1.

Alternatively or additionally, a movement detector 12 in the master control unit 21 may provide a movement detector signal 15 if a person enters the predetermined range defined by the movement detector 12 and, thus, modify the external control signal 23 such that e.g. all lighting units 1 are switched on, or switched from a power safe mode, where the light is completely switched off or remains at a certain dimming level, to a full illumination mode or a brighter dimming level, e.g. when a person enters a room.

Thus the lighting units 7 or control entities in a network 20 of lighting units 1 include additional optional intelligence based on movement sensors which may be used to evaluate the real required light intensity.

In Figure 4 another embodiment of the lighting unit 1 is depicted which is also formed as a suspended lamp. In Figure 5 a cross section of the embodiment of the lighting unit 1 depicted in Figure 4 is shown. A top side PCB (printed circuit board 50) is arranged within a top side reflector element 51. On the top side PCB 50 the LED or LED arrays forming the indirect illumination lighting element 5 are placed. At the bottom side 2 a bottom side PCB 52 is placed within a bottom side reflector element 53. Further, protection elements 54 are provided, which can additionally be used for defusing the light of the LEDs.

At the bottom side 2 further a movement detector 12 is placed, preferably inside the bottom side reflector element 53. Thus the detecting cone of the movement detector 12 can basically coincide with the lighting cone of the direct illumination element.

The movement detector 12 detects a movement and provides this information as movement detector signal 15 to the control unit 7. The control unit 7 provides an internal control signal 14 to the individual or group of LEDs placed on the PCB boards, see also Figure 1. This can be realised by providing the internal control signal to an electrical circuit externally or internally in regard to the LED or group of LEDs or LED unit. The electrical circuit then provides a corresponding driving current or driving voltage to the LED or group of LEDs or LED unit. The control unit 7 can be formed by separated sub units, e.g. of which one controls the direct illumination element 4, the other one the indirect illumination element 5.

Also in this embodiment the direct illumination lighting element 4 comprises a protection element 54, a warm light LED unit 8 and a cold light LED unit 9 placed on a bottom side PCB board 52.

The indirect illumination lighting element 5 comprises a protection element 54, a multicolour first LED 10 placed on a top side PCB 50 and a top side reflector element 51.

The connection element 6 is placed on a position where a good reception of external signals is ensured and short transmission paths to the control unit 7 can be ensured.

In Figure 6 the bottom side PCB 52 is depicted. In an alternating manner, warm light LED units 8 and cold light LED units 9 comprising each at least one LED are arranged on the bottom side PCB 52. Thus, a desired overall colour of light from the direct illumination lighting element 4 can be achieved.

Alternatively the arrangement of the LED units may be differently, e.g. areas on which predominantly warm light LED units 8 arranged and those with predominantly cold light LED units 9.

The bottom side PCB board 52 may comprise several individual PCB boards, which are connected to each other.

For connecting the individual PCBs with each other a PCB connector 55 is provided at an end of an individual PCB board. Further, a cable connector 56 is provided for establishing electrical connections between the individual PCB boards or to a component outside the PCB board. Preferably, the electrical connection between the individual PCB boards is established by the PCB connector 55, too, so that at least a part of the cable connector 56 is integrated in a PCB connector 55.

In Figure 7 the top side PCB 50 is depicted. Each of the first LEDs 10 is a LED combination of a red, green and blue LED. Added to this combination is an amber coloured LED 11, either separately or within the same housing. These LED groups are arranged turned in respect to each other in order to achieve a more conform illumination of the interior with a common mixed colour. Again, the top side PCB 50 may comprise several elements, which are connected to each other by PCB connectors 55.

A security device 57 is provided in order to compensate a failure of one or more LED's in order to keep the lighting unit in function, when one or more of the LED is broken. Further, an array of resistors 58 is provided to adapt the top side PCB 50 or/and the bottom side PCB 51 for a position in the left side, the middle left side, the middle right side or the right side of the lighting unit. Holes 59 are provided to fix a PCB with screws or rivets in the lighting unit.

