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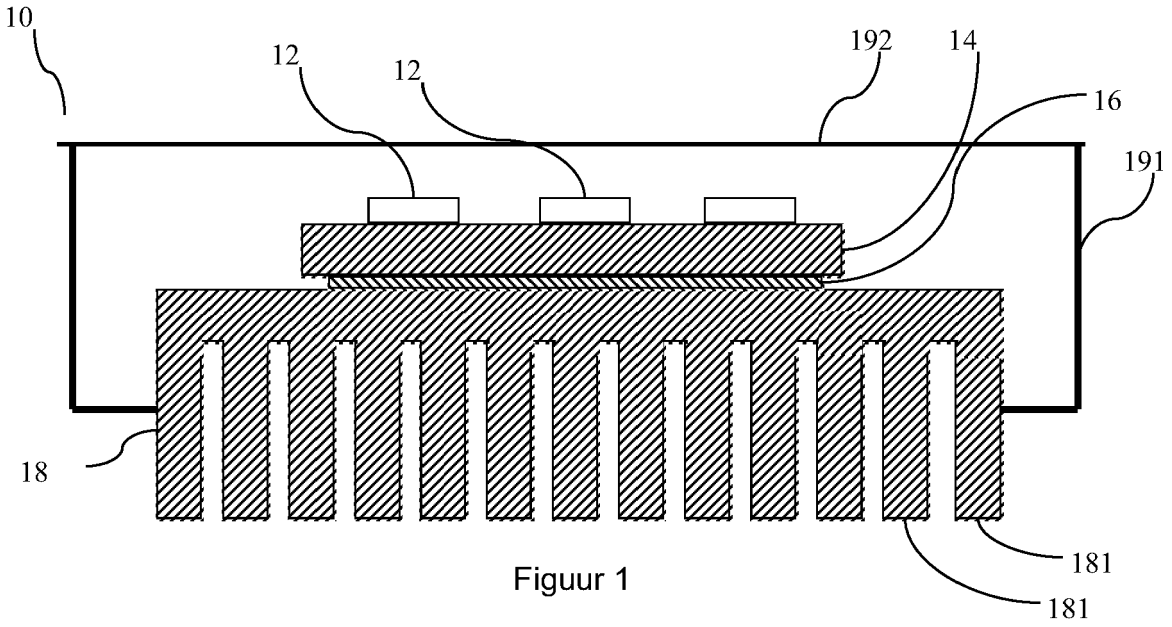
(54) **Luminaire, in particular for LED lighting**

(57) The present invention relates to a luminaire (10), in particular for Light Emitting Diode (LED) lighting, comprising a support (14) having a first side and a second side, a heat sink (18) which is in heat-exchanging contact with the first side of the support, at least one LED element (12) placed on the second side of the support, wherein the luminaire (10) further comprises a thermally conductive mat (16) disposed between the first side of the support (14) and the heat sink (18).

The present invention further relates to a unit comprising a heat sink (18), a thermally conductive mat (16) and a support (14), which support (14) comprises at least one LED element (12), wherein said unit is designed for use in a luminaire (10) as described above.



Figuur 1

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Description

[0001] The present invention relates to a luminaire, in particular for LED lighting, comprising a support having a first side and a second side, a heat sink which is in heat-exchanging contact with the first side of the support, and at least one LED element placed on the support on the second side thereof.

[0002] Such a known luminaire is disclosed in WO 2010/051985 A2.

[0003] Such a luminaire generally accommodates a group of LED elements, with the number of LED elements partially determining the light output of the luminaire.

[0004] LED elements exist in various sizes and embodiments; they can be soldered to the support via legs or connection contacts. In addition to that, the LED elements may also be mounted on the support by means of a Surface Mounted Device (SMD) technique. The construction of the LED elements is such that most LED elements comprise, in addition to the semiconductor LED, a reflector or a lens by means of which the aperture angle of the light from the LED can be determined.

[0005] The use of LEDs has several advantages over conventional light sources, such as incandescent lamps and discharge lamps. LEDs have a longer life, for example, and they are more energy-efficient than such conventional light sources.

