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(54) Title: LIGHTING DEVICE

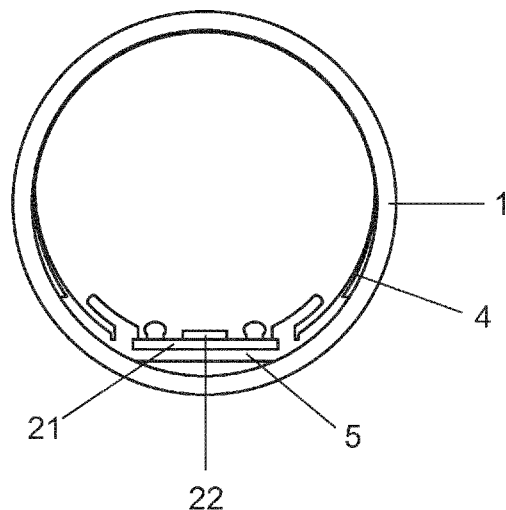


Figure 2

(57) Abstract: The present invention relates to a lighting device (100), which comprises: a lamp tube (1) having two open ends; a light engine (2) arranged in the lamp tube (1); a carrier supporting the light engine (2); and two end caps (3) closing the open ends, characterized in that the lighting device (100) further comprises a diffuser (4), the carrier supporting the light engine (2) is held on the diffuser (4), and the diffuser (4) is held on the inner wall of the lamp tube (1).





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Description

Lighting Device

5 **Technical Field**

The present invention relates to a lighting device, particularly a retrofit lamp.

Background Art

It is well known that LED illumination has non-substitutable advantages such as energy saving, ultra low power consumption, an almost 100% electro-optical power conversion, 80% or higher energy saving compared with traditional light sources at the same luminous efficiency, and a relatively long service life. Considering the advantages mentioned above, LEDs are more and more used as light sources, for example, LED retrofit lamps appearing in the market in a great number. Such LED retrofit lamps possess a contour of traditional light sources, an incandescent lamp or a lamp tube for instance, and can thus be better adapted to an existing lighting system as light source.

In an existing technical solution of retrofit lamps for replacing traditional lamp tubes, the retrofit lamp has a lamp tube made of a transparent plastic, an LED light engine as light source is arranged inside said lamp tube, an additional holding structure is hereby usually required to fix the LED light engine, and said holding structure arranges the LED light engine on end caps closing two open ends of the lamp tube. In another existing technical solution, the retrofit lamp, viewed from a cross section thereof, comprises two parts, viz. a lamp cover of a transparent plastic and a heat sink that is assembled together with the lamp cover and used for an LED light engine, wherein the heat sink and the trans-

parent lamp cover are assembled to form a cylindrical structure. Hereby, both the heat sink and the transparent lamp cover require a specifically configured mounting structure, so that good leak tightness is assured, while the two are reliably fixed together. However, the above solutions have certain obvious disadvantages, viz. the holding structure has to be specifically configured, which increases the cost of the retrofit lamp resulting in complexity and difficulty of assembly. In addition, a lamp tube made of plastics has relatively bad flexural behavior, and might have undesired bend in case of a relatively long lamp tube. In order to solve said problem, the heat sink has to be configured to be relatively heavy, which increases the cost of the retrofit lamp. Moreover, a plastic lamp cover has relatively bad optical performance, and complex configurations have to be performed on the plastic lamp cover to obtain desired light distribution performance, which further increases the cost of the retrofit lamp.

Summary of the Invention

In order to solve the technical problems mentioned above, the present invention provides a lighting device, particularly a retrofit lamp. The lighting device according to the present invention requires low cost and has a simple structure. Moreover, the lighting device according to the present invention is easier to assemble and has fine light distribution performance, while sufficient structural strength is insured.

The object of the present invention is achieved through a lighting device in such a manner, viz. said lighting device comprises: a lamp tube having two open ends; a light engine arranged in the lamp tube; a carrier supporting the light engine; and two end caps closing the open ends, wherein the lighting device further comprises a diffuser, the carrier

supporting the light engine is held on the diffuser, and the diffuser is held on the inner wall of the lamp tube. In an embodiment of the present invention, a diffuser is used, in order to obtain good light distribution performance, while
5 said diffuser also functions for positioning the light engine and the carrier supporting the light engine inside the lamp tube, so that the specifically configured holding structure used in the prior art can be omitted. It significantly reduces the manufacturing cost of the lighting device according
10 to the present invention.

