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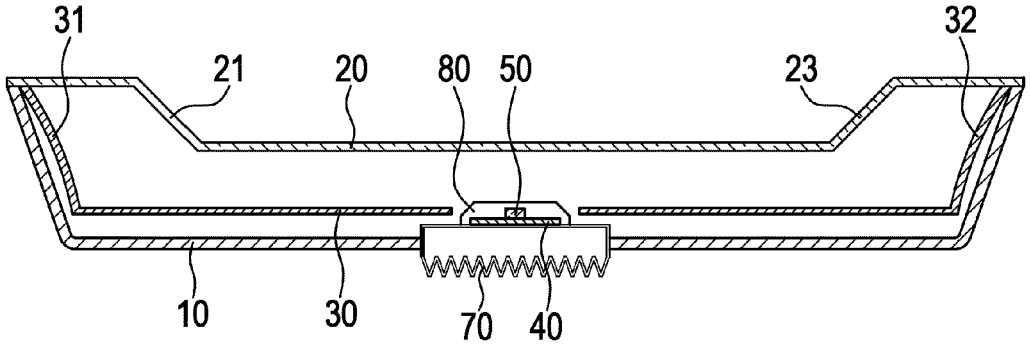
Remarks:
•The references to the drawing(s) no. 11-14 are deemed to be deleted (Rule 56(4) EPC).
•Amended claims in accordance with Rule 137(2) EPC.

## (54) LED ceiling light

(57) A LED ceiling light is disclosed. It comprises a housing (10) covered by a lens (20). The lens has a planar section holding optical structures, parallel to a planar reflector (30) within the housing. A plurality of LEDs (50) is mounted within the housing recessed against the reflector. Light emitted by the LEDs is at least partially reflected by the lens towards the reflector and reflected back to a different section of the lens, passing the lens to the outside. Therefore, the light output ratio will be increased. There are further side reflectors for limiting radiation to the sides of the lamp.

**Fig. 1**




EP 2 587 118 A1

## Description

### Field of the invention

**[0001]** The invention relates to a LED-based lighting component and to an assembly method of such a component. It specifically relates to a ceiling light having a reflector and a lens.

### Description of the related art

**[0002]** LED lighting systems offer significant advantages over traditional incandescent, HID and fluorescent lamps. LEDs are of smaller size, offer higher reliability, longer operational life and lower energy consumption. However, there are specific requirements when using LEDs. As increased operating temperature significantly reduces lifetime, cooling is of high importance. Furthermore, most LED chips are approximately isotropic light sources with a lambertian light distribution, which must be adapted to specific requirements of a lighting system.

**[0003]** In the German utility patent application DE 20 2008 017 182 U1 a LED lamp is shown. Each LED is located within an individual mirror producing a parallel bundle of light. This light is radiated to a large lens, which is further deflecting the light into the required radiation pattern. This embodiment is comparatively complex, as it requires individual reflectors for each LED.

**[0004]** The European patent application publication EP 2 093 480 A2 discloses a vehicle lighting device, wherein the light emitted by a LED is deflected and shaped by a large solid lens. This embodiment is comparatively expensive, as it requires a large lens for each LED.

### Summary of the invention

**[0005]** The problem to be solved by the invention is to provide a LED ceiling light, which has a reduced mechanical and optical complexity and therefore can be manufactured in large volumes at reduced costs. Furthermore, the LED ceiling light should be adaptable to light distributions, which are required according to various standards for offices or other locations, where ceiling lights are used. In addition, the light output should be increased. Another aspect is to provide proper cooling of the LEDs to obtain increased lifetime and reliability.

**[0006]** Solutions of the problem are described in the independent claims. The dependent claims relate to further improvements of the invention.

**[0007]** The LED ceiling light has a housing holding all optical components including at least one LED and at least one lens. The lens furthermore covers at least part of the housing. The lens has an approximately planar shape with optical structures. These optical structures may be incorporated in the lens or at the outer side of the lens. The optical structures allow the reflection of light and/or penetration of light through lens and/or deflection of light during penetration. Approximately parallel to the lens and located under the lens is a reflector. The reflector also has an approximately planar shape. The reflector may be a metal plate or a metalized, metal, or at least reflecting part of the housing. The preferred distance between the lens and the reflector is in the range of 10 mm to 50 mm. At least one, preferably a plurality of LEDs are located under the lens and at least partially surrounded by the reflector. It is preferred, if the LEDs are recessed against the at least one reflector, thus having a slightly larger distance to the lens than the reflector. Accordingly is preferred, if no light from the LEDs can be radiated directly to the reflector. Instead, light emitted by the at least one LED is preferably radiated directly to the lens. Parts of the lens allow penetrating of the light and passing to an outside of the lamp, while other parts of the lens reflect the light to the reflector. The reflector reflects this light again back to a different location of the lens, there it can penetrate the lens to the outside of the lamp. There may be multiple reflections of light between the lens and reflector, before the light may penetrate the lens to the outside. This embodiment of the invention is a very simple mechanical design having a low number of parts. Anyway, it allows of a flexible design of the light distribution, specifically an even distribution over a larger area, without glare. Furthermore, the embodiment can easily be adapted to different radiation patterns by simply exchanging the lens and/or the cover. Another aspect of the invention is the distribution of light over a large surface of the lamp, thus reducing luminance while keeping luminous intensity constant and therefore reducing glare. It is preferred, if the lamp has a rectangular or square shape. In further embodiments the lamp may be circular or even elliptical, or may have any other form. By the invention, the light output ratio will be increased.