[0006] A problem of the use of LEDs is that relatively much heat is generated during use. Said heat has a negative effect on the light output, which rapidly decreases if the heat is not properly dissipated. Poor thermal regulation will also result in a shorter life of the LED. To reduce this effect, measures need to be taken for realising rapid and efficient dissipation of the generated heat. Many LED luminaires, such as the LED luminaire disclosed in WO 2010/105985 A2, for example, to that end comprise a heat sink, which is preferably provided with cooling fins.

[0007] In the case of LED elements which are used in luminaires for generating a high light output, in particular if use is made of high-power LED elements, the above-described heat regulation problem is even more manifest.

[0008] In order to realise a good mechanical and thermal connection between the LED elements and the heat sink, use is generally made of a thermally conductive glue.

[0009] The use of such a thermally conductive glue has the drawback that hazardous substances are released in use due to the generation of heat. Said substances constitute a health hazard and have a negative effect on the LED elements, which are affected by said glue. Because of this, a long life and a high light output can no longer be guaranteed.

[0010] Another drawback of the use of glue is that it results in a stiff construction, because the glue is rigid after curing. Temperature changes due to the generation of heat by the LED elements causes the various parts of the luminaire to expand and shrink. This leads to a deteriorated contact surface between, for example, the heat sink and the support, resulting in a decreased dissipation of heat to the heat sink. This may lead to an unacceptable increase of the temperature of the LED elements, so that there is an increased risk of defects and the degradation process of the LED elements is accelerated.

[0011] Accordingly, it is an object of the present invention to provide a luminaire in which the heat is efficiently dissipated in use without the attendant drawbacks as described above.

[0012] In order to accomplish that object, a luminaire according to the present invention is **characterised in that** the luminaire further comprises a thermally conductive mat disposed between the first side of the support and the heat sink.

[0013] It is an advantage of the luminaire according to the present invention that the use the thermally conductive mat obviates the need to glue the support provided with LED elements to the cooling fin block. Since practically no harmful substances are released, at least in use, if the thermally conductive mat is used, the use of said mat is safer than the use of glue. The use of the thermal mat does not have an adverse effect on the heat dissipating capacity of the luminaire; the heat is dissipated in an efficient manner by the thermally conductive mat.

[0014] In addition to that, this aspect has resulted in a simpler production process. The heat sink may be provided with such a thermally conductive mat in advance, whereupon the support provided with the LED elements can be placed on the heat sink.

[0015] In another embodiment, the thermally conductive mat extends over the entire area of the first side of the support.

[0016] A thermally conductive mat that extends over the entire area of the support has the advantage that in this way a larger contact area between the support and the mat is obtained. Said larger contact area leads to a reduced total thermal resistance of the mat, so that the mat can dissipate a larger amount of heat to the heat sink.

[0017] In another embodiment, the housing of the luminaire comprises clamping means for clampingly accommodating the thermally conductive mat between the support and the heat sink.

[0018] In order to prevent the occurrence of play between the parts, the luminaire is provided with clamping means. Said clamping means cause the support to be pressed against the heat sink with a certain pressure so as to prevent the occurrence of play between the two parts and retain an optimum heat transfer.

[0019] If the luminaire is provided with such clamping means and the thermally conductive mat comprises a compressible material, the effect of the clamping means is enhanced. Said clamping means can press the support partially into the thermally conductive mat in that case, so that at least a large part of the play between the parts can be compensated. Depending on the different coefficients of expansion and the generation of heat in the luminaire, a specific thickness of the compressible ther-

mal mat can be selected. Major variations in the coefficients of expansion and a major generation of heat lead to a maximum amount of play between the parts. A thick compressible thermal mat into which the support is pressed by the clamping means can compensate for said variation, because the support can be pressed into the mat to an extent greater than that to which play can occur as a result of the generation of heat.

[0020] In specific embodiments, the clamping means form part of the luminaire.

[0021] The advantage of a luminaire in which the clamping means form part of the luminaire is that it leads to a simpler construction of the luminaire. The clamping means no longer need to be provided separately, but form part of the luminaire. As a result, the luminaire clamps the support against the heat sink, so that the thermally conductive mat is clamped therebetween.

[0022] In another embodiment, the LED element comprises an optical element for bundling the light from the LED element.

[0023] The use of such an optical element has the advantage that it makes it possible to form a more efficient light beam. The exit aperture and the angle at which the light exits the luminaire can be determined by the optical element.