It is provided according to the present invention that the diffuser is configured to be elastic and rests on the inner wall of the lamp tube in a predetermined stress. In an embodiment according to the present invention, the diffuser *per*
15 *se* is configured to be capable of expanding outwardly in a radial direction of the lamp tube. After the diffuser is placed inside the lamp tube, the expansion trend of the diffuser in the radial direction is limited by the inner wall, thereby forming a predetermined stress between the inner wall
20 of the lamp tube and the diffuser; in other words, the diffuser exerts an abutting force on the inner wall of the lamp tube, which force assures that the diffuser, then the carrier held on the diffuser which supports the light engine would not move relative to the inner wall of the lamp tube.

25 According to a preferable embodiment of the present invention, it is provided that the diffuser is a tubular structure formed by bending an elastic plate-shaped part. In such a simplest embodiment, the diffuser bend into a tubular structure is similar to a curved leaf spring, and the restoring
30 force of the leaf spring prompts the formation of the abutting force or the predetermined stress.

It is preferable that the diffuser extends over the whole longitudinal length of the lamp tube. Thus, the diffuser covers the light emergent surface of the lamp tube over the whole longitudinal length to obtain hereby a large effective lighting region as possible.

It is further provided according to the present invention that the lamp tube is a glass tube. Glass tubes are widely used in different fluorescent lamp tubes, as they require low costs and can be obtained from the market with low prices. Moreover, glass tubes have better flexural behavior compared with plastic lamp tubes. In this case, the heat sink for heat dissipation can be configured to be relatively light, under the precondition that the demands on heat dissipation are satisfied. Furthermore, glass tubes have finer optical performance.

It is advantageous that the carrier is a heat sink. In an embodiment of the present invention, said heat sink can be made of aluminum, which is a relatively light in weight. Of course, the heat sink can also be made of other materials such as heat conductive plastics etc.

It is further preferable that the heat sink is fixed on the diffuser. The diffuser according to the present invention is made of an elastic plate-shaped part. Thus, while fixing the heat sink, only one edge of the plate-shaped part has to be fixed with the heat sink, and there is no need to fix the other edge with the heat sink, so as to ensure that the diffuser bent into a tubular shape can further have an expansion trend after being fixed on the heat sink.

It is further provided according to the present invention that the light engine includes a circuit board and at least

one LED chip arranged on the circuit board. LED chips have advantages of high luminous efficiency, environmental protection and long service life.

It is preferable that the circuit board extends over the whole longitudinal length of the lamp tube, so that LED chips arranged on the circuit board are also successively distributed in the longitudinal direction of the circuit board, and then be enabled to uniformly output light in the longitudinal direction of the whole lighting device.

It is preferable that the light engine is arranged in a space defined by the heat sink and the diffuser, so that light emitted by the LED chip emerges through the diffuser. Through such an arrangement way, an observer would not view the LED chips from outside, which improves the aesthetic property of the lighting device. Moreover, light emitted by the LED chips would not emerge directly through the lamp tube, which avoids detrimental influence on the light distribution performance.

According to the present invention, it is provided that the diffuser includes a plate-shaped part base body which is made of a transparent and elastic material, wherein said material can be PC or PET material, and can certainly be other transparent and elastic materials.

It is preferable that a microstructure is formed on the surface of the plate-shaped part base body, and the microstructure is configured to enable light that emerges through the diffuser to have uniform light distribution performance. For example, a frosted surface etc. can be formed on the surface of the base body in a sheet form.

Alternatively, a diffusant, e.g. white powder etc., is added

to the material forming the plate-shaped part base body, so that emergent light through the diffuser has uniform light distribution performance.

According to the present invention, it is provided that a pin
5 for insertion into a socket is formed on the end cap, wherein the pin is in electrical connection with the light engine through a lead. In an embodiment of the present invention, the end cap functions for closing the open end of the lamp tube and providing electrical connection with the light en-
10 gine. Such an end cap has the same contour as end caps used in traditional fluorescent lamps, so that the lighting device according to the present invention can be easily inserted into a socket provided in a traditional fluorescent lamp tube.