**[0008]** In a further embodiment, there is at least one side reflector, preferably two side reflectors. The side reflectors are preferably located at one or both sides of the reflector. The side reflectors reflect light from the LED, which either has previously been reflected by the lens and/or the reflector or is directly radiated to the side reflectors through the gap between the lens and the reflector. The side reflectors may have a planar shape, but preferably, they are concave or most preferably convex shaped. They may reflect light back to the reflector, but most preferably, they reflect light either through the lens or through a sidewall to the outside of the lamp. For covering the side reflectors at least one, preferably two or four sidewalls may be provided. Preferably, the sidewalls are attached to the lens. Most preferably, the lens and the sidewalls are made of one piece. Furthermore, the sidewalls may be connected to a frame, which allows mounting of the lens and the sidewalls by the frame to the housing. It is preferred, if the sidewalls are extending over the lens, thus resulting in a lens being recessed into the housing. This embodiment, specifically by using the side reflectors further reduces glare of the lamp and increases the radiation area, therefore decreasing luminance of the lamp. The side reflectors allow limiting the

radiation angle to the sides of the lamp but without reducing efficiency as they reflect light back and do not absorb it.

**Description of Drawings**

**[0009]** In the following, the invention will be described by way of example, without limitation of the general inventive concept, on examples of embodiment with reference to the drawings.

Figure 1 shows a preferred embodiment of the invention.

Figure 2 shows exemplary beams of light in the preferred embodiment.

Figure 3 shows a simplified embodiment.

Figure 4 shows exemplary beams of light.

Figure 5 shows details of the surface of the lens.

Figure 6 shows the arrangement of a plurality of LEDs.

Figure 7 shows individual LEDs and the barriers in between in detail.

Figure 8 shows a top view of a cover.

Figure 9 shows a bottom view of the cover.

Figures 10 to 14 show different embodiments of surface mounted reflectors.

**[0010]** In figure 1, a preferred embodiment according to the invention is shown in a sectional view. The ceiling light comprises a housing 10 and a lens 20, which also acts at least partially as a cover. The lens may also be part of a cover of the lamp. In general, the term lens herein refers to a body of transparent material. It preferably has at least one planar section and most preferably is a plate. It may have optical structures for deflecting light into desired directions. Preferably, the housing 10 and the lens 20 are made of plastic material. The housing contains at least one printed circuit board 40 with at least one LED 50. It furthermore has at least one base reflector. Preferably, the base reflector is planar. It is furthermore preferred, if the base reflector 30 has a section essentially parallel to the lens 20. Herein the base reflector is shown comprising two parts, although it may comprise only one part. It preferably is manufactured by punching or laser cutting a metal plate. Preferably, the base reflector may also comprise of two parts or even a higher number of parts forming essentially a plane.

**[0011]** Preferably, there is a first side reflector 31 at a first side of base reflector 30 and a second side reflector 32 at the second side of base reflector 30. The side reflectors allow further directing of the light and therefore further reduction of glare. The lens 20 is extended by a first sidewall 21 and second sidewall 23 allowing covering the side reflectors while keeping the distance between the lens 20 and the base reflector 30. Preferably, the sidewalls are of transparent material, most preferably they are made of the same material as lens 20. It is most preferred, if the sidewalls and the lens are one piece. Preferably, at least one of the side reflectors has a concave or preferably a convex shape. Furthermore, a barrier 80 may be provided for limiting radiation of LED 52 to its sides. Such or a similar barrier may be used in any embodiment shown herein.

**[0012]** Furthermore, the LED 50 may be recessed against the reflector. This results in that the at least one LED 50 cannot radiate directly to the surface of the reflector 30.

