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(54) **CATADIOPTRIC LIGHTING DEVICE**

(57) A lighting device (10) is disclosed comprising an array of light sources (25) on an annular carrier (20), said carrier delimiting a first aperture (21), a first annular reflector (30) having a first light reflective surface (35) opposing the array of light sources and delimiting a light exit aperture (31) of the lighting device, a second reflector (40) positioned in the first aperture and having a further light reflective surface (45) facing the first light reflective

surface and a collimating arrangement (50) arranged to collimate the light of the light sources onto the first light reflective surface. The first annular reflector is arranged to reflect the collimated light onto the further light reflective surface, and the second reflector is arranged to further reflect the reflected light received from the first annular reflector through the light exit aperture. Also disclosed is a luminaire comprising such a lighting device.

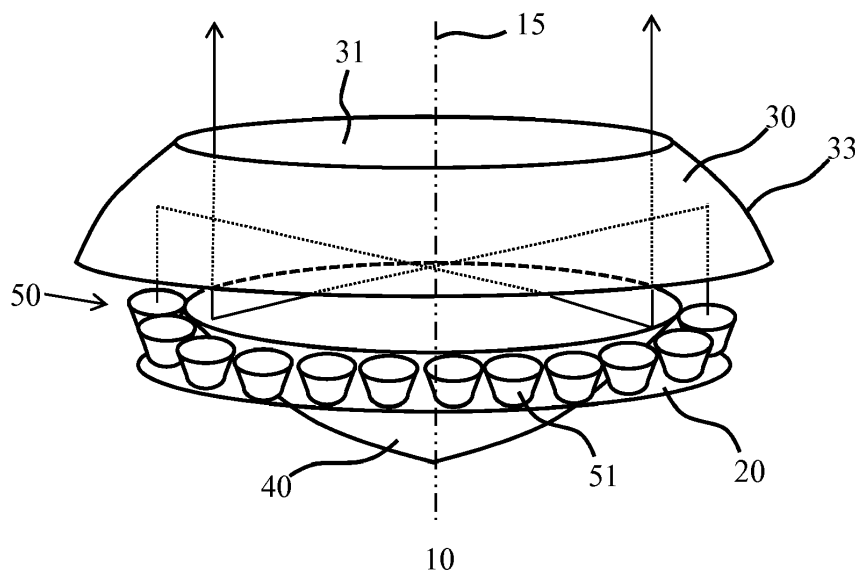


FIG. 1

Description

FIELD OF THE INVENTION

[0001] The present invention relates to a lighting device comprising an array of light sources on an annular carrier delimiting a first aperture and a reflector arrangement for redirecting the luminous output of the light sources.

[0002] The present invention further relates to a luminaire comprising such a lighting device.

BACKGROUND OF THE INVENTION

[0003] With a continuously growing population, it is becoming increasingly difficult to meet the world's energy needs as well as to control carbon emissions to curb greenhouse gas emissions that are considered responsible for global warming phenomena. These concerns have triggered a drive towards more efficient energy consumption in an attempt to reduce energy consumption.

[0004] One such area of concern is lighting applications, either in domestic or commercial settings. There is a clear trend towards the replacement of traditional incandescent light bulbs, which are notoriously energy inefficient, with more energy efficient replacements. Indeed, in many jurisdictions the production and retailing of incandescent light bulbs has been outlawed, thus forcing consumers to buy energy-efficient alternatives, e.g. when replacing incandescent light bulbs.

[0005] A particular promising alternative is provided by solid state lighting (SSL) element-based lighting devices, which can produce a unit luminous output at a fraction of the energy cost of incandescent light bulbs, whilst offering superior lifetime due to the increased robustness of the SSL elements. An example of such a SSL element is a light emitting diode.

[0006] A drawback of SSL element-based lighting devices is that individual SSL elements have a much lower luminous output than e.g. incandescent, tungsten halogen or fluorescent light bulbs, such that it is necessary to include multiple SSL elements in a single light bulb to obtain the required luminous output levels.

[0007] However the footprint of the lighting device, e.g. a light bulb, is a limiting factor in how many SSL elements can be integrated into a single device such as a GU10 or MR16 light bulb. In addition, it is far from straightforward to create a narrow beam angle or even a collimated beam angle with such SSL element-based lighting devices, as the SSL elements tend to generate their output over wide angles, which may compromise the perceived quality of light produced by the SSL element-based lighting device.