[0024] The optical element can be configured so that it can be connected to the luminaire. As a result, the optical element presses against the support and the thermally conductive mat is clamped between the heat sink or on one side and the support provided with the optical element on the other side. The optical element is in that case the part in the luminaire which provides the clamping engagement of the thermally conductive mat.

[0025] The optical element is configured as a reflector or as a lens, for example. Preferably, the optical element is a convergent, divergent or collimator lens for generating the desired light beam.

[0026] In another embodiment, the luminaire further comprises an exit window arranged for clampingly accommodating the at least one optical element, the support and the thermally conductive mat between the exit window and the heat sink.

[0027] The function of the exit window is at least twofold. Thus, the window functions to close the luminaire, with the light being able to exit the luminaire at the location of the window. The window is to that end provided with a light-transmitting material, at least at the location of the LED elements / optical elements. The advantage of the use of such a window is that the parts in the luminaire, such as the support and the LED elements, are screened from moisture and dirt.

[0028] In another function, the exit window forms part of the luminaire, such that this leads to a simpler construction of the luminaire. By placing the exit window against the optical elements, the thermally conductive mat can be clamped between the support and the heat sink. The exit window exerts a pressure on the optical elements, causing them to press against the support, as a result of which the support presses against the heat sink, resulting in the clamping engagement of the thermally conductive mat that is present therebetween. An adequate heat transfer from the support to the heat sink is thus ensured.

[0029] Another advantage of the exit window is that it makes it possible to configure the luminaire as a module. The heat sink can function as part of the housing in that case. Subsequently, the thermally conductive mat is placed on the heat sink. On said mat the support provided with LED elements is placed, with the optical elements being placed on top of that. The whole is closed with the exit window in such a manner that the parts are clamped down and the occurrence of play between the parts is prevented.

[0030] In another embodiment, the thermally conductive mat comprises a material which is at least substantially electrically insulating.

[0031] Such a luminaire has the advantage that the addition of the electrically insulating, thermally conductive mat provides an additional insulation layer between the support and the heat sink. Because of the presence of said additional insulation layer, the electrical circuit is better insulated and a safer installation is obtained. As a result, the luminaire can be classified in a higher insulation class than in the situation in which such a thermally conductive, electrically insulating mat is not used.

[0032] Usually a support will be configured as a printed circuit board, on the upper side of which the LED elements are mounted as SMD parts. The use of an electrically insulating, thermally conductive mat has the additional advantage, however, that it is possible to use printed circuit boards which are provided with conductive tracks on the underside, being the side of the heat sink. The conductive tracks are insulated from the metal heat sink by the electrical insulation of the thermally conductive mat, so that short-circuits and breakdowns are prevented.

[0033] In another embodiment, the thermally conductive mat comprises a compressible material.

[0034] If the thermally conductive mat comprises a compressible material, this has the advantage that the compressibility of the thermally conductive mat compensates for the differences in the expansion of the various parts in the luminaire. The generation of heat may locally set up tension in the support or even cause the support to bend. As a result of said bending, the contact surface between the support and the heat sink is not even all over. Said unevennesses can be compensated by the compressible mat. This in contrast to an adhesive bond as used in the prior art, where the differences in the expansion of the various parts may lead to a stress in the adhesive bond such that failure of the rigid adhesive bond results. A decreased heat transfer will occur at the location of the failure, resulting in a deteriorated heat management in the luminaire housing. The thermally conductive mat may in particular comprise a polymer or a silicone material.

[0035] The thermally conductive mat that is used may also be built up of a multitude of layers, with the various layers performing different functions. Thus, an electrically conductive intermediate layer may be used, such as a copper or aluminium layer, which is screened, with a high thermal conduction, by outer layers made of an electrically insulating material having a high breakdown voltage, such as silicone, Teflon, rubber or glass fibre, for example.

[0036] In another embodiment, there is provided a unit comprising a heat sink, a thermally conductive mat and a support, wherein the support comprises at least one LED and wherein the unit is designed for use in a luminaire as described above.

[0037] The invention will now be explained in more detail with reference to a drawing, in which:

Figure 1 is a schematic view of a first embodiment of a luminaire according to the invention;
Figures 2, 3, 4 and 5 are views of further embodiments of a luminaire according to the invention.

[0038] For a better understanding of the invention, like parts shown in the various figures will be indicated by identical numerals in the description of the figures below.