**[0013]** Generally, plastic materials have poor thermal conducting properties. To improve cooling of LEDs a heat sink 70 may be provided. The at least one LED 50 and/or the at least one printed circuit board 40 is preferably mounted to or at least in good thermal contact with heat sink 70. With heat sink is penetrating the housing 10 and/or has at least part outside of the housing 10 to transfer heat out of the housing 10.

**[0014]** Preferably, the lamp shown in this document is of a rectangular or square shape. Alternatively circular lamp may be continued by using one LED or a plurality of LEDs at the center of a round or circular reflector 30. In such an embodiment preferably, there is no barrier 80.

**[0015]** In figure 2 exemplary beams of light are shown in the preferred embodiment. A first beam of light 65 leaving LED 50 under an angle of about 0° is going straight through lens 20. Beam 63, which is emitted under a slightly larger angle by the LED, is reflected by optical structures of the lens into the direction of the base reflector 30. It is further reflected back by the base reflector towards lens 20 and leaves lens 20 to the outside. A further beam of light 66 leaving a LED 50 at an angle of about 45° penetrates lens 20 under a slight deflection. A beam of light 67 being emitted under a larger angle is reflected by lens 22 towards the first side reflector 31 and reflected thereby through the first sidewall 21. A beam of light 68 being emitted under a further enlarged angle is radiated directly to first side reflector 31 and propagates through sidewall 21 of lens 20.

**[0016]** In figure 3 a simplified embodiment is shown. This embodiment does not have the side reflectors 31, 32. Accordingly, it is more compact and has a flat structure. Due to the absence of the side reflectors, its flexibility in controlling radiation patterns is somewhat limited.

**[0017]** Figure 4 shows exemplary individual beams of light which are deflected depending upon their primary direction. A first beam of light 61 emitted by LED 50 under an angle of 0° may be directed immediately outwards of the lamp through lens 20. The same may happen to beams of light under small angles. For example beam

61 which is emitted under an angle of approximately 20° is deflected by optical structures (not shown here in detail) of the lens in a direction parallel to the first beam 60. Instead, it may also leave the lens 20 under the same angle of approximately 20°. Beam 63, which is emitted under a slightly larger angle by the LED, is reflected by optical structures of the lens into the direction of the base reflector 30. It is further reflected back by the base reflector towards lens 20 and leaves lens 20 to the outside. Beam 64 which leaves the LED in an angle of about 45° is also reflected by the lens towards the reflector and also reflected thereby back to the lens and leaving the lens straight through. Beam 62 is emitted under a further larger angle by the LED and is leaving the lens without further reflection. Beam 65, which comes under a comparatively large angle from the LED, is reflected by the lens towards the reflector and reflected back to the lens, leaving to the outside without further deflection. Circle 89 denotes a section which is later shown in more detail.

**[0018]** Figure 5 shows details of the surface of the lens, specifically section 89 from the previous figure. The lens has optical structures 81, 82, 83, 84 at its surface. The optical structures may be glued to the surface. It is preferred, if the structures and the lens are of one piece, most preferably one injection molded piece. The structures are for at least one of directing, deflecting and focusing of light. Herein as an exemplary embodiment wedge shaped structures are shown. The structures may extend over the whole length of the lens. A first beam of light 64 is reflected by structure 81 towards the base reflector (not shown here). The second light beam 62 is passing lens 20 without significant deflection. The same happens to light beam 63 coming from the base reflector. As there are different optical structures distributed over the surface, light may be deflected by the structures, while light may pass to the outside between the structures. This results in partial reflecting and partial passing of light. Dependent on the function optical structures 81, 82, 83 may either be at the inside of the lens (towards base reflector 30) and/or at the outside of the lens (structure 84).

**[0019]** In figure 6, the arrangement of a plurality of LEDs is shown. LEDs 50a, 50b, 50c, 50d are attached to the printed circuit board 40. The LEDs are separated by barriers 80a, 80b, 80c, 80d, 80e, preventing unwanted radiation and reducing glare into the directions from each LED to its neighbored barriers.

**[0020]** Figure 7 shows individual LEDs and the barriers in between in more detail. Between the LEDs 50a, 50b, 50c, 50d and 50e mounted to a printed circuit board 40, there are barriers 60a, 60b, 60c, 60d, 60e. Preferably the barriers are free form mirrors, having reflecting surfaces formed in such a way that radiation from each LED towards its neighboring LEDs is limited, therefore limiting glare of the lamp and directing light to the required radiation pattern.

**[0021]** In figure 8 shows a top view of a cover. This view shows the outside of a cover 90 bearing the lens 20. The lens 20 has at least a planar lens area surrounded by sidewalls 21- 24. A frame 91 may be provided as an extension of the sidewalls and for further attaching the cover to a housing. Outer optical structures 25, 26 are provided at the lens for deflecting light. These outer optical structures may extend over the length of the planar lens area. Preferably, they are wedge shaped. In this embodiment, the outer optical structures are located close to the center of the lens. They may also be located at different positions on the outer surface of the lens.