[0008] WO 2014/155241 A1 is an earlier application by the present applicant in which a lighting device is disclosed including a reflective element comprising a reflective conical central section having a conic constant in the range of -0.7 to -1.3 and an annular array of reflective

ellipsoid surfaces extending radially from said reflective conical central section, each reflective ellipsoid surface creating a first focal point inside the reflective conical central section and a second focal point. The lighting device further comprises a solid state lighting element located at the second focal point of each of said reflective ellipsoid surfaces and arranged to emit light towards said reflective ellipsoid surface; and an exit window opposite said reflective conical central section.

SUMMARY OF THE INVENTION

[0009] The present invention seeks to provide a lighting device having an improved optical performance at least in terms of optical efficiency.

[0010] The present invention further seeks to provide a luminaire including such a lighting device.

[0011] According to an aspect, there is provided a lighting device comprising an array of light sources on an annular carrier, said carrier delimiting a first aperture; a first annular reflector having a first light reflective surface opposing the array of light sources and delimiting a light exit aperture of the lighting device; a second reflector positioned in the first aperture and having a further light reflective surface facing the first light reflective surface; and a collimating arrangement arranged to collimate the light of the light sources onto the first light reflective surface, wherein the first annular reflector is arranged to reflect the collimated light onto the further light reflective surface, and the second reflector is arranged to further reflect the reflected light received from the first annular reflector through the light exit aperture.

[0012] Embodiments of the present invention thus provide a catadioptric lighting device having improved optical performance as substantially all light generated with the light sources, e.g. a plurality of SSL elements, is collimated onto the first annular reflector, thereby avoiding light originating from the light sources incident on this reflector under undesirable angles. In addition, as the light exit aperture of the lighting device is defined by the first annular reflector, a larger light exit aperture can be achieved without compromising the optical performance of the lighting device as a better preservation of the étendue of the collimated light output produced by the collimating arrangement can be achieved accordingly.

[0013] In a first set of embodiments, the collimating arrangement comprises a plurality of collimating lenses, with each of said lenses arranged over one of said light sources. Such an arrangement is particularly effective in collimating the luminous outputs of the light sources, e.g. the SSL elements. In an alternative set of embodiments, the collimating arrangement comprises an annular collimating lens arranged over the plurality of light sources. This is a particularly cost-effective arrangement as the collimating arrangement is formed by a single component as opposed to a plurality of discrete components as may be the case in the first set of embodiments.

[0014] The further reflective surface of the second re-

flector preferably is a concave reflective surface in order to restrict the beam angle of the luminous output produced by the lighting device. More preferably, the first annular reflector and the second reflector are concave parabolic reflectors to achieve a particularly narrow beam angle. In the context of the present application, where reference is made to a parabolic reflector, it should be understood that this is to mean that a cross-section of such a reflector has a shape corresponding to an equation defining a parabola, i.e. these cross-sections define part of a parabola.

[0015] In a first example embodiment, the concave parabolic reflectors have a common focal point, which typically lies in the optical path between these opposing parabolic reflectors. This allows the second reflector to be shaped such that a highly collimated light beam, i.e. a light beam having a particularly narrow beam angle, can be formed.

[0016] However, embodiments of the present invention are not limited to this particular reflector arrangement. In a second example embodiment, a focal point of the first annular reflector coincides with the further light reflective surface and a focal point of the second reflector coincides with the first light reflective surface such that the first annular reflector and the second reflector define a Kohler integration arrangement, thereby also yielding a particularly robust optical system.

[0017] Moreover, embodiments of the present invention are not limited to parabolic reflectors. In yet another example embodiment, first annular reflector and the second reflector are conical reflectors having a straight generatrix in a sectional view. Such a reflector arrangement still improves the optical efficiency of the lighting device compared to the aforementioned prior art system whilst the reflectors can be manufactured in a straightforward and particularly cost-effective manner. For example, in this (and other) embodiment(s), the first annular reflector and the second reflector may be metal sheet reflectors that are formed by bending the metal sheets in their desired shapes.

[0018] In a further embodiment, at least one of the first light reflective surface and the further light reflective surface is faceted in order to increase the robustness of the optical system of the lighting device.

[0019] Where a more diffusive luminous output is desirable, e.g. to reduce glare effects, at least one of the first light reflective surface and the further light reflective surface may be a scattering surface to diffuse the luminous output. This increases the beam angle of the luminous output beam produced by the lighting device without significantly affecting the optical efficiency of the lighting device, in particular when only the further light reflective surface is a scattering surface. Alternatively or additionally, the lighting device may further comprise a diffuser in the light exit aperture to diffuse its luminous output.

[0020] The lighting device may be a light bulb although embodiments of the present invention are not limited thereto. Such a light bulb may have any suitable size and

shape, and preferably is a spot light bulb for generating a light beam having relatively narrow beam angle, e.g. a beam angle of 20° or less, or even 10° or less in some embodiments. Non-limiting examples of such spot light bulbs include sizes such as E27, MR11, MR16, GU10, AR111, PAR30, PAR38, BR30, BR40, R20, R50, and so on.