[0039] Figure 1 shows a schematic view of a first luminaire 10 according to the invention. The luminaire 10 is made up of a wall portion 191 and a light exit portion 192, three LED elements 12, a support 14, a thermally conductive mat 16 and a heat sink 18.

[0040] The LED elements 12 are mounted on a first side of the support 14. In a practical embodiment, the support 14 will be configured as a printed circuit board. Such a printed circuit board is known from the prior art. The printed circuit board 14 is in thermal contact with the heat sink 18 for dissipating the heat being generated by the LED elements 12 from the luminaire 10. The heat sink 18 can subsequently deliver the heat to the environment via a multitude of cooling fins 181.

[0041] According to the invention, a thermally conductive mat 16 is disposed between the heat sink 18 and the printed circuit board 14. This obviates the need for an adhesive bond and thus eliminates all the inherent drawbacks thereof.

[0042] The thermally conductive mat 16 being used is composed of a non-rigid, elastic material, which is compressible. As a result, the thermally conductive mat 16 is stretchable in its longitudinal direction along the printed circuit board 14, accommodating to the shape of the printed circuit board 14. It can continue to do so also in the case of deformation of the printed circuit board due to the generation of heat in the luminaire 10. As a result, a large contact area between the printed circuit board 14 and the heat sink 18 is retained and an adequate heat regulation is ensured.

[0043] Since the thermally conductive mat 16 is elastic, it is compressible, thereby making it possible to compensate for any tolerance in a warped or uneven printed circuit board 14. At locations where the contact surface of the printed circuit board 14 locally comes nearer the heat sink, the mat is compressed further than at the locations where the printed circuit board 14 is further removed from the heat sink 18. As a result, the thermal contact between the printed circuit board 14 and the heat sink 18 is the same at all locations and an adequate heat management is realised.

[0044] In this figure and in the other figures, the heat sink 18 is configured as a cooling fin block. On said cooling fin block, the heat is delivered to the environment via a multitude of fins 181.

[0045] In this embodiment the whole is housed in a luminaire 10 consisting of a wall portion 191 and a light exit portion 192, through which the light from the LED elements can exit the housing. This is merely an example given by way of illustration, various luminaire housings are conceivable. In the luminaire 10 built up of wall portions 191 and the light exit portion 192, the heat sink 18 is partially disposed outside the luminaire so as to realise an adequate heat transfer to the environment. It is also possible, however, to enclose the whole of heat sink 18 with the thermally conductive mat 16, the printed circuit board 14 and the LED elements 12 in the luminaire 10. The heat sink 18, the thermally conductive mat 16, the printed circuit board 14 and the LED elements 12 jointly form a lighting module. In a practical embodiment, a multitude of such lighting modules are present within the luminaire 10.

[0046] In a practical embodiment, the printed circuit board 14 consists of an epoxy board, on the first side of which the LED elements 12 are mounted as SMD elements. Such printed circuit boards are known and are available in various embodiments thereof.

[0047] Figure 2 shows a schematic view of a luminaire 20, in which the electrically conductive mat 16 extends over the entire area of the printed circuit board 14. The advantage of this is that a maximum contact area is obtained, so that a maximum amount of heat can be dissipated from the printed circuit board 14 to the heat sink 18.

[0048] In the schematic view of a luminaire 30 shown in figure 3, a number of additional elements are shown to have been added. The luminaire 30 is provided with clamping means, an exit window 34 and several optical elements 32.

[0049] The exit window 34 is at least partially provided, at the location of the optical elements 32, with a transparent material, such as glass, for example, or a hard transparent plastic material. The light generated in the LED elements 12 can in that case exit the luminaire 30 through the exit window 34, possibly via the optical elements 32.

[0050] The exit window 34 has in addition to that another function. The fact is that the exit window may also be placed directly on the LED elements 12. The exit window 34 must be made of a material that is resistant to heat (to a limited extent), however, for example a heat-resistant glass. The exit window 34 may also be placed

directly on or over the optical elements 32.

[0051] The exit window 34 can be pressed against the optical elements 32, as shown in figure 3, by the clamping means 36. The optical elements 32 thus press against the LED elements 12 and/or the printed circuit board 14, which are thus pressed into the thermally conductive mat 16, resulting in a good mechanical contact between the support and the heat sink 18. In fact, the optical elements 32, the LED elements 12, the printed circuit board 14 and the thermally conductive mat 16 are all clamped between the exit window 34 and the heat sink 18. The clamping means 36 may further be configured as a screw so as to make it possible to adjust the amount of pressure between the exit window 34 and the heat sink 18.