**[0022]** In figure 9 a bottom view of the cover is shown. This view shows the inner side of the cover 90 bearing the lens 20. The lens 20 is directed towards the reflector and the LEDs. The lens has a plain area 28 at its center. On both sides of this plain area, 28 there are inner optical structures 27, 29. In this embodiment, the inner optical structures 27, 29 and outer optical structures 25, 26 only partially overlap. They may also overlap completely or not at all. The inner optical structures may extend over the length of the planar lens area. Preferably, they are wedge shaped. In this embodiment, the inner optical structures are located close to the sidewalls of the lens. They may also be located at different positions on the outer surface of the lens.

**[0023]** Figure 10 shows the fully assembled lamp comprising of a housing 10 and the cover 90 bearing lens 20 attached thereto. It can be seen that the lens is a recessed over the outer frame of the lamp. The depth of the recess is defined by the required distance between the lens and the reflector under the lens as well as the height of the side reflectors.

**List of reference numerals**

**[0024]**

| | |
|---|---|
| 10 | housing |
| 20 | cover/lens |
| 21-24 | sidewalls |
| 25, 26 | outer optical structures |
| 27, 29 | inner optical structures |
| 28 | plain area |
| 30 | planar base reflector |
| 31 | first side reflector |
| 32 | second side reflector |
| 40 | printed circuit board |
| 50 | LED |
| 60-68 | light paths |
| 70 | heat sink |
| 80 | barriers |
| 81-84 | optical structures |
| 89 | section |
| 90 | cover |
| 91 | frame |

## Claims

**1.** LED ceiling light comprising at least

- a housing (10),
- a lens (20), covering at least part of the housing,
- at least one reflector (30),
- at least one LED (50),

**characterized in, that**
the at least one reflector (30) is planar and essentially parallel to the at least one lens (20).

**2.** LED ceiling light according to claim 1,
**characterized in, that**
the at least one LED (50) is a recessed against the at least one reflector (30).

**3.** LED ceiling light according to any one of the preceding claims, **characterized in, that**
the lens (20) has at least one optical structure (81-84) for deflecting light from the at least one LED.

**4.** LED ceiling light according to any one of the preceding claims, **characterized in, that**
the lens (20) has at least one optical structure (81-84) for reflecting light from the at least one LED back to the reflector.

**5.** LED ceiling light according to any one of the preceding claims, **characterized in, that**
the lens (20) has at least one section where light reflected by the reflector can pass to the outside.

**6.** LED ceiling light according to any one of the preceding claims, **characterized in, that**
at least one side reflector (31, 32) is provided at least one side of the base reflector (30).

**7.** LED ceiling light according to any one of the preceding claims, **characterized in, that**
the lens has sidewalls extending over the lens surface.

**8.** LED ceiling light according to any one of the preceding claims, **characterized in, that**
the lens is part of a cover.

**9.** LED ceiling light according to any one of the preceding claims, **characterized in, that**
the lens is recessed into the housing.

**Amended claims in accordance with Rule 137(2) EPC.**

**1.** LED ceiling light comprising at least

- a housing (10),
- a lens (20), covering at least part of the housing,
- at least one reflector (30),
- at least one LED (50),

wherein the at least one reflector (30) is planar and essentially parallel to the at least one lens (20)
**characterized in, that**
the lens (20) has at least one optical structure (81 - 84) for reflecting light from the at least one LED back to the reflector.

**2.** LED ceiling light according to claim 1,
**characterized in, that**
the at least one LED (50) is a recessed against the at least one reflector (30).

**3.** LED ceiling light according to any one of the preceding claims,
**characterized in, that**
the lens (20) has at least one optical structure (81-84) for deflecting light from the at least one LED.

**4.** LED ceiling light according to any one of the preceding claims,
**characterized in, that**
the lens (20) has at least one section where light reflected by the reflector can pass to the outside.