15 It is preferable that the end cap is made of an insulating material.

According to the present invention, it is provided that the lighting device is configured as a T5, T8, and T10 retrofit lamp.

20 It is to be understood that the features of the various exemplary embodiments described herein may be combined with each other, unless specifically noted otherwise.

Brief Description of the Drawings

The accompanying drawings constitute a part of the present
25 Description and are used to provide further understanding of the present invention. Such accompanying drawings illustrate the embodiments of the present invention and are used to describe the principles of the present invention together with the Description. In the accompanying drawings the same compo-

nents are represented by the same reference numbers. As shown in the drawings:

Figure 1 is an exploded schematic diagram of a lighting device according to the present invention;

5 Figure 2 is a sectional view of the lighting device according to the present invention; and

Figure 3 is a schematic diagram of the lighting device according to the present invention in an assembled state, wherein a section of the lamp tube is respectively cut off
10 from the two end regions, so as to clearly show the internal structure of the lighting device.

Detailed Description of the Embodiments

In the following detailed description, reference is made to the accompanying drawings, which form a part thereof, and in
15 which is shown by way of illustration specific embodiments in which the invention may be practiced. In this regard, directional terminology, such as "inside", "outside", "left", "right", is used in reference to the orientation of the figures being described. Because components of embodiments of
20 the present invention can be positioned in a number of different orientations, the directional terminology is used for purposes of illustration and is in no way limiting. It is to be understood that other embodiments may be utilized and structural or logical changes may be made without departing
25 from the scope of the present invention. The following detailed description, therefore, is not to be taken in a limiting sense, and the scope of the present invention is defined by the appended claims.

Figure 1 shows an exploded schematic diagram of a lighting

device 100 according to the present invention, and it can be seen from the figure that the lighting device 100 comprises: a lamp tube 1 having two open ends; a light engine 2 arranged in the lamp tube 1; a carrier supporting the light engine 2; and two insulating end caps 3 closing the open ends. Moreover, it can be seen from the figure that the lighting device 100 further comprises a diffuser 4. The lighting device 100 according to the present invention is configured as an LED retrofit lamp, particularly a T5, T8 or T10 retrofit lamp.

The light engine 2 is thereby configured as an LED light engine, and includes a circuit board 21 and at least one LED chip 22 arranged on the circuit board 21. It can further be seen from the figure that a plurality of LED chips 22 is provided on the circuit board 21. In addition, the circuit board 21 extends over the whole longitudinal length of the lamp tube 1. However, only a section of the circuit board 21 is shown in the view of Figure 1, while in an actual situation, the circuit board 21 shall extend from one end cap 3 to the side of another opposite end cap 3.

Moreover, in the example as shown in Figure 1, the end cap 3, particularly the left end cap 3 in Figure 1, has a pin 31 for insertion into a socket, wherein the pin 31 is in electrical connection with the circuit board 21 of the light engine 2 through a lead 32. In an embodiment of the present invention, the end cap 3 functions for closing the open end of the lamp tube 1 and providing electrical connection with the light engine 2. Such an end cap 3 has the same contour as end caps used in traditional fluorescent lamps, so that the lighting device 100 according to the present invention can be easily inserted into a socket provided in a traditional fluorescent lamp tube. However, there is a slight difference between the right end cap 3 and the left end cap 3 in Figure 1, viz. only a bolt is formed on said right end cap, and the function of

said bolt only lies in fixation of the lamp tube in the socket, while no electrical connection is provided. However, said right end cap 3 can also have the same structure as the left end cap 3, while there is just no need to perform electrical connection with the circuit board 21 of the light engine 2 through a lead.

Furthermore, the circuit board 21 shown in Figure 1 is supported on the carrier (see Figure 2). Said carrier is configured as a heat sink 5. In the present example, the heat sink 5 is made of aluminum, which is relatively light in weight. Of course, the heat sink 5 can also be made of other materials such as heat conductive plastics etc.

In addition, the lamp tube 1 is a glass tube. The glass tube 1 is widely applied to different fluorescent lamp tubes, as it requires low cost and can be obtained from the market with low price. Moreover, the glass tube 1 has better flexural behavior compared with plastic lamp tubes, and the heat sink for heat dissipation can therefore be configured to be relatively light, under the precondition that the requirements on heat dissipation are satisfied. Furthermore, a glass tube has finer optical performance.