[0052] In said figure 3, the heat sink 18, the clamping means 36, the side wall portion 191 and the exit window 34 jointly form the luminaire housing 30. A separate housing is not directly necessary, therefore, since the whore of the parts is enclosed by the heat sink 18, the clamping means 36, the side wall portion 191 and the exit window 34. It is also possible, however, to place the unit of parts in a luminaire that encloses the whole. For luminaires where a high light output is required, several units can be placed in a luminaire so as to thus realise a large light output.

[0053] In figure 4, the pressure means 42 are provided in the luminaire 40 in such a manner that they press the printed circuit board 14 directly against the heat sink 18. This obviates the need to use the optical elements 32 and the exit window 34 as such, at least for pressing the printed circuit board against the heat sink 18. The optical elements also function to generate a light beam, however, and in the absence of said optical elements 32 the LED elements 12 will be provided with a lens so as to have the LED elements 12 generate a light beam. The LED elements 12 thus have essentially built-in optical elements.

[0054] In this figure the pressure means 42 are configured so that they press the support against the heat sink 18. It is also possible, however, for the printed circuit board 14 to be provided with pre-drilled holes, so that a screw can be screwed into the heat sink 18.

[0055] Figure 5 shows an embodiment of a luminaire 50 according to the invention in which the heat sink 18 forms the larger part of the luminaire. The heat sink 18 is made of a block of metal; it is recessed on the opposite side of the cooling fins 181.

[0056] Said recessed portion accommodates several elements. The whole is closed by the exit window 34 and the pressure means 52, which are provided in the heat sink 18 as a screw in this embodiment so as to thus realise a pressure of the exit window 34 on the optical elements 32, by which the support 14 with the LED elements 12 can be pressed into the thermally conductive layer.

[0057] The various parts of the luminaire 50 are essentially built up in layers, with the exit window 34 functioning to close the luminaire. The thermally conductive mat 16 is larger than the area of the printed circuit board 14 in this embodiment. As a result, the entire contact area of the printed circuit board 14 will be in contact with the thermally conductive mat 16 at all times.

Claims

1. A luminaire, in particular for LED lighting, comprising a support having a first side and a second side;
a heat sink which is in heat-exchanging contact with the first side of the support; and
at least one LED element placed on the second side of the support, **characterised in that** the luminaire further comprises a thermally conductive mat disposed between the first side of the support and the heat sink.

2. A luminaire according to claim 1, **characterised in that** the thermally conductive mat extends over the entire surface of the first side of the support.

3. A luminaire according to any one or more of the preceding claims, **characterised in that** the housing of the luminaire comprises clamping means for clamping the thermally conductive mat between the support and the heat sink.

4. A luminaire according to claim 3, **characterised in that** said clamping means form part of the luminaire.

5. A luminaire according to any one or more of the preceding claims, **characterised in that** the LED element comprises an optical element for bundling the light from the LED element.

6. A luminaire according to claim 5, **characterised in that** the luminaire further comprises an exit window arranged for clamping the at least one optical element, the support and the thermally conductive mat between the exit window and the heat sink.

