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(54) **Title**: CASING FOR ELECTRONIC EQUIPMENT WITH AN INTEGRATED HEAT SINK

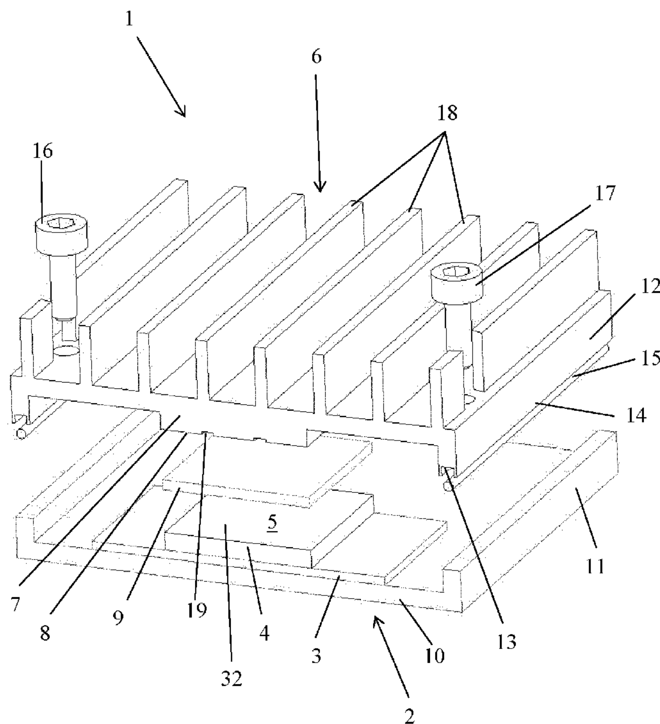

Fig. 1

(57) Abstract: A casing (1) for electronic equipment comprising a base (2) arranged for attachment of at least one printed circuit board (3) with at least one component in a component casing (4) which is to be cooled is described. The casing (1) also comprises a cover (6) which is to be fastened to the base (2) to cover the printed circuit board (3) and which comprises a heat sink (7) having a contact surface (8), defining a contact plane, arranged to be facing and arranged to be parallel to the component casing (4) to be cooled, and to be in contact with a thermally conductive gap filler (9) arranged on the component casing (4). The contact surface (8) of the heat sink (7) is structured.

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CASING FOR ELECTRONIC EQUIPMENT WITH AN INTEGRATED HEAT SINK

Technical field

The present invention relates to a casing for electronic equipment comprising a base arranged
5 for attachment of at least one printed circuit board with at least one component in a component casing which is to be cooled, and a cover, which is to be fastened to the base over the printed circuit board and which comprises a heat sink for cooling of a component casing on the printed circuit board. Primarily the present invention relates to a casing for electronic equipment which is arranged for outdoor placement.

10 **Background of the invention**

Heat sinks are used for cooling purposes in different applications such as, e.g., in cooling of electronic components arranged in component casings on printed circuit boards (PCB). The heat sink is usually arranged on the component casing with a thermally conductive gap filler between the component casing and the heat sink. In order to provide a sufficient thermal
15 contact between the component casing and the heat sink the heat sink has to be pressed against the component casing. In indoor applications the force pressing the heat sink on the component casing is usually provided by means of a spring. In outdoor applications the printed circuit board is usually arranged on a base plate and the heat sink integrated in a cover which is screwed onto the base plate. The cover may be an internal cover or an external cover.
20 In the first case the cover is arranged to lead the heat from the heat sink to the base plate and further to an external cover. In both instances the external cover is preferably arranged with cooling fins.

As stated above the heat sink has to be pressed against the component casing in order to get a sufficient thermal contact. The cover and possibly also the base plate usually comprise side
25 walls. The cover is arranged to be screwed onto the base plate so that walls on the cover comes into contact with the base plate. Thus the distance between the heat sink and the base plate depends on the height of the walls of the cover and the walls of the base plate. The total height of the PCB, the component casing and the thermally conductive gap filler should be slightly greater than the distance between the base plate and the heat sink to provide a suitable
30 compression of the thermally conductive gap filler. However, due to the tolerances in manufacture of the base plate and the cover and due to the tolerances in the mounting of the

PCB on the base plate it is difficult to achieve the appropriate relationship between the heights. This may result in the breakage of the component casing when the height of the walls of the cover and/or the base plate are to low in relation to the total height of the PCB, the component casing and the thermally conductive gap filler. Alternatively it may result in inferior thermal contact between the heat sink and the component casing when the walls of the cover and/or the base plate are to high in relation to the total height of the PCB, the component casing and the thermally conductive gap filler.

Summary of the invention

The object of the present invention is to provide a casing with a heat sink device which casing is an alternative to the casings of the prior art.

Another object of the present invention is to provide a casing with a heat sink device which at least partly solves one of the problems with the prior art.

A further object of the present invention is to provide a casing with an integrated heat sink for contact with a component casing with which the problem with an excessive pressure on the component casing is alleviated.