The key point of the present invention lies in the diffuser 4. The diffuser 4 according to the present invention is a tubular structure formed by bending an elastic plate-shaped part. However, in the example as shown in Figure 1, said diffuser 4 is not formed as a closed tubular structure, instead of that, there is a certain distance between the two opposite ends. In the present example, said diffuser 4 includes a plate-shaped base in a sheet form that is made of a transparent and elastic material, said material is PC or PET material, and can certainly be other transparent and elastic ma-

materials. In a specific example, a microstructure is formed on the surface of the plate-shaped base body, in order to obtain uniform light distribution performance, while in other examples, a diffusant, e.g. white powder etc., can be added to the material forming the plate-shaped base body. In addition, the diffuser 4 extends over the whole longitudinal length of the lamp tube 1. Hereby, the diffuser 4 covers the light emergent surface of the lamp tube 1 in the whole longitudinal length, so as to obtain a large effective lighting region as possible.

Figure 2 shows a sectional view of the lighting device 100 according to the present invention. It can be seen from the figure that the heat sink 5 is fixed on the diffuser 4. The diffuser 4 according to the present invention is made of an elastic plate-shaped part. Thus, while fixing the heat sink 5, only one edge of the plate-shaped part has to be fixed with the heat sink 5, and there is no need to fix the other edge with the heat sink 5, so as to ensure that the diffuser 4 bent into a tubular shape can further have an expansion trend after being fixed on the heat sink 5. It can be seen from the figure that the diffuser 4 with the heat sink 5 is inserted into the lamp tube 1, and the diffuser 4 rests on the inner wall of the lamp tube 1 in a predetermined stress. The diffuser 4 *per se* is configured to be capable of expanding outwardly in a radial direction of the lamp tube 1. After the diffuser 4 is placed inside the lamp tube 1, the expansion trend of the diffuser 4 in the radial direction is limited by the inner wall, thereby forming a predetermined stress between the inner wall of the lamp tube 1 and the diffuser 4; in other words, the diffuser 4 exerts an abutting force on the inner wall of the lamp tube, which force assures that the diffuser 4, then the heat sink 5 held on the diffuser 4 which supports the light engine 2 would not move

relative to the inner wall of the lamp tube.

Moreover, it can further be seen from Figure 2 that the light engine 2 is arranged in a space defined by the heat sink 5 and the diffuser 4, so that light emitted by the LED chip 22 emerges through the diffuser 4.

Figure 3 shows is a schematic diagram of the lighting device 100 according to the present invention in an assembled state, wherein a section of the lamp tube is respectively cut off from the two end regions, so as to clearly show the internal structure of the lighting device 100. There is no additional holding structure for the assembly inside the lamp tube 1 in said lighting device 100, while the assembly inside the lamp tube 1 including the diffuser 4 is fixed inside the lamp tube 1 just through the diffuser 4.

The above is merely preferred embodiments of the present invention but not to limit the present invention. For the person skilled in the art, the present invention may have various alterations and changes. Any alterations, equivalent substitutions, improvements, within the spirit and principle of the present invention, should be covered in the protection scope of the present invention.

List of reference signs

1	lamp tube
2	light engine
21	circuit board
5 22	LED chip
3	end cap
4	diffuser
5	heat sink
100	lighting device

Patent claims

1. A lighting device (100) comprising: a lamp tube (1) having two open ends; a light engine (2) arranged in the
5 lamp tube (1); a carrier supporting the light engine (2); and two end caps (3) closing the open ends, characterized in that the lighting device (100) further comprises a diffuser (4), the carrier supporting the light engine (2) is held on the diffuser (4), and the diffuser
10 (4) is held on the inner wall of the lamp tube (1).
2. The lighting device (100) according to Claim 1, characterized in that the diffuser (4) is configured to be elastic and rests on the inner wall of the lamp tube (1) in a predetermined stress.
- 15 3. The lighting device (100) according to Claim 2, characterized in that the diffuser (4) is a tubular structure formed by bending an elastic plate-shaped part.
4. The lighting device (100) according to Claim 3, characterized in that the diffuser (4) extends over the whole
20 longitudinal length of the lamp tube (1).
5. The lighting device (100) according to any one of Claims 1 to 4, characterized in that the lamp tube (1) is a glass tube.
6. The lighting device (100) according to any one of Claims
25 1 to 4, characterized in that the carrier is a heat sink (5).
7. The lighting device (100) according to Claim 6, characterized in that the heat sink (5) is fixed on the dif-

fuser (4).