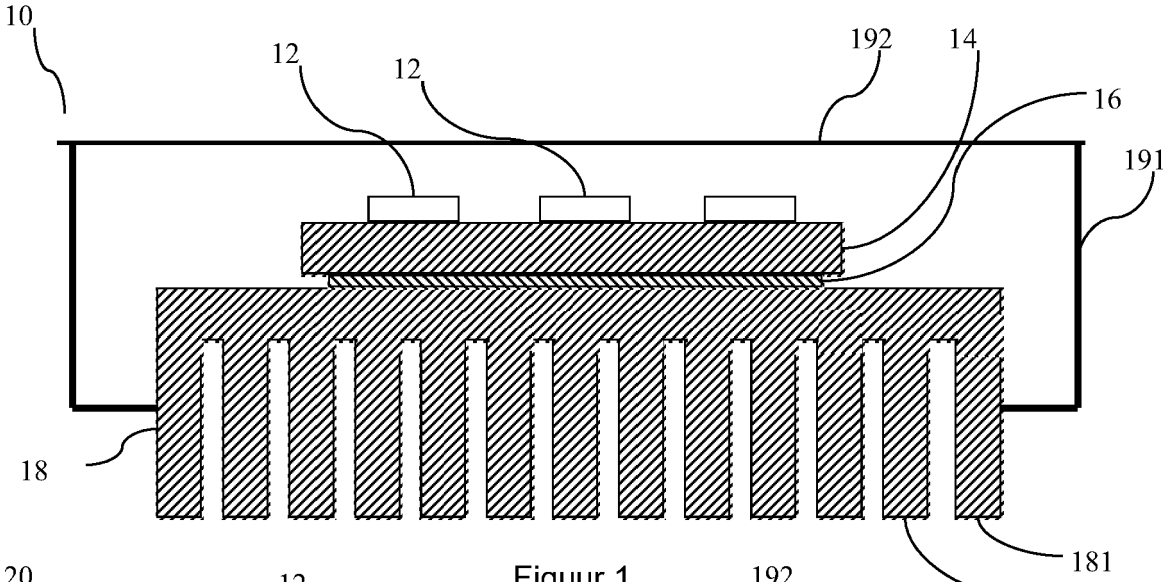
7. A luminaire according to any one or more of the preceding claims, **characterised in that** the thermally conductive mat comprises a material which is at least substantially electrically insulating.

8. A luminaire according to any one or more of the preceding claims, **characterised in that** the thermally conductive mat comprises a compressible material.

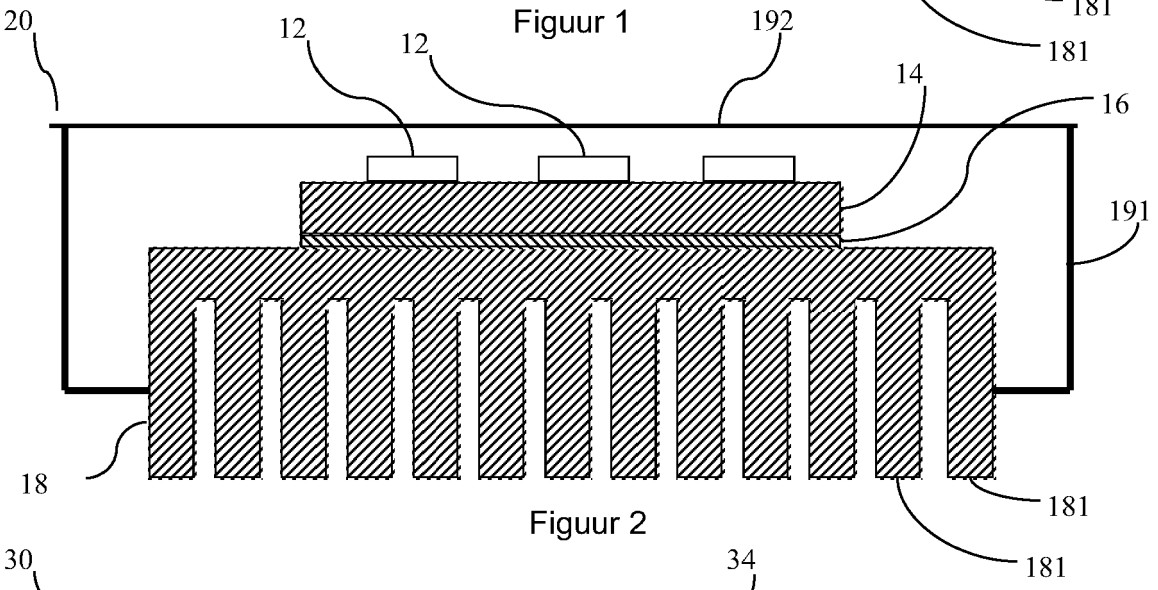
9. A luminaire according to claim 8, **characterised in that** the thermally conductive mat comprises a polymer and in particular a silicone material.