At least one of these objects is provided with a casing for electronic equipment according to the present invention. The casing comprises a base arranged for attachment of at least one printed circuit board with at least one component in a component casing which is to be cooled and which comprises a top surface. The casing also comprises a cover, which is to be fastened to the base over the printed circuit board and which comprises a heat sink having a contact surface, defining a contact plane, arranged to be facing and arranged to be essentially parallel to the top surface of the component casing to be cooled, and to be in contact with a thermally conductive gap filler arranged on the component casing. The casing is characterised in that the contact surface of the heat sink is structured.

By having a structured contact surface only a the highest part of the contact surface will initially come into contact with the thermally conductive gap filler when the cover is moved downwards towards the base during attachment of the cover on the base. Thus the compression force on the component casing will be lower than would have been the case if the contact surface was flat. During the downward movement of the heat sink the material in

the thermally conductive gap filler may expand into the grooves in the structured contact surface. Thus, for a certain downward movement of the heat sink from the initial contact the total compression of the thermally conductive gap filler is less than it would have been if the contact surface was flat. This leads to a lower force on the component casing compared to the case with a flat contact surface.

The contact surface may have the form of flat surfaces with grooves between the flat surfaces. This is a form that relatively easily may be manufactured in many different ways. It is for example possible to mold the cover with the heat sink. Alternatively, the cover with the heat sink may be manufactured using a combination of molding and machining.

The flat surfaces are may be in a common plane. This provides for an even compression over the entire surface. It is possible to vary the height over the surface in order to vary the force over the surface of the component casing.

The flat surfaces may have an essentially circular shape. Also other shapes are possible. An advantage of having a circular shape of the flat surfaces is that this provides for a smooth variation of the force on the thermally conductive gap filler when the heat sink is forced into the thermally conductive gap filler.

Alternatively, the flat surfaces may have an essentially square shape. Such a shape is easily manufactured by machining.

The walls of the grooves between the flat surfaces may be straight and may also be essentially perpendicular to the flat surfaces. Such walls are easily be machined. However, it might be desirable to have a curvature on the walls in order to achieve the optimal compression of the thermally conductive gap filler.

The cover may be arranged as an outer cover or as an internal cover. In the latter case the cover is in contact with the base and an outer cover is also attached to the base.

The outer cover may be provided with cooling fins in order to increase the cooling of the casing.

The casing may be made of an aluminium alloy. Aluminium has a high heat conductivity, a low density and is corrosion resistant making it suitable for application as casing for outdoor applications.

The distance perpendicular to the contact surface between the highest and lowest point of the
5 structure is preferably adapted to the thickness of the thermally conductive gap filler but preferably is in the interval 0,1-10 mm.

The lowest point of the structure defines a first plane which is parallel to the contact plane and the highest point of the structure defines a second plane which is parallel to the contact plane, wherein the area of the contact surface and the distance between the first plane and the second
10 plane define a structure volume, and wherein at least 50 % of the structure volume is constituted by the material of the heat sink and the rest of the structure volume is void. This has proven to be a suitable volume in order to provide a good thermal contact between the component casing and the heat sink while simultaneously providing a low compressive force on the component casing. Also, suitably no more than 90 % of the structure volume is
15 constituted by the material of the heat sink and the rest of the structure volume is void.

Further advantages of the invention will be apparent from the following detailed description.

Brief description of the drawings

The appended drawings are intended to clarify and explain different embodiments of the
20 present invention in which:

Fig. 1 shows a schematic view of a casing with a heat sink device according to the invention in an exploded view.

Fig. 2 shows in cross section the casing of Fig. 1 with the cover screwed onto the base.

Fig. 3a is a perspective view of the heat sink in Fig. 1 with a contact surface according to a
25 first embodiment of the present invention.

Fig. 3b shows the heat sink in Fig. 3a in cross section.

Fig. 4a shows a heat sink according to a second embodiment of the present invention.

Fig. 4b shows the heat sink in Fig. 4a in cross section.

Fig. 5a shows a heat sink according to a third embodiment of the present invention.

Fig. 5b shows the heat sink in Fig. 5a in cross section.

Fig. 6 shows a casing according to an alternative embodiment with the heat sink arranged on
5 an inner cover.

Fig. 7 is a view from below of a cover according to an embodiment of the present invention.

Detailed description of embodiments of the invention

In the following description of preferred embodiments of the invention similar features will be denoted with the same reference numeral. It is to be noted that the drawings are not drawn to
10 scale.

Fig. 1 shows in cross section an exploded view of a casing 1 for electronic equipment and a base 2 arranged for attachment of at least one printed circuit board 3 with at least one component in a component casing 4 which is to be cooled. The component casing 4 has an essentially flat top surface 5. The casing 1 also comprises a cover 6, which is to be fastened to
15 the base 2 to cover the printed circuit board 3 and which comprises a heat sink 7 having a contact surface 8 arranged to be facing the component casing 4 to be cooled and to be in contact with a thermally conductive gap filler 9 arranged on the top surface 5 of the component casing 4. The component casing is characterised in that the contact surface 8 of the heat sink 7 is structured. As is seen in Fig. 1 the base has a bottom 10. Side walls 11 rise
20 from the bottom 10 at the edges of the bottom 10. Corresponding side walls 12 extend from the cover 6 and are arranged to mate with the side walls 11 of the bottom 10. A groove 13 is arranged at the edge 14 of the side walls 12 of the cover 6. A gasket 15 is arranged in the groove 13 at the edge 14. Screws 16, 17, are arranged through the cover 6 and are arranged to be screwed into the base 2 in order to attach the cover 6 to the base 2. The cover 6 functions
25 as an outer cover with cooling fins 18 arranged on the cover to provide cooling of the cover 6 and thus also the heat sink. The contact surface 8 of the heat sink is structured and comprises grooves 19. The casing is preferably made of an aluminium alloy which has a good thermal conductance.