**List of reference numbers**

|    |                                        |    |                               |
|----|----------------------------------------|----|-------------------------------|
| 1  | lighting unit                          | 18 | fixing point                  |
| 2  | bottom side                            | 20 | lighting network              |
| 3  | top side                               | 21 | master control unit           |
| 4  | direct illumination lighting element   | 22 | overall control signal        |
| 5  | indirect illumination lighting element | 23 | external control signal       |
| 6  | connection element                     | 24 | person                        |
| 7  | control unit                           | 25 | detection cone                |
| 8  | warm light LED unit                    | 50 | top side PCB                  |
| 9  | cold light LED unit                    | 51 | top side reflector element    |
| 10 | multicolour LED (red, green, blue)     | 52 | bottom side PCB               |
| 11 | amber LED                              | 53 | bottom side reflector element |
| 12 | movement detector                      | 54 | protection elements           |
| 13 | housing                                | 55 | PCB connector                 |
| 14 | internal control signal                | 56 | cable connector               |
| 15 | movement detector signal               | 57 | security device               |
| 16 | second LED                             | 58 | array of resistors            |
| 17 | vertical                               | 59 | holes                         |



## Claims

1. Lighting unit (1) for illuminating an interior comprising
  - a housing (13) with a bottom side (2) and a top side (3);
  - a direct illumination lighting element (4) arranged at the bottom side (2) with at least one warm light LED unit (8) providing white light with a first colour temperature and at least one cold light LED unit (9) providing white light with a second colour temperature;
  - an indirect illumination lighting element (5) arranged at the top side (3) comprising at least a first LED (10) and a second LED (16) having different colours and at least one amber coloured LED (11);
  - a connection element (6) for connecting the lighting unit (1) to a control unit (7).
2. Lighting unit (1) according to claim 1, further comprising a control unit (7) for controlling the light intensity of the lighting unit (1).
3. Lighting unit (1) according to claim 2 wherein the control unit (7) is adapted such that for controlling the light intensity of the lighting unit (1) an internal control signal (14) is provided for setting the light intensity of at least one of direct illumination element (4), warm light LED unit (8), cold light LED unit (9), indirect illumination element (5), first LED (10), second LED (16) and amber LED (11).
4. Lighting unit (1) according to any of the previous claims wherein the connection element (6) is a transmission interface for wireless transmission and/or wired transmission.
5. Lighting unit (1) according to claim 4 wherein the connection element (6) is a transmission interface for wired transmission for a connection to a DALI bus system.
6. Lighting unit (1) according to claim 4, wherein the transmission interface is adapted for wired transmission via a power line.

7. Lighting unit (1) according to any of the previous claims further comprising a movement detector (12) for detecting a movement within a predetermined range of the lighting unit (1) which provides a movement detector signal (15) to the connection element (6).
- 5 8. Lighting unit (1) according to any of the previous claims, wherein the lighting unit (1) is fixed at a certain position, particularly as a suspended lamp.
9. Lighting unit (1) according to claim 7, wherein the control unit (7) is positioned inside or outside the housing (13).
- 10 10. Lighting unit (1) according to any of the previous claims, wherein the lighting unit (1) comprises a foot element for placing the lighting unit (1) on a surface.
11. Lighting network (20) comprising at least two lighting units (1) according to any of the previous claims and a master control unit (21) for providing an external control signal (23) to at least one of the control units (7).
- 15 12. Lighting network (20) according to claim 11, wherein the connection element (6) is adapted for wired, particularly power line communication or/and communication across a DALI Interface, and/or wireless transmission.
13. Lighting network according to claims 11 or 12, wherein the external control signal (23) is transmitted via a wired connection, particularly a power line connection, from the master control unit (21) to at least one of the control units (7).
- 20 14. Lighting network according to claims 11 or 12, wherein the external control signal (23) is transmitted in a wireless mode from the master control unit (21) to at least one of the control units (7).
- 25 15. Method for lighting an interior using at least one lighting unit (1) according to any of the claims 2 to 10 or a lighting network (20) according to any of the claims 11 to 14 comprising the following steps:
  - providing an external control signal (23) to the control unit (7);

- providing the internal control signal (14) from the control unit (7) to the direct illumination lighting element (4) and/or the indirect illumination lighting element (5);
- setting a light intensity and a light temperature for the direct illumination lighting element (4) on the basis of the internal control signal (14);
- setting the colour of the indirect illumination lighting element (5) by adjusting the intensity of at least one of first LED (10) and second LED (16) and by adjusting the intensity of the amber LED (11).