8. The lighting device (100) according to Claim 7, characterized in that the light engine (2) includes a circuit board (21) and at least one LED chip (22) arranged on
5 the circuit board (21).

9. The lighting device (100) according to Claim 8, characterized in that the circuit board (21) extends over the whole longitudinal length of the lamp tube (1).

10. The lighting device (100) according to Claim 8, characterized in that the light engine (2) is arranged in a space defined by the heat sink (5) and the diffuser (4),
10 so that light emitted by the LED chip (22) emerges through the diffuser (4).

11. The lighting device (100) according to any one of Claims
15 1 to 4, characterized in that the diffuser (4) includes a plate-shaped base body, which is made of a transparent and elastic material.

12. The lighting device (100) according to Claim 11, characterized in that the material is PC or PET material.

20 13. The lighting device (100) according to Claim 11, characterized in that a microstructure is formed on the surface of the plate-shaped base body, and the microstructure is configured to enable light that emerges through the diffuser (4) to have uniform light distribution performance.
25

14. The lighting device (100) according to Claim 11, characterized in that a diffusant is added to the material

forming the plate-shaped base body, so that emergent light through the diffuser (4) has uniform light distribution performance.

15. The lighting device (100) according to any one of Claims
5 1 to 4, characterized in that a pin (31) for insertion into a socket is formed on the end cap (3), wherein the pin (31) is in electrical connection with the light engine (2) through a lead (32).
16. The lighting device (100) according to Claim 15, characterized in that the end cap (31) is made of an insulating material.
10
17. The lighting device (100) according to any one of Claims 1 to 4, characterized in that the lighting device (100) is configured as a T5, T8, and T10 retrofit lamp.