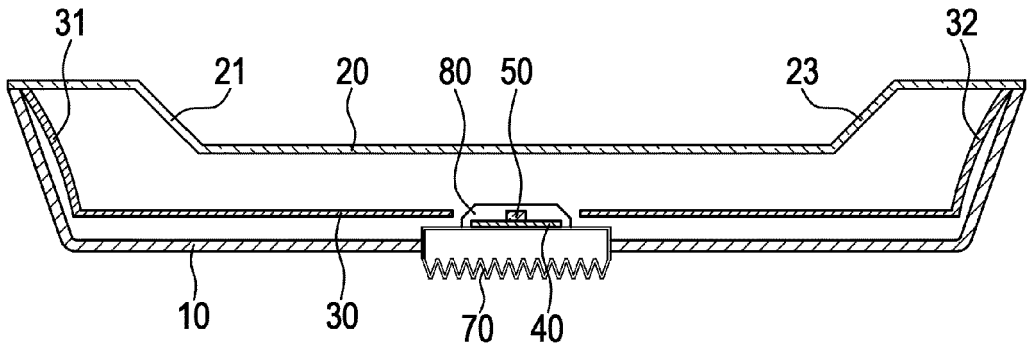
**5.** LED ceiling light according to any one of the preceding claims,
**characterized in, that**
at least one side reflector (31, 32) is provided at least one side of the base reflector (30).

**6.** LED ceiling light according to any one of the preceding claims,
**characterized in, that**
the lens has sidewalls extending over the lens surface.

**7.** LED ceiling light according to any one of the preceding claims,
**characterized in, that**
the lens is part of a cover.

**8.** LED ceiling light according to any one of the preceding claims,
**characterized in, that**
the lens is recessed into the housing.

Fig. 1


31
21
20
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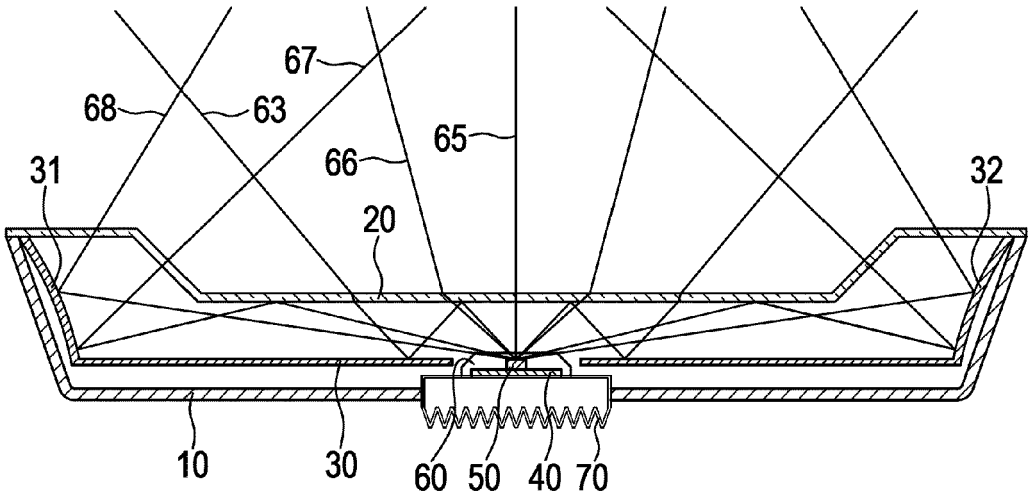
50
23
32
10
30
70
40

Fig. 2


67
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31
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40
70