Fig. 2 shows in cross section the casing with the cover 6 screwed onto the base 2. The heat sink 7 is in contact with the thermally conductive gap filler 9, which has been compressed between the heat sink 7 and the component casing 4. Also the gasket 15 has been compressed between the side walls 11 of the base and the side walls 12 of the cover 6. The compression of
5 the thermally conductive gap filler 9 depends on the total height of the side walls 11 of the bottom 10 and the side walls 12 of the cover 6, the distance between the contact surface 8 of the heat sink 7 and the top surface of the component casing 4, the thickness of the thermally conductive gap filler 9 and the structure of the contact surface 8 of the heat sink. The force on the top surface of the component casing 4 depends on the elasticity and the compression of
10 the thermally conductive gap filler 9. The structure of the contact surface means that the thermally conductive gap filler may expand into the spaces of the structure when it is subjected to a pressure from the heat sink. Alternatively or additionally only partial areas of the thermally conductive gap filler 9 have to be compressed when being subjected to the pressure from the heat sink.

15 Fig. 3a is a perspective view of the heat sink 7 with the contact surface 8 according to a first embodiment of the present invention. Fig. 3b shows the heat sink in cross section. The structure of the contact surface shown in Fig. 3 is similar to curved pyramides with smooth valleys between. The lowest point of the structure defines a first plane 20 (Fig. 3b) which is parallel to and in the shown embodiment coincides with the contact plane. The highest point
20 of the structure defines a second plane 21 (Fig. 3b) which is parallel to the contact plane and thus also the first plane 20. The area of the contact surface and the distance between the first plane 20 and the second plane 21 define a structure volume. Preferably at least 50 % of the structure volume is constituted by the aluminium alloy to achieve a good contact between the heat sink and the thermally conducting gap filler 9. As much as 95 % of the structure volume
25 may be constituted by the aluminium alloy. The area is defined by the length L and the width W of the heat sink in case of a rectangular heat sink as in the embodiment of Fig. 3a.

Fig. 4a and 4b show a heat sink according to a second embodiment of the present invention. The structure of the contact surface 25 is in the form of flat surfaces 22 surrounded by rounded slopes 23 down to a flat bottom 24. The grooves are constituted by the slopes and the
30 flat bottom 24. The flat bottom define a first plane 20 The flat surfaces 22 are all in a common second plane 21.

Fig. 5a and 5b show a heat sink according to a third embodiment of the present invention. The structure of the contact surface 8 comprises a number of cylindrical mesas 26 each having a flat top surface 22. The mesas extend from an essentially flat bottom defining a first plane 20. The flat top surfaces 22 all are in a common second plane 21. The walls 31 of the grooves between the flat surfaces extend essentially perpendicular to the flat surfaces and are thus straight.

The distance perpendicular to the contact surface between the highest and the lowest point of the structure is in the interval 0,1-10 mm and is adapted to the thickness of the thermally conductive gap filler 9.

Fig. 6 shows a casing according to an alternative embodiment of the present invention in which the heat sink 7 is arranged on an inner cover 28 which is in contact with the bottom 10 of the base 2. The casing also comprises an outer cover 29 with cooling fins 18. Also the base is provided with cooling fins 18. The reference numerals refer to the features described in Fig. 1 and 2.

Fig. 7 is a view from below of a cover 6 according to an embodiment of the present invention. The heat sink 7 comprises a contact surface 8 with a structure in the form of square mesas 27 having square flat top surfaces 30.

The present invention is not limited to the embodiments described above, but also relates to and incorporates all embodiments within the scope of the appended independent claim. Thus, it is possible to combine features from the embodiments described above as long as the combinations are possible.

The thermally conductive gap filler may be silicone based gap filler such as a ceramic filled silicone sheet, a boron nitride filled silicone sheet, a reinforced boron nitride filled silicone sheet, or any equivalent material. Such thermally conductive gap fillers are provided for example by Laird Technologies.

CLAIMS

1. A casing (1) for electronic equipment comprising a base (2) arranged for attachment of at least one printed circuit board (3) with at least one component in a component casing (4) which is to be cooled and which comprises a top surface (5), and a cover (6), which is to be fastened to the base (2) over the printed circuit board (3) and which comprises a heat sink (7) having a contact surface (8), defining a contact plane, arranged to be facing and arranged to be essentially parallel to the top surface (5) of the component casing (4) to be cooled, and to be in contact with a thermally conductive gap filler (9) arranged on the component casing (4), **characterised in** that the contact surface (8) of the heat sink (7) is structured.

2. The casing (1) according to claim 1, wherein the contact surface (8) has the form of flat surfaces (22) with grooves (19) between the flat surfaces.