16. Method according to claim 15, comprising the further steps:

- providing an overall control signal (22) containing information on a lighting scenario;
- creating an external control signal (23) in the master control unit (21) on basis of said overall control signal (22).

17. Method according to any of the previous claims 15 or 16 comprising the further steps:

- receiving a movement detector signal (15);
- creating an internal control signal (14) or an external control signal (23) using the movement detector signal.

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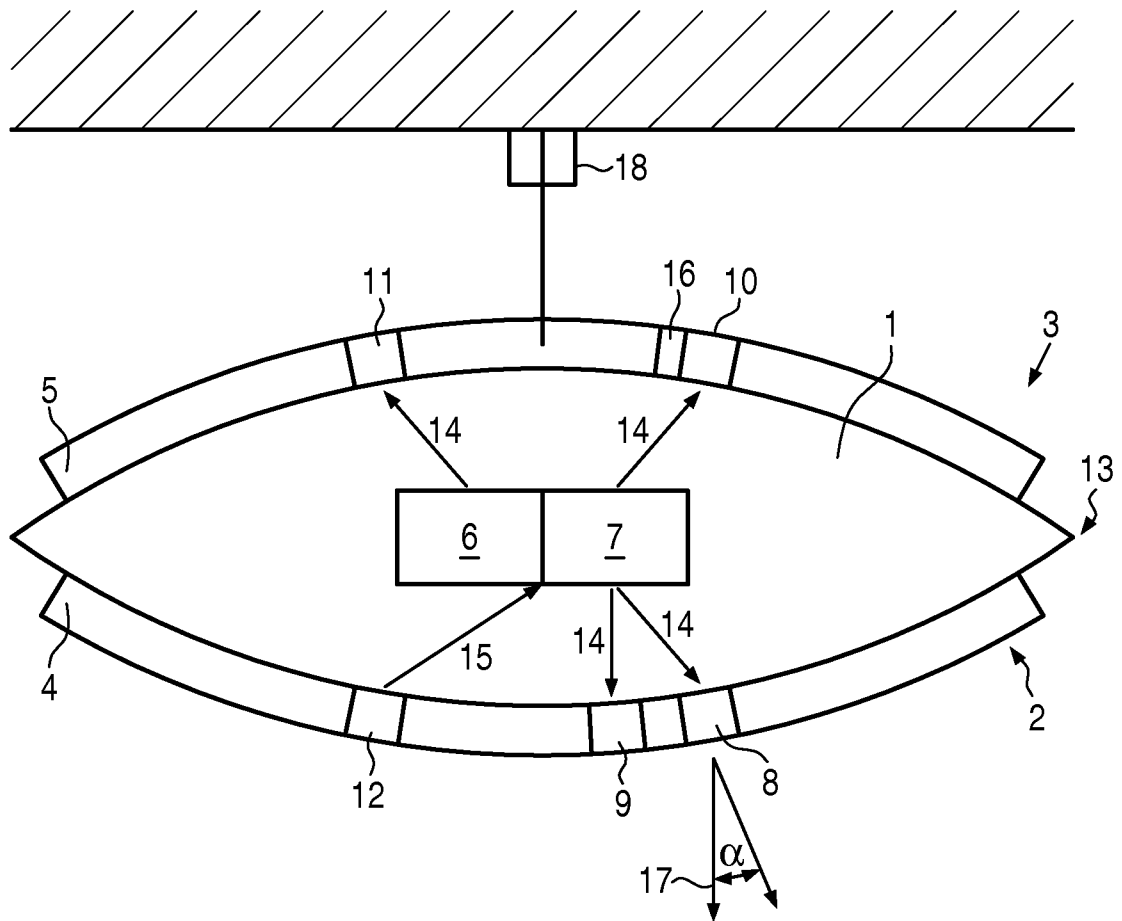