10. A unit comprising a heat sink, a thermally conductive mat and a support, which support comprises at least one LED element, wherein the unit is arranged for a luminaire according to any one or more of the pre-

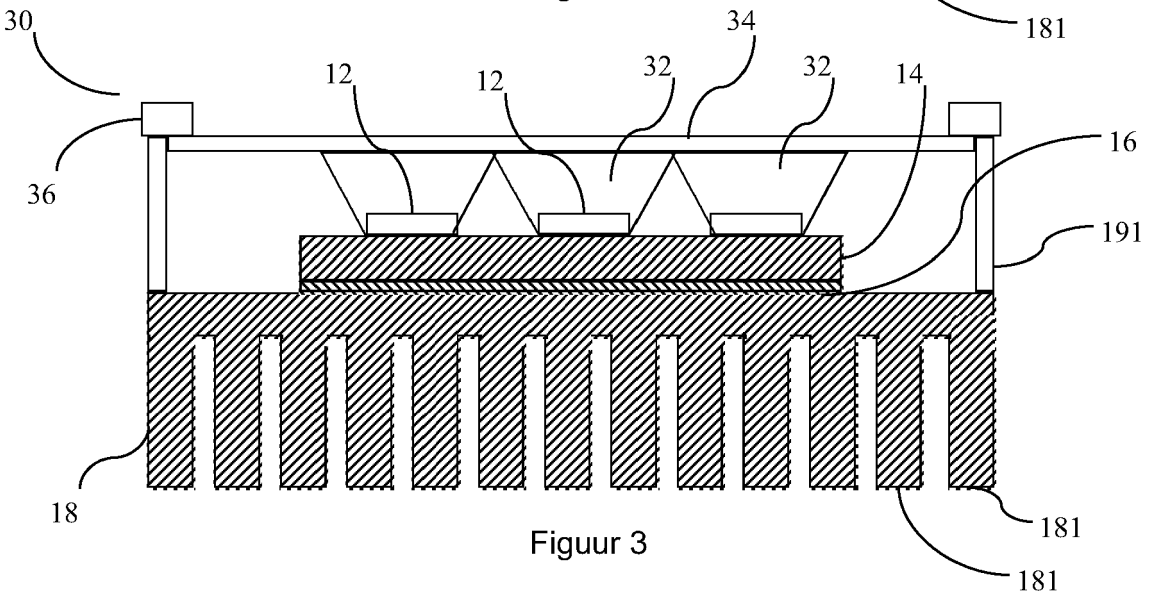
ceding claims.