3. The casing (1) according to claim 2, wherein the flat surfaces (22) are in a common plane (21).

4. The casing according to claim 2, wherein the flat surfaces (22) have an essentially circular shape.

5. The casing according to claim 2, wherein the flat surfaces (30) have an essentially square shape.

6. The casing according to any claim 1, wherein the walls of the grooves (19) between the flat surfaces (22, 30) are straight.

7. The casing according to claim 6, wherein the walls (31) of the grooves (19) are essentially perpendicular to the flat surfaces (22, 30).

8. The casing according to claim 1, wherein the cover (6) is arranged as an outer cover.

9. The casing according to claim 8, wherein the cover (6) is provided with cooling fins (18).

10. The casing according to claim 1, wherein the casing (1) is made of an aluminium alloy.

11. The casing according to claim 1, wherein the distance essentially perpendicular to the contact surface (8) between the highest and lowest point of the structure is in the interval 0,1-10 mm.

12. The casing according to claim 1 or 11, wherein the lowest point of the structure defines a first plane (20) which is parallel to the contact plane and the highest point of the structure defines a second plane (21) which is parallel to the contact plane, wherein the area of the contact surface (8) and the distance between the first plane (20) and the second plane (21) define a structure volume, and wherein at least 50 % of the structure volume is constituted by the material of the heat sink (7) and the rest of the structure volume is void.

13. The casing according to claim 12, wherein the no more than 90 % of the structure volume is constituted by the material of the heat sink (7) and the rest of the structure volume is void.