FIG. 1

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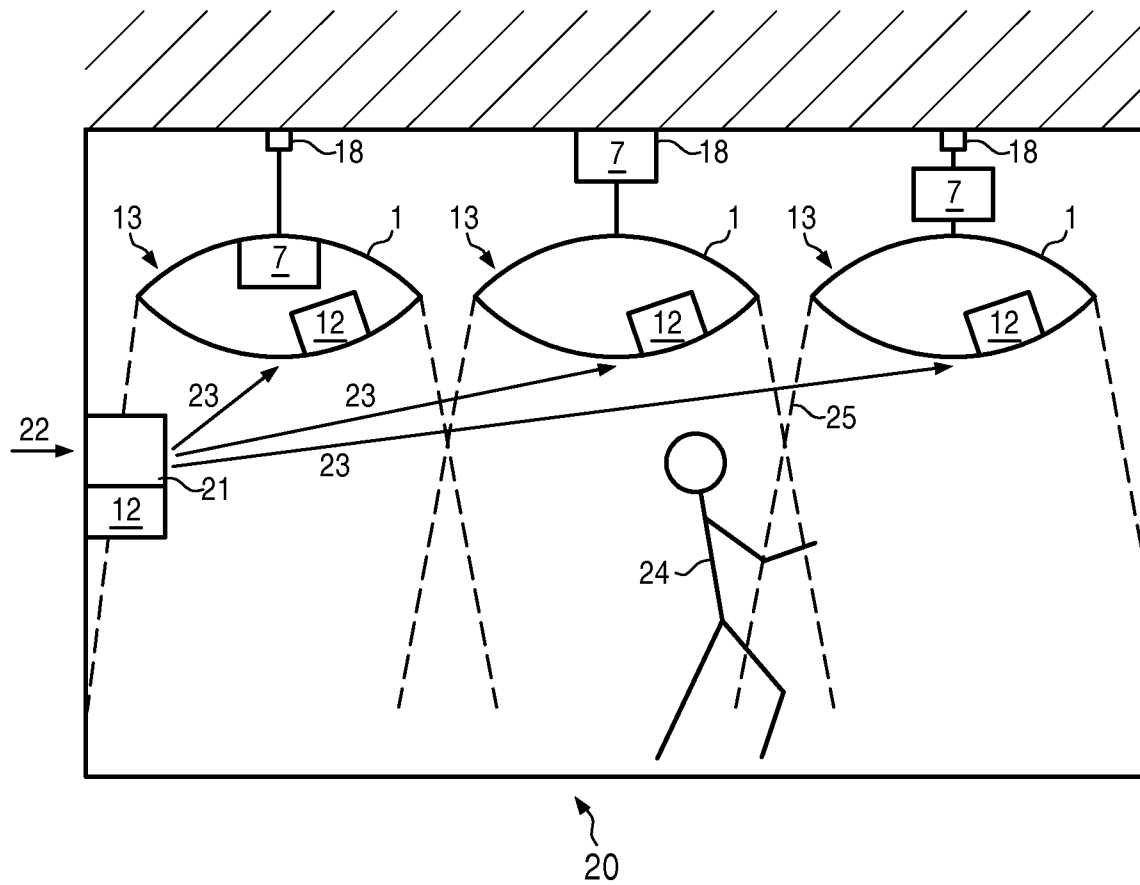