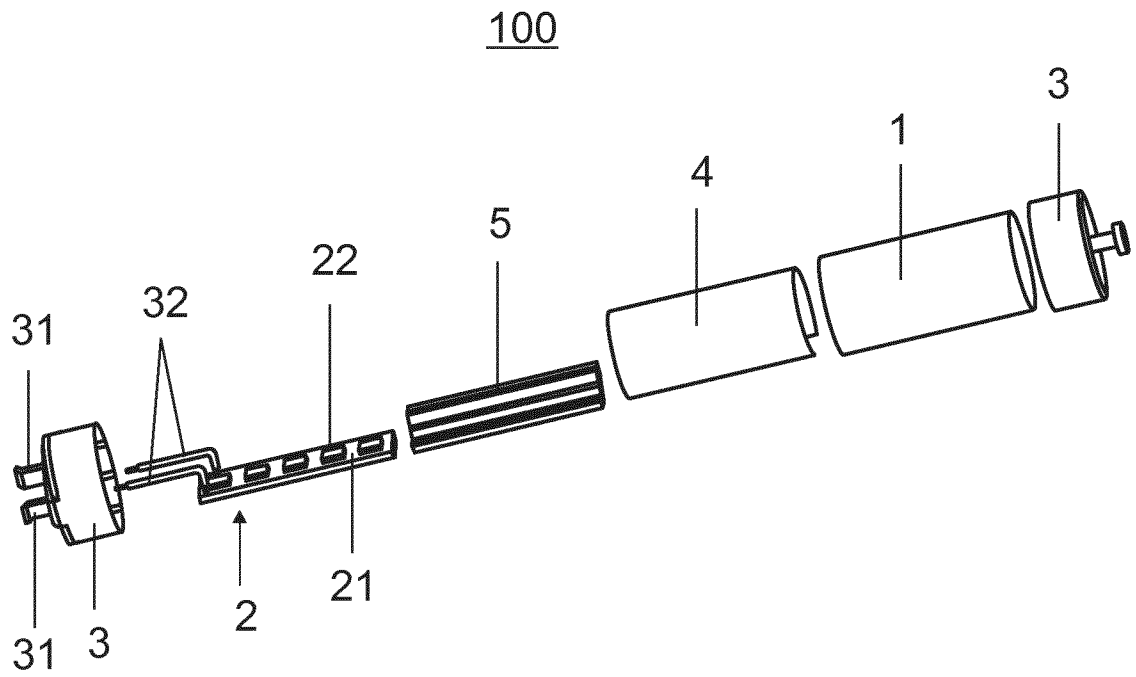


Figure 1

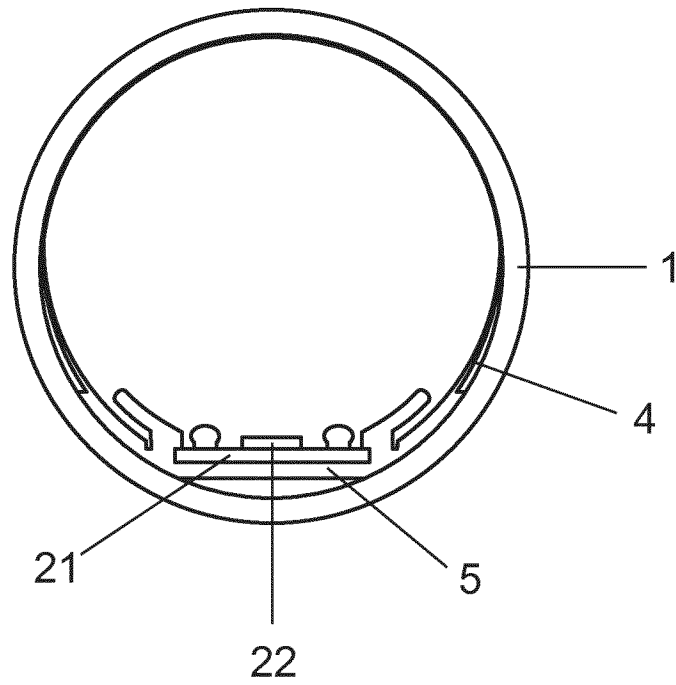


Figure 2

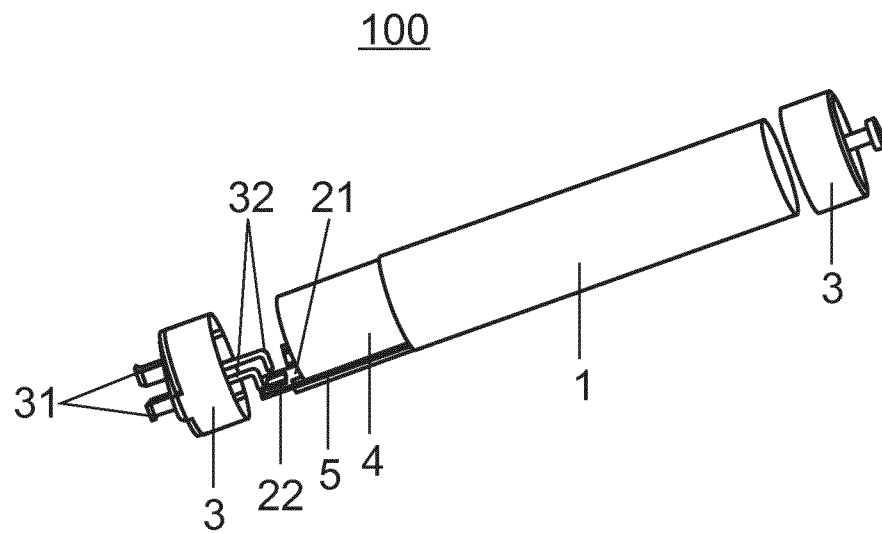


Figure 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2014/052936

A. CLASSIFICATION OF SUBJECT MATTER

INV. F21K99/00 F21V3/04 F21V17/16
ADD. F21Y101/02 F21Y103/00 F21V29/00 F21S4/00

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)

F21K F21V F21S

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 practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"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

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15 April 2014

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Dinkla, Remko

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2014/052936

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2012/001645 A1 (KONINKL PHILIPS ELECTRONICS NV [NL]; HIKMET RIFAT ATA MUSTAFA [NL]; KR) 5 January 2012 (2012-01-05) page 9, line 4 - line 14 figure 9 -----	1,5, 14-17
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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