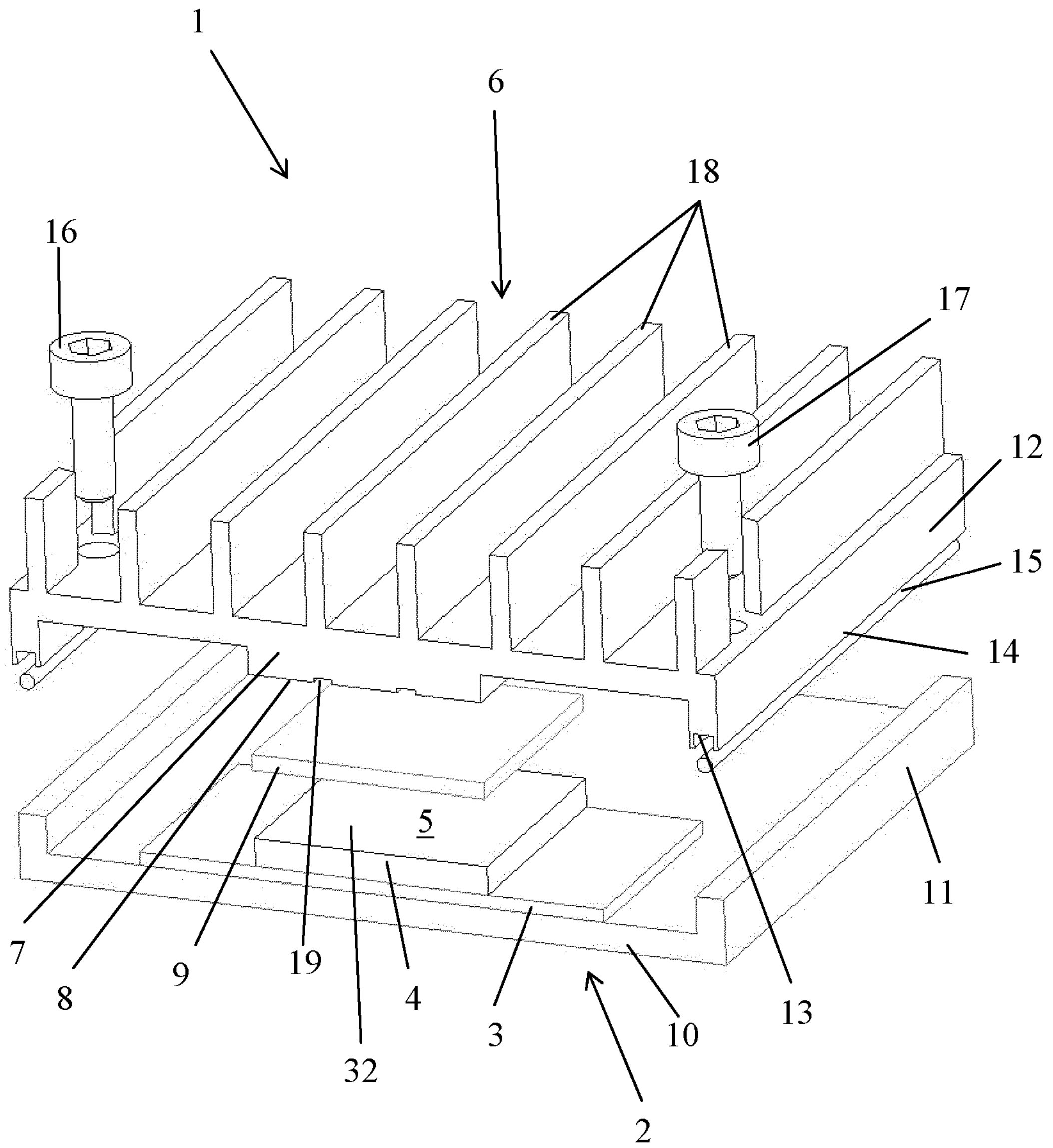

Fig. 1

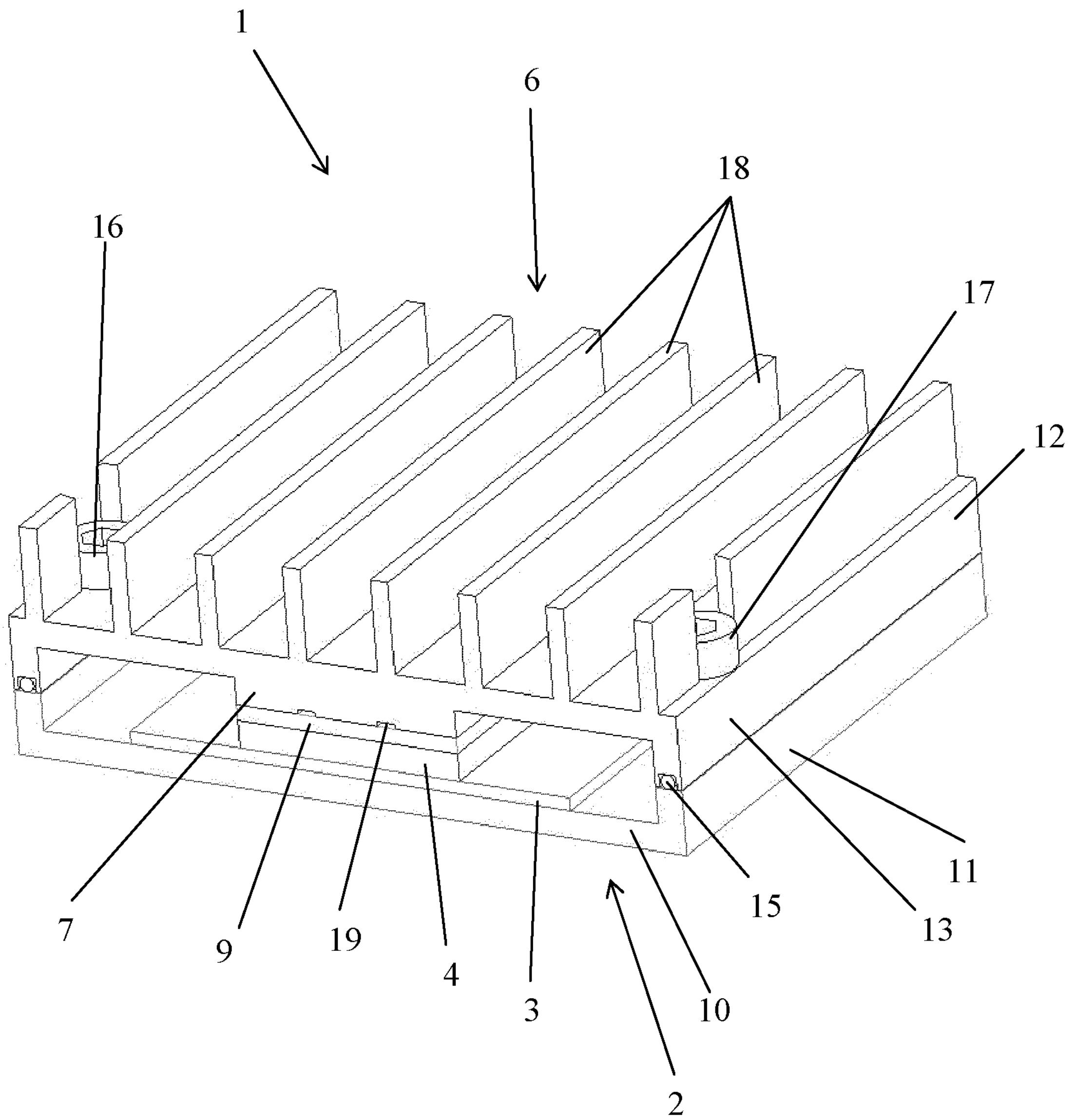

Fig. 2

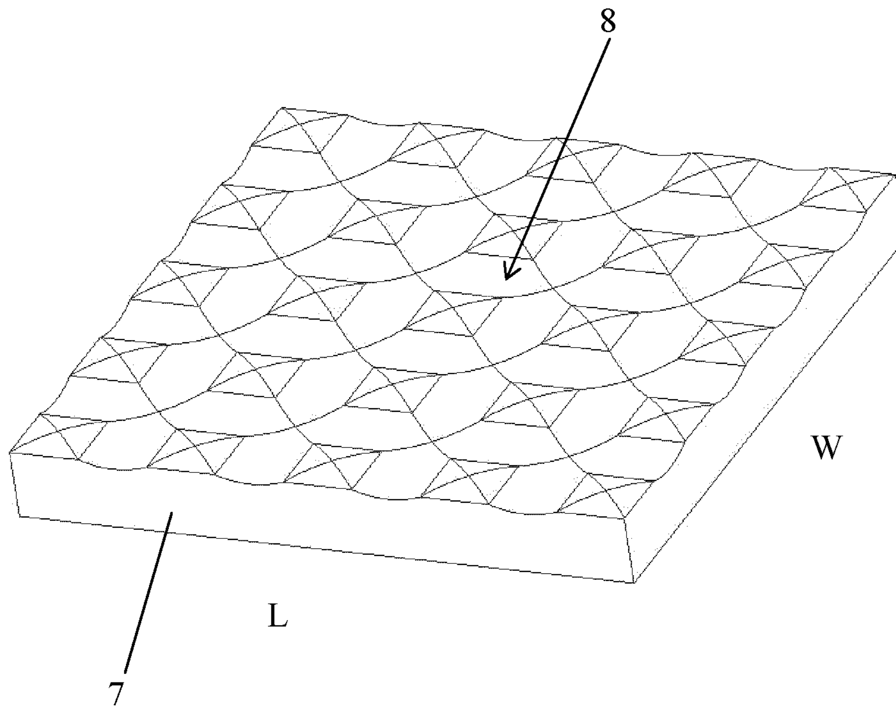

Fig. 3a

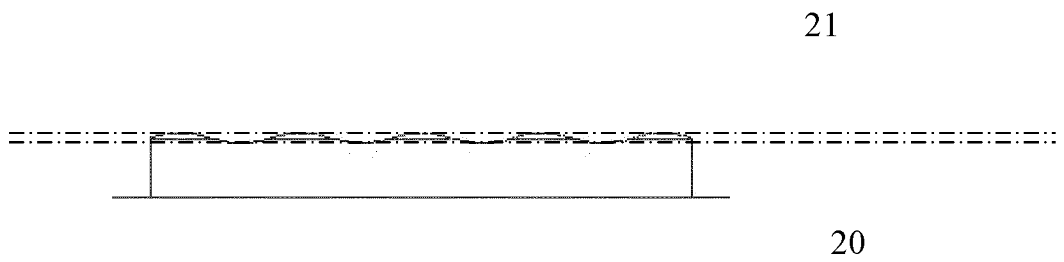

Fig. 3b

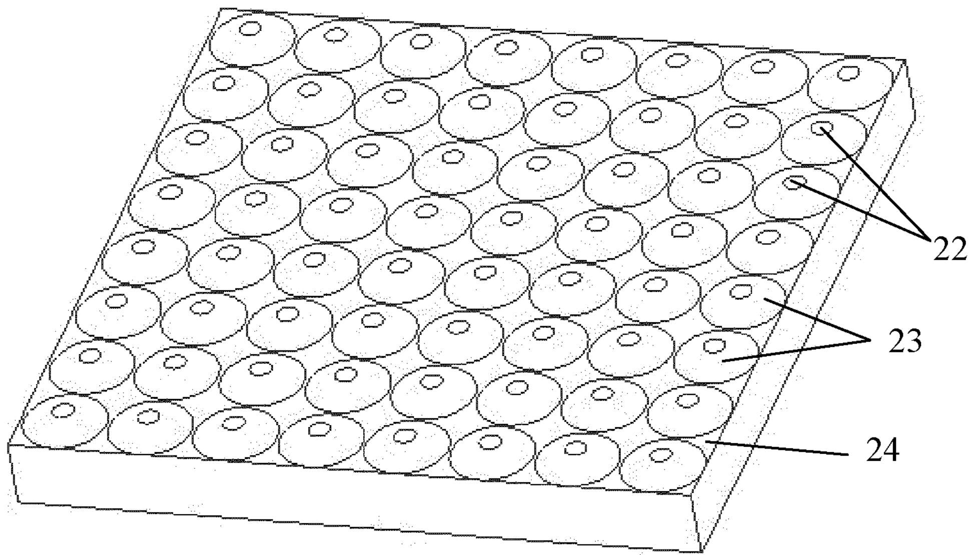

Fig. 4a

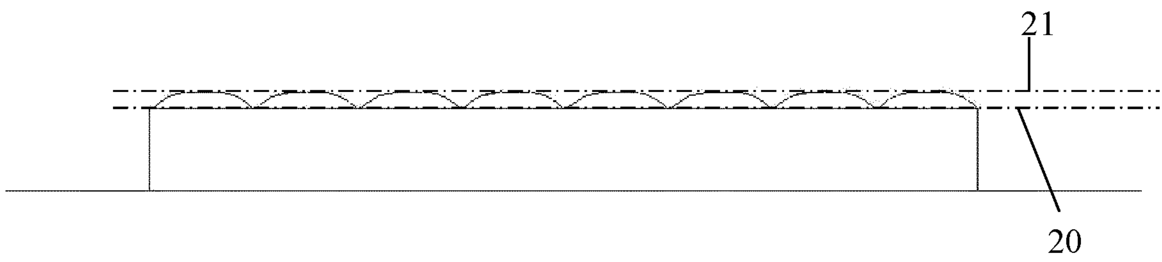

Fig. 4b

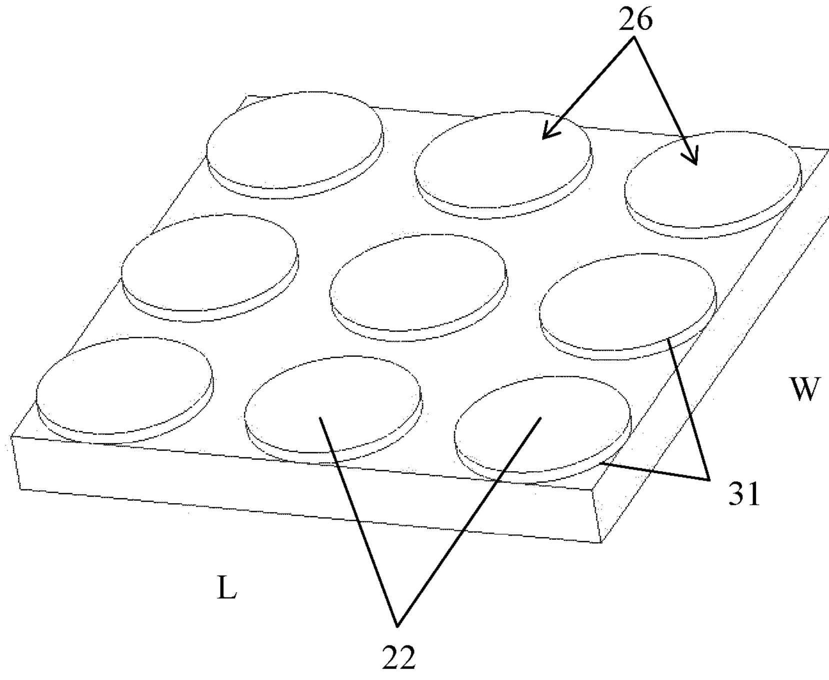

Fig. 5a

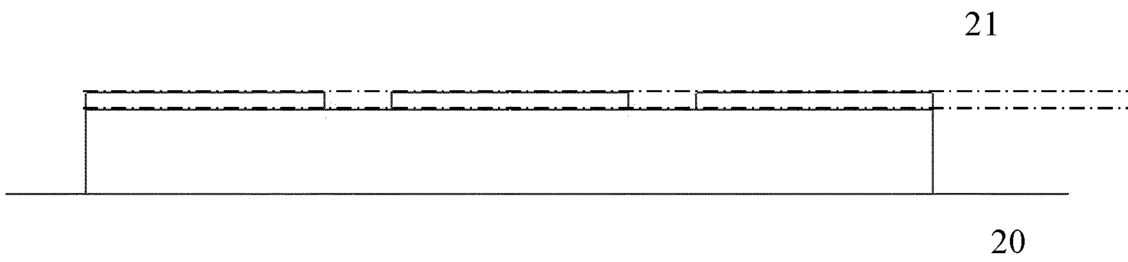

Fig. 5b

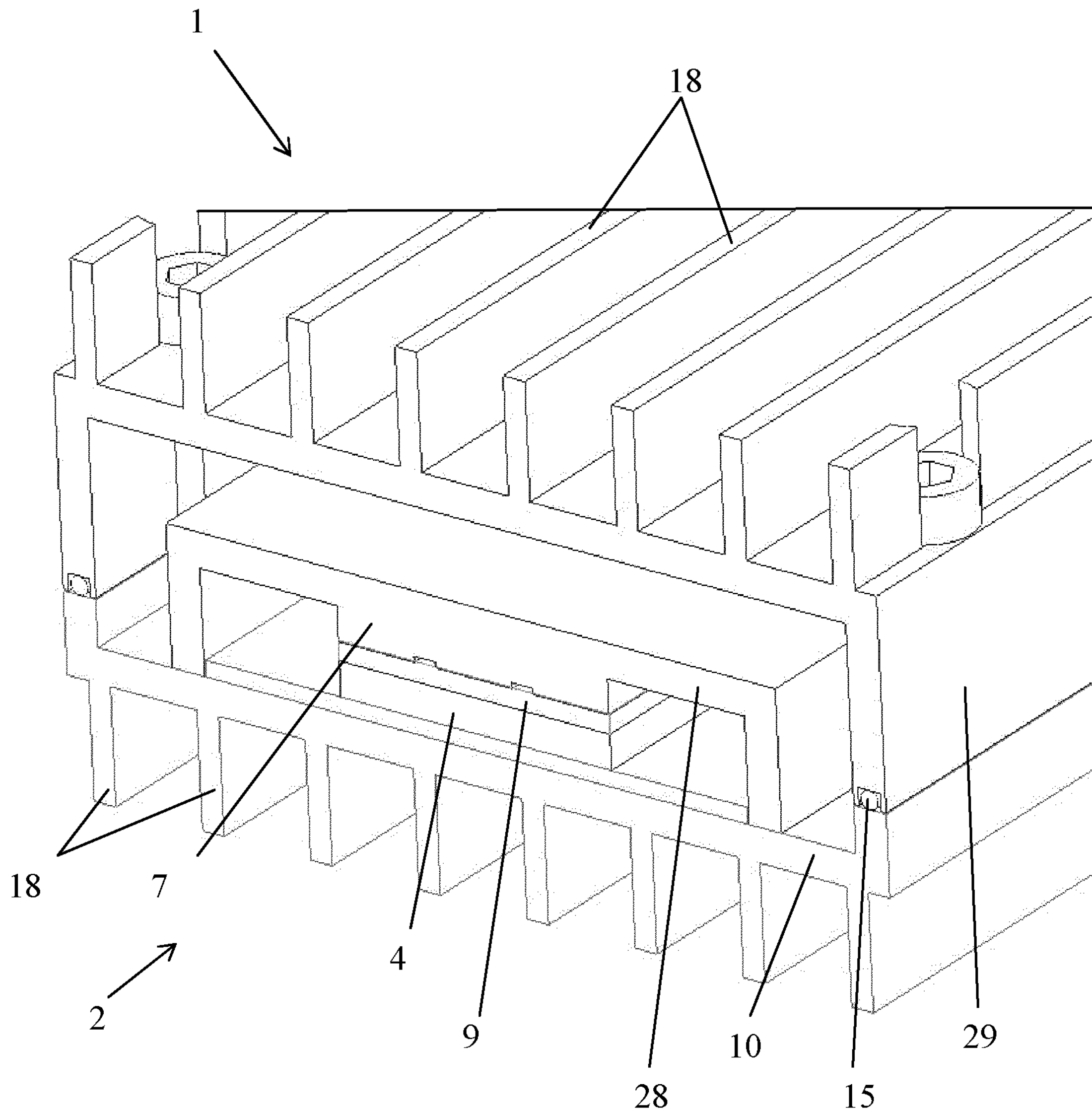