Fig. 3

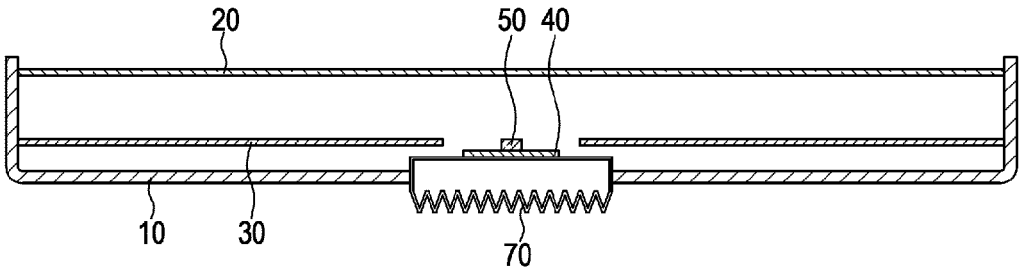



Fig. 4

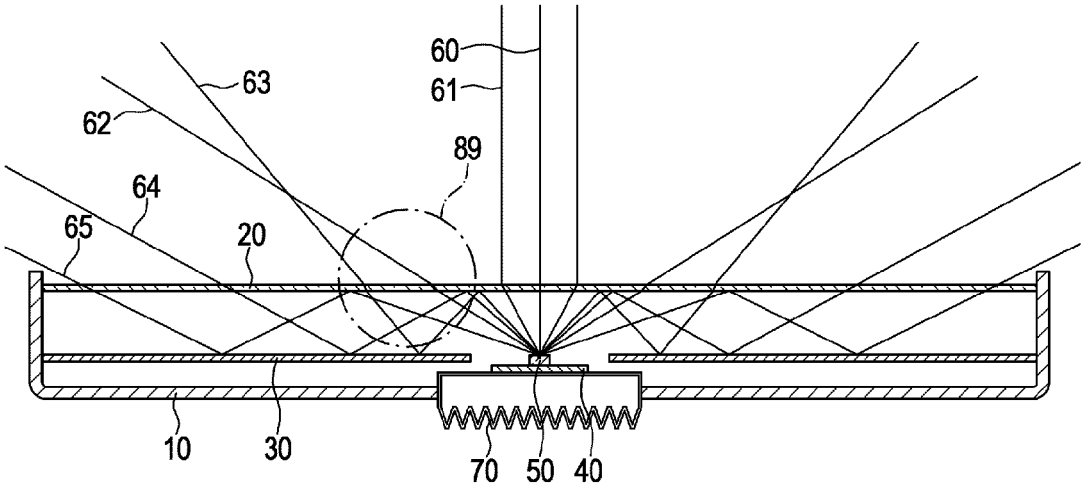



Fig. 5

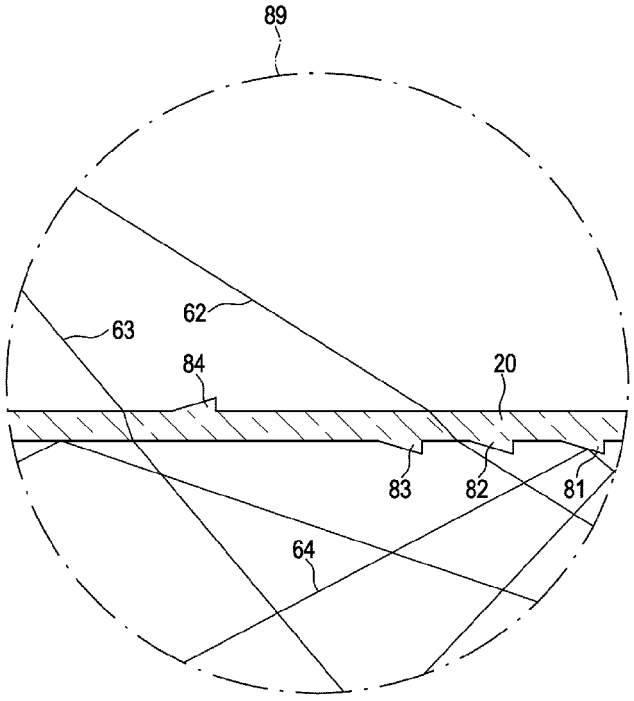


Fig. 6

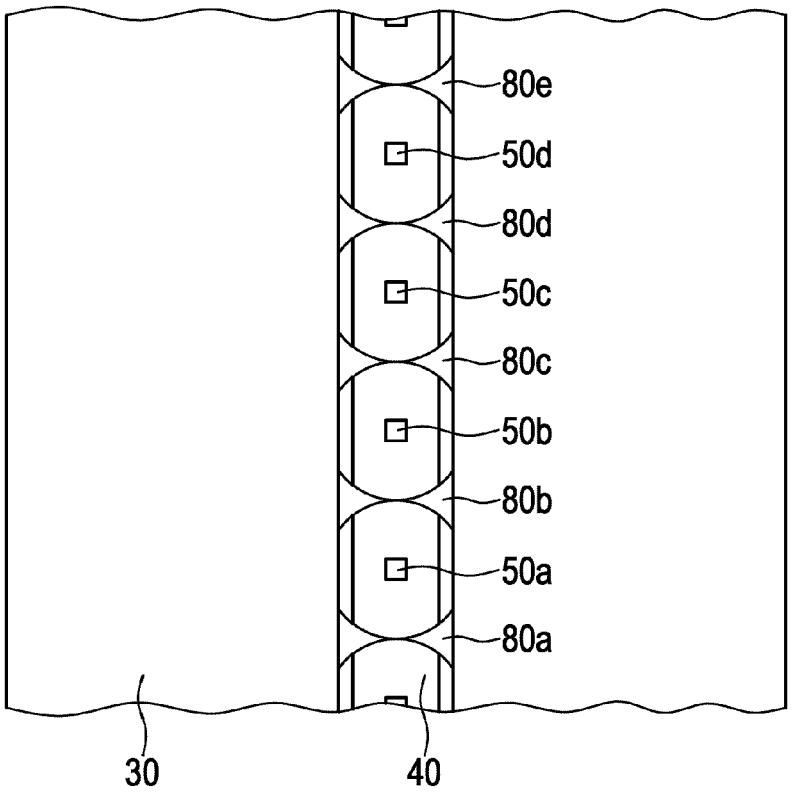

80e
50d
80d
50c
80c
50b
80b
50a
80a
30
40

Fig. 7

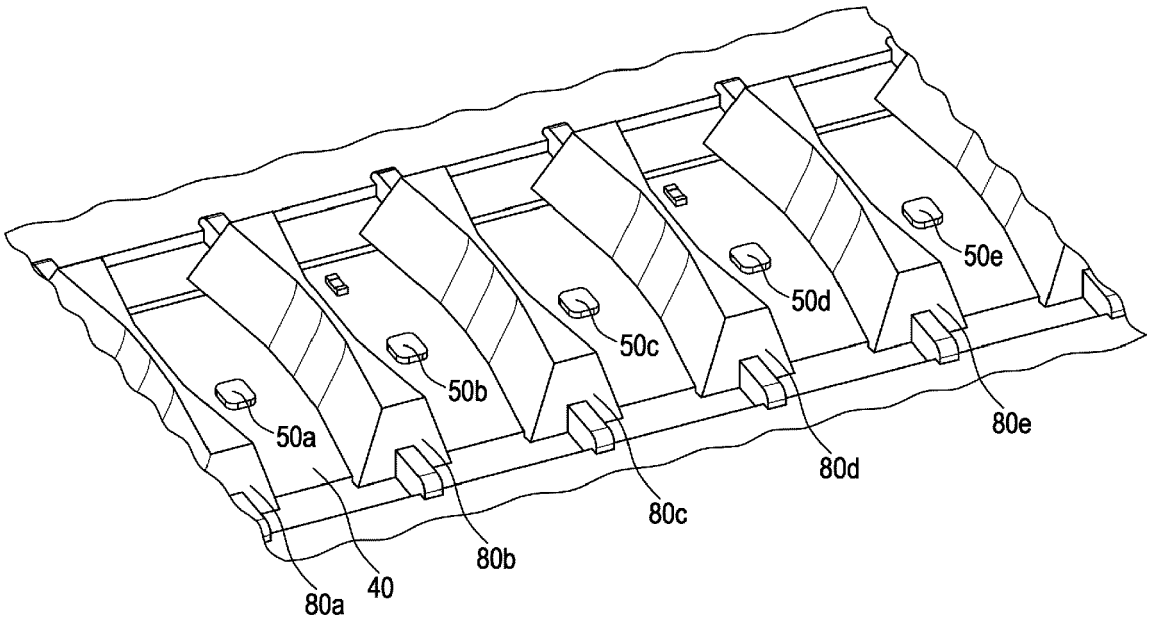

50e
50d
50c
50b
50a
80e
80d
80c
80b
40
80a

Fig. 8

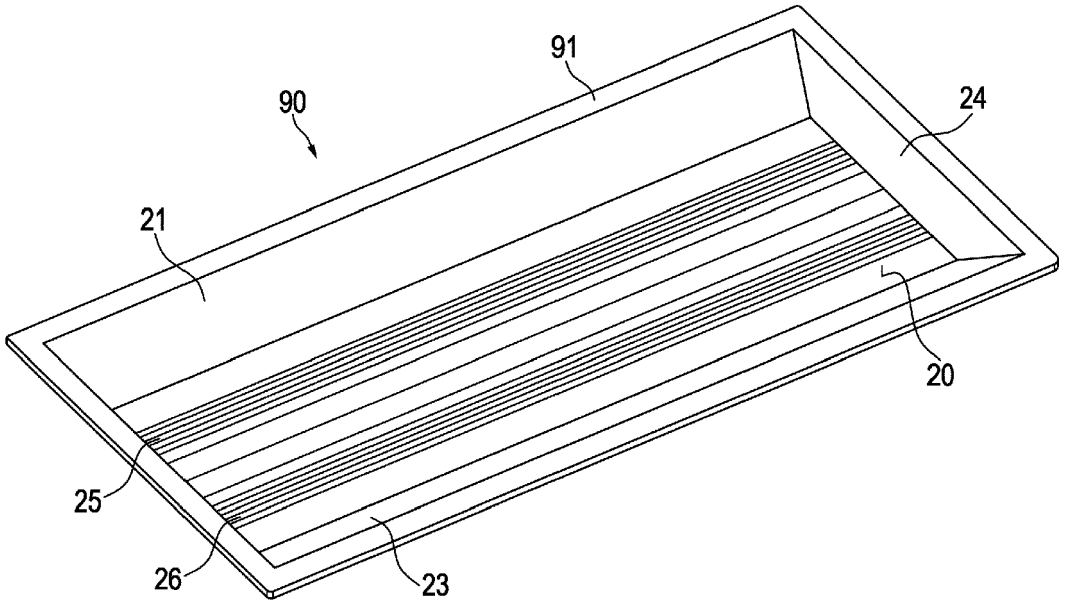



Fig. 9