[0021] According to another aspect, there is provided a luminaire comprising at least one lighting device according to any of the herein described embodiments. Such a luminaire may be a ceiling lamp, wall-mounted lamp, and so on, and alternatively may form part of an apparatus such as an oven, extractor, cooker hood, and so on, or any other apparatus including a luminaire for directing light having a high degree of collimation onto a surface such as a work surface.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] Embodiments of the invention are described in more detail and by way of non-limiting examples with reference to the accompanying drawings, wherein:

- Fig. 1 schematically depicts a perspective view of a lighting device according to an embodiment;
- Fig. 2 schematically depicts a cross-sectional view of the lighting device of Fig. 1;
- Fig. 3 schematically depicts a cross-sectional view of a lighting device according to a preferred embodiment;
- Fig. 4 schematically depicts a cross-sectional view of a lighting device according to another embodiment;
- Fig. 5 schematically depicts a cross-sectional view of a lighting device according to yet another embodiment;
- Fig. 6 schematically depicts a perspective view of a lighting device according to still another embodiment; and
- Fig. 7 schematically depicts a perspective view of a lighting device according to an alternative embodiment.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0023] It should be understood that the Figures are merely schematic and are not drawn to scale. It should also be understood that the same reference numerals are used throughout the Figures to indicate the same or similar parts.

[0024] Fig. 1 schematically depicts a perspective view of the optical arrangement of a lighting device 10, with Fig. 2 schematically depicting this optical arrangement in a cross-sectional view. For the sake of clarity only, the housing of the lighting device 10 in which this optical arrangement is placed has been omitted. It should be understood that the shape or form of this housing including the materials used for such a housing is not particularly

limited and any suitable shape or form may be contemplated for the lighting device 10. It is furthermore should be understood that such a lighting device 10 in addition to such an optical arrangement may further comprise one or more electrical components such as a driver for the light sources 25 of the lighting device 10, which one or more electrical components may be integrated in the lighting device 10 in any suitable manner. As such integration is entirely commonplace to the skilled person, this is not explained in further detail for the sake of brevity only.

[0025] The lighting device 10 comprises an annular carrier 20, e.g. an annular printed circuit board (PCB) or the like, onto which a plurality of light sources 25 are mounted. In a preferred embodiment, the light sources 25 are SSL elements, e.g. LEDs such as white light LEDs, colored LEDs or a combination thereof in case of a lighting device 10 having a configurable luminous output in terms of its spectral composition, e.g. a luminous output of which the color or color temperature in case of white light can be configured. Where the lighting device 10 has such a configurable luminous output, the respective light sources 25 may be individually addressable, e.g. by a driver (not shown) responsive to a configuration instruction that may be provided over the power supply of the lighting device 10, e.g. as a modulation of the power supply, or alternatively may be provided as a wireless configuration instruction in which case the lighting device 10 may further comprise or be responsive to a wireless communication module (not shown) arranged to receive such a configuration instruction. The annular carrier 20 delimits a first aperture 21. The annular carrier 20 and the first aperture 21 preferably have a circular outline although other outlines, e.g. approximately circular outlines, may be contemplated.

[0026] The lighting device 10 further comprises a collimating arrangement 50, here represented by a plurality of discrete collimating lenses 51, with each collimating lens 51 positioned over one of the light sources 25, e.g. over a discrete SSL element or cluster of SSL elements. The collimating lenses 51 preferably are total internal reflection (TIR) collimating lenses as such lenses have a particularly high optical efficiency and prevent significant light loss of the light produced by the light sources 25 in unwanted directions, e.g. through the sidewalls of the collimating lenses 51, as such light loss can compromise the optical efficiency and narrowness of the light beam produced by the lighting device 10. The collimating lenses 51 may be made of any suitable refractive material, e.g. glass or optical grade polymer such as polycarbonate, polyethylene terephthalate, poly (methyl methacrylate) and so on. The advantage of using optical grade polymers to manufacture the collimating lenses 51 is that the lenses can be manufactured using molding techniques, which allows for the lenses to be manufactured in a particularly cost-effective manner.

[0027] The optical arrangement of the lighting device 10 further comprises an annular first reflector 30 having

a first reflective surface 35 arranged to receive the luminous output of the collimating arrangement, i.e. the collimating lenses 51 in the present embodiment. The annular first reflector 30 delimits a light exit aperture 31 of the lighting device 10 through which the light generated by the light sources 25 exits the lighting device 10. The annular first reflector 30 and the light exit aperture 31 preferably have a circular outline although other outlines, e.g. approximately circular outlines, may be contemplated.