FIG. 2

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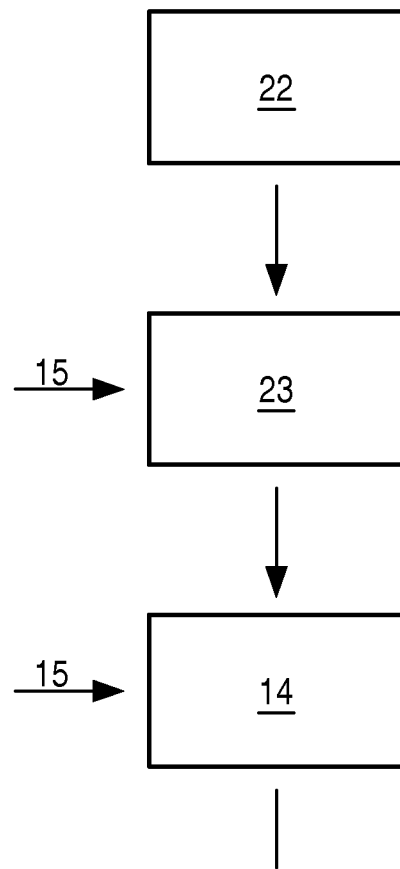


FIG. 3

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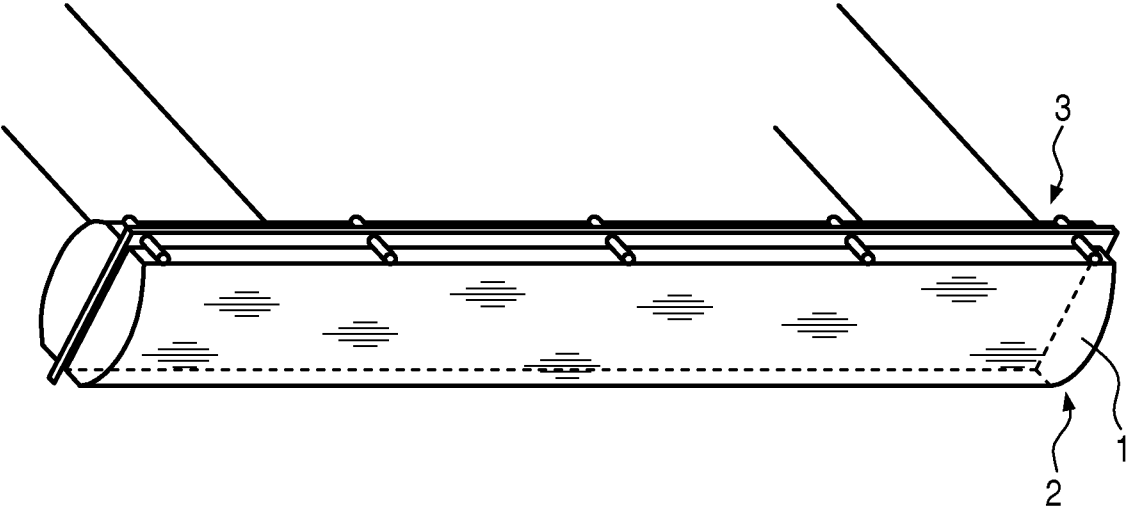