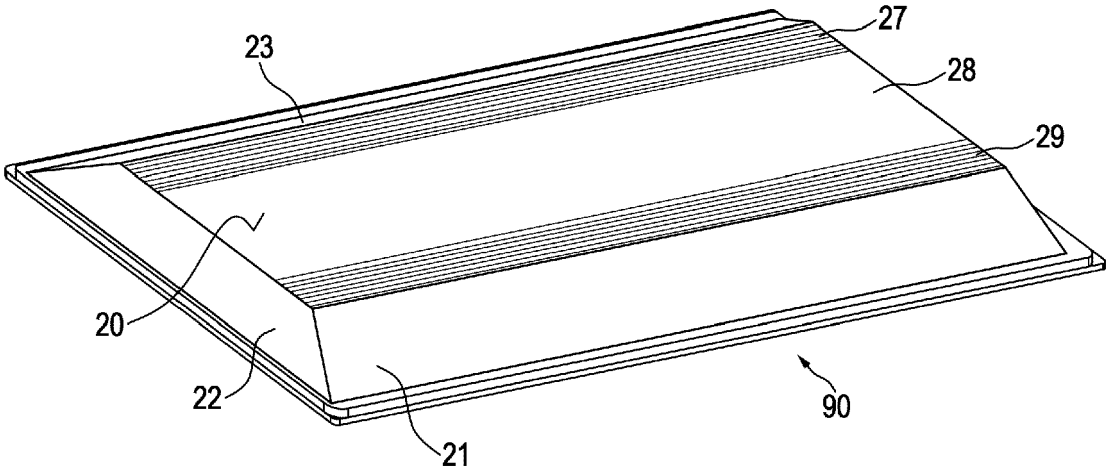
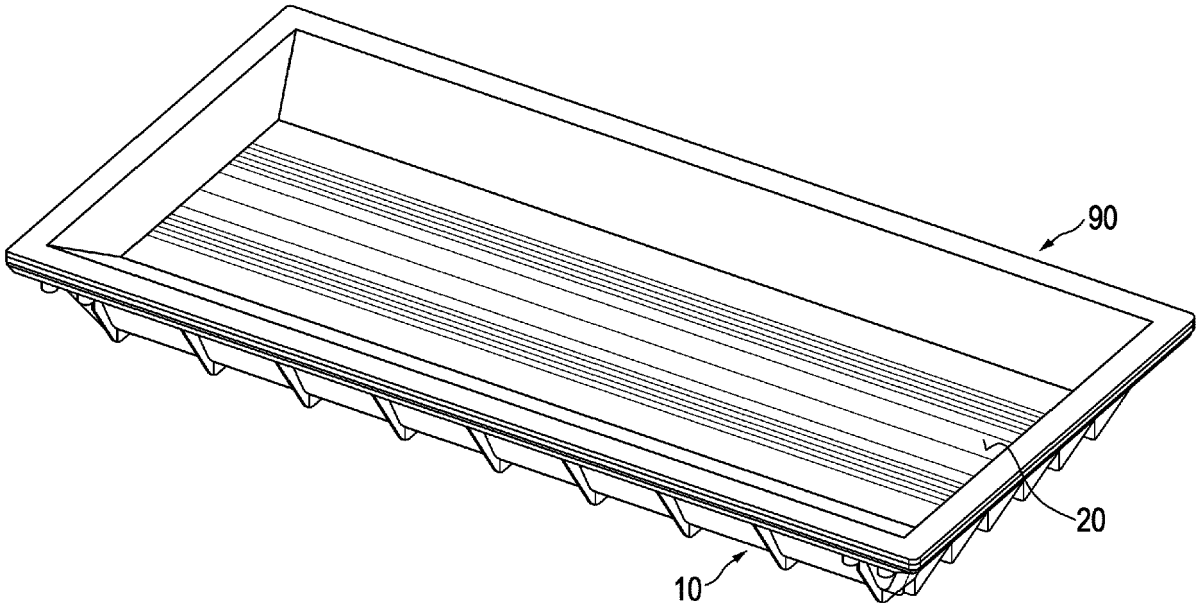


Fig. 10



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# EUROPEAN SEARCH REPORT

Application Number
EP 11 18 6476

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
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TECHNICAL FIELDS SEARCHED (IPC)

F21S
F21K
F21V

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| Munich | 20 April 2012 | Arboreanu, Antoniu |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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1

EPO FORM 1503 03.82 (P04C01)

## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 11 18 6476

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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20-04-2012

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