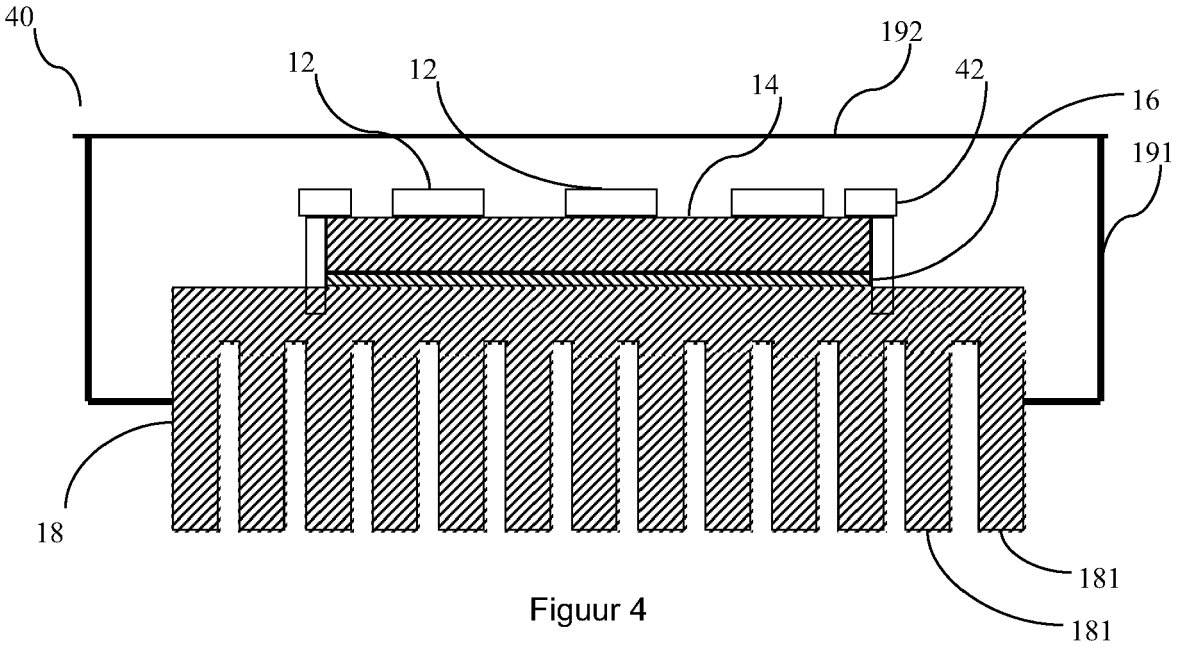
Figuur 1



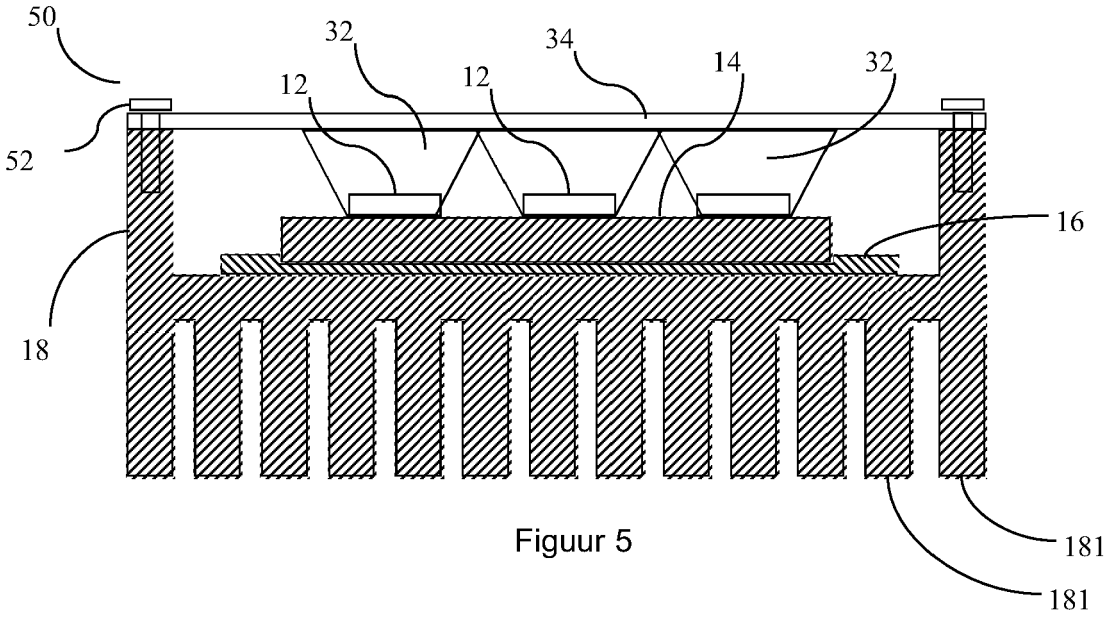
Figuur 2



Figuur 3



Figuur 4



Figuur 5

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EUROPEAN SEARCH REPORT

Application Number
EP 12 15 4278

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	US 2010/220476 A1 (KUO CHENG-HSIUNG [TW] ET AL) 2 September 2010 (2010-09-02) * paragraph [0022] * * figure 1 *	1,2,4-10 3	INV. F21V29/00 F21K99/00
X	US 2010/008085 A1 (IVEY JOHN [US] ET AL) 14 January 2010 (2010-01-14) * paragraph [0026] * * figure 2 *	1-10	
Y A	DE 20 2008 006325 U1 (COOLER MASTER CO LTD [TW]) 17 July 2008 (2008-07-17) * figure 3 *	3 1	

TECHNICAL FIELDS SEARCHED (IPC)
F21V
F21K

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	22 May 2012	Amerongen, Wim

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22-05-2012

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2010220476 A1	02-09-2010	TW M367290 U	21-10-2009
		US 2010220476 A1	02-09-2010
US 2010008085 A1	14-01-2010	US 2010008085 A1	14-01-2010
		US 2011235321 A1	29-09-2011
		WO 2010005796 A2	14-01-2010
DE 202008006325 U1	17-07-2008	DE 202008006325 U1	17-07-2008
		TW M332793 U	21-05-2008
		US 2009135613 A1	28-05-2009

EPO FORM P0459

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Patent documents cited in the description

- WO 2010051985 A2 **[0002]**
- WO 2010105985 A2 **[0006]**