FIG. 4

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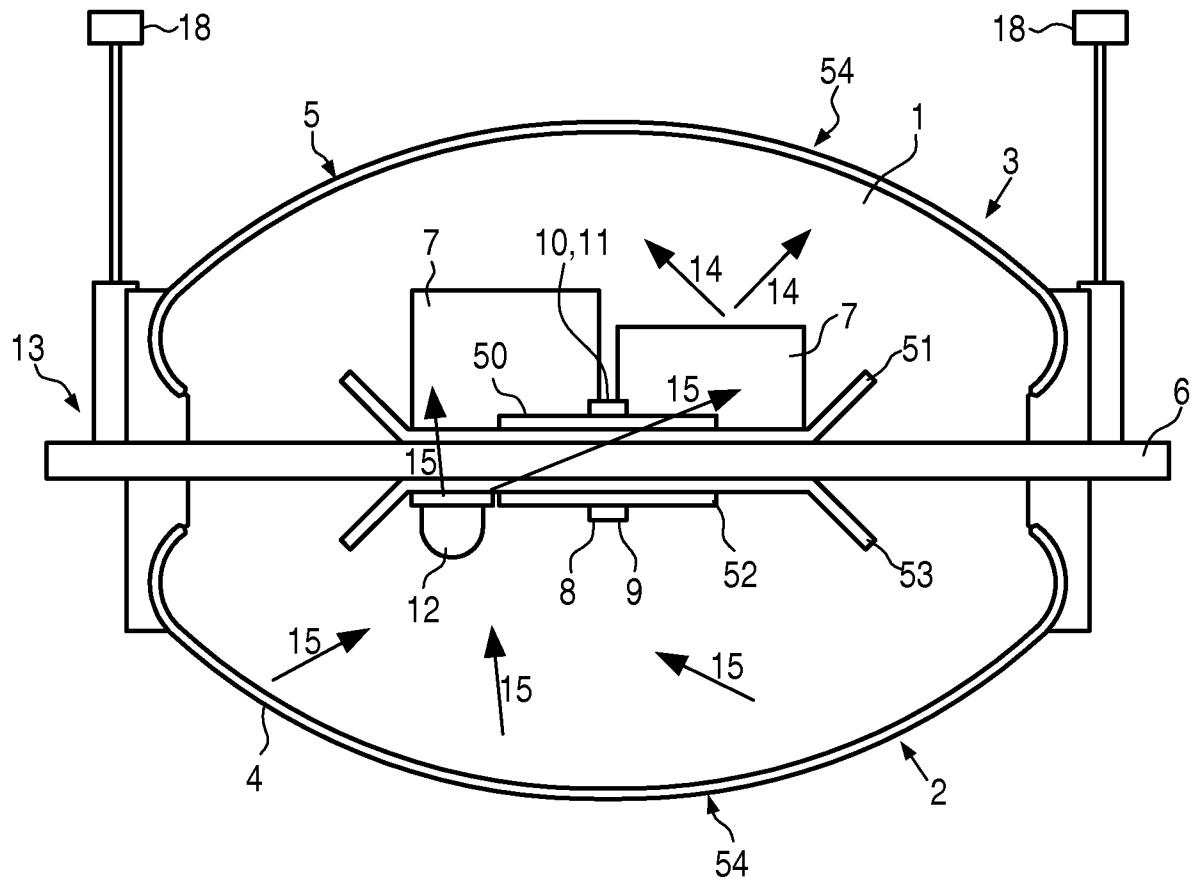


FIG. 5



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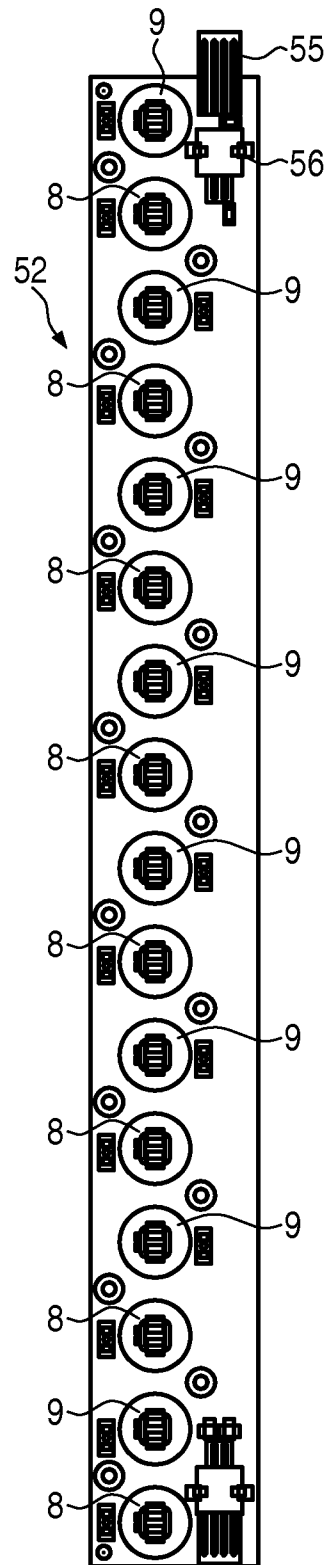