Fig. 6

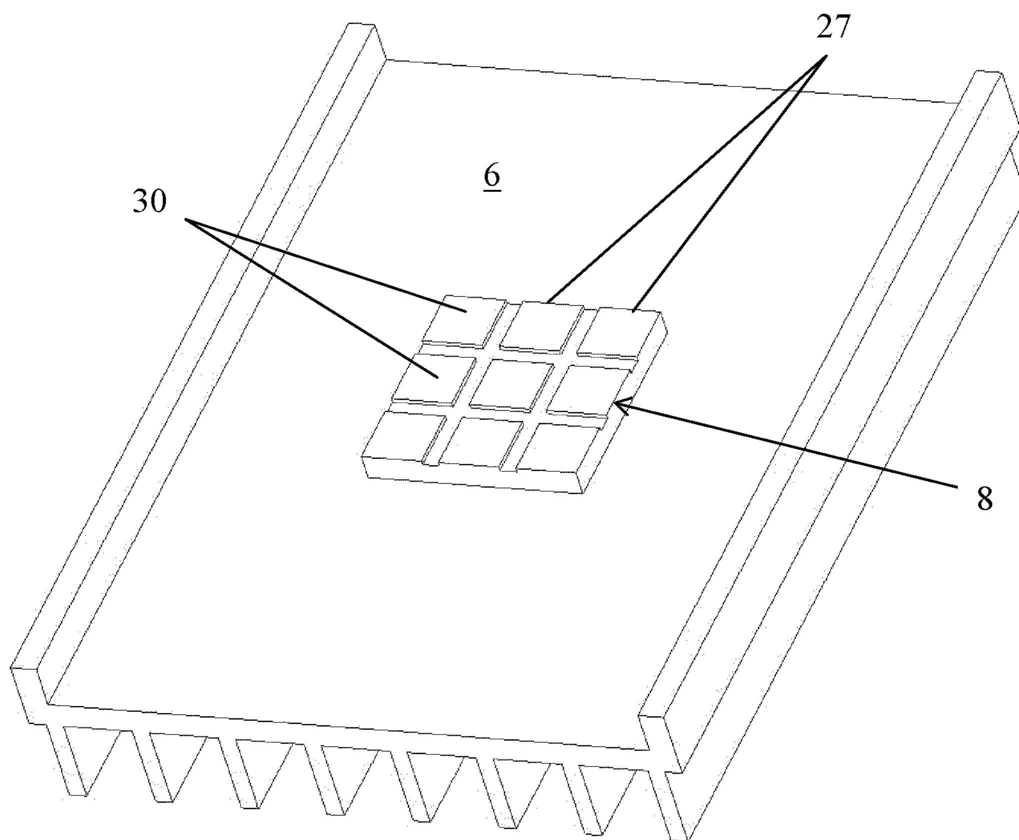

Fig. 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/052075

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01L23/42 H01L23/367
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)
H01L

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	US 2006/215369 A1 (OHASHI YASUSHI [JP] ET AL) 28 September 2006 (2006-09-28) paragraphs [0020] - [0026], [0032]; figures 1,5	1-13
X	US 6 821 816 B1 (LAWLYES DANIEL A [US]) 23 November 2004 (2004-11-23) column 2, line 53 - column 3, line 42; figures 1,2	1
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A	JP 2000 196269 A (TOSHIBA CORP) 14 July 2000 (2000-07-14) abstract; figure 5	1

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 October 2012	19/10/2012

Name and mailing address of the ISA/
European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
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Fax: (+31-70) 340-3016

Authorized officer
Zeisler, Peter

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/052075

C(Continuation). 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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INTERNATIONAL SEARCH REPORT

Information on patent family members

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