FIG. 6

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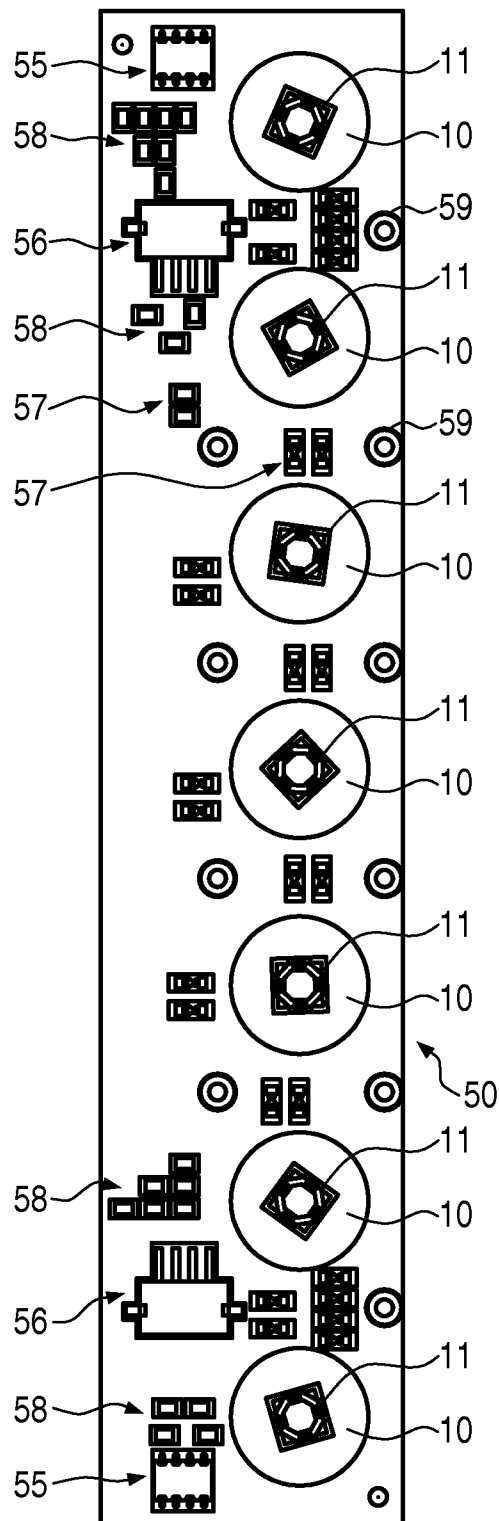


FIG. 7

# INTERNATIONAL SEARCH REPORT

International application No  
PCT/EP2010/058150

**A. CLASSIFICATION OF SUBJECT MATTER**  
INV. F21S8/06 F21V7/00  
ADD.

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)  
F21S F21V

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. |
|-----------|-----------------------------------------------------------------------------------------------------------------|-----------------------|
| X         | US 2009/002986 A1 (MEDENDORP JR NICHOLAS W [US] ET AL) 1 January 2009 (2009-01-01) paragraph [0055]<br>figure 9 | 1-17                  |
| A         | DE 201 05 386 U1 (INPROTEC INNOVATIVE PRODUKTION [DE])<br>27 September 2001 (2001-09-27)<br>figure 1            | 1-17                  |

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

\* Special categories of cited documents :

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Date of the actual completion of the international search

29 September 2010

Date of mailing of the international search report

05/10/2010

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2010/058150

| Patent document<br>cited in search report |    | Publication<br>date | Patent family<br>member(s) | Publication<br>date |
|-------------------------------------------|----|---------------------|----------------------------|---------------------|
| US 2009002986                             | A1 | 01-01-2009          | NONE                       |                     |
| DE 20105386                               | U1 | 27-09-2001          | NONE                       |                     |