[0028] In order to redirect the light reflected by the annular first reflector 30 through the light exit aperture 31, the lighting device 10 further comprises a second reflector 40 mounted in the aperture 21 and having a further reflective surface 45 arranged to receive the light reflected by the annular first reflector 30 and the further reflect this light through the light exit aperture 31. Hence, light generated by the light sources 25 and collimated by the collimating lenses 51 is projected onto the annular first reflector 30, which reflects this light onto the second reflector 40, which in turn reflects this incident light through the light exit aperture 31, as schematically depicted by the arrows in Figs. 1 and 2.

[0029] The outline or rim of the second reflector 40 defines a (cylindrical) spatial volume centered on the optical axis 15 of the optical arrangement of the lighting device 10. Typically, the annular first reflector 30 is dimensioned such that no part of this reflector lies inside this spatial volume, i.e. there is no overlap between the annular first reflector 30 and this spatial volume.

[0030] The consequence of this arrangement is that the diameter (or maximum cross-section) of the light exit aperture 31 can match or even exceed the diameter (or maximum cross-section) of the aperture 21 in which the second reflector 40 is mounted, which is particularly beneficial for reasons of preserving the étendue of the collimated light produced by the light sources 25 in combination with the collimating arrangement 50, here formed by the plurality of collimating lenses 51. At this point it is noted that the collimated luminous output produced by the collimating lenses 51 has a symmetry axis parallel to the optical axis 15 by way of non-limiting example only. It is for instance feasible to have this symmetry axis angle away from the optical axis 15, which may facilitate an even larger light exit aperture 31.

[0031] The annular first reflector 30 and the second reflector 40 each may be made of any suitable material, e.g. a non-reflective body carrying a reflective coating on the first reflective surface 35 and/or the further reflective surface 45, a reflective body such as a metal body, and so on. The first reflective surface 35 and/or the further reflective surface 45 further may be faceted surfaces in order to increase the optical robustness of the optical arrangement of the lighting device 10.

[0032] In order to obtain a lighting device 10 generating a luminous output through its light exit aperture 31 having a particularly narrow beam angle, the first reflective surface 35 of the annular first reflector 30 and the further

reflective surface 45 of the second reflector 40 are concave surfaces, i.e. each reflector has a focal point in a direction towards the opposite reflector, or more accurately, has a focal annulus in this direction. Preferably but not necessarily, the first reflective surface 35 of the annular first reflector 30 and/or the further reflective surface 45 of the second reflector 40 have a parabolic cross-sectional shape, which cross section lies in a plane coinciding with the optical axis 15 of the optical arrangement of the lighting device 10. As will be immediately understood by the skilled person, in case of the annular first reflector 30, this means that the surface segment 33 of this reflector obeys a parabolic equation.

[0033] Fig. 3 schematically depicts a preferred embodiment of the lighting device 10 in which the first annular reflector 30 and the second reflector 40 are concave parabolic reflectors sharing an annulus of focal points 32, i.e. each reflector has a separate annulus focal points 32 with the respective annuli coinciding. Such reflectors may be designed in the following manner. The annular first reflector 30 may be designed by rotating a suitable 2D curve around the optical axis 15 of the optical arrangement of the lighting device 10, which 2D curve is a parabola that focuses the parallel rays coming from the collimating arrangement 50 into a point, i.e. a point 32 on the aforementioned focal annulus that is generated when rotating the 2D curve around the optical axis 15. The second reflector may be designed by rotating a further 2D profile around the optical axis 15. This further 2D curve is a further parabola that transforms the rays coming from the focal annulus 32 into a parallel fan exiting the lighting device 10 through the light exit aperture 31. With this particular arrangement, a light beam can be produced by the lighting device 10 having a particularly narrow beam angle due to the fact that the second reflector 40 generates highly collimated light through the light exit aperture 31. It is of course also feasible to design the annular first reflector 30 and the second reflector 40 such that their respective focal annuli do not coincide, which for example may be utilized to tune the beam angle of the light beam produced with the lighting device 10.

[0034] Fig. 4 schematically depicts an alternative embodiment of the lighting device 10 in which the first annular reflector 30 and the second reflector 40 are concave parabolic reflectors. In this embodiment, the first annular reflector 30 exhibits a first annulus of focal points 34 coinciding with (a central portion of) the further reflective surface 45 of the second reflector 40, whereas the second reflector 40 exhibits a second annulus of focal points 44 coinciding with (a central portion of) the first reflective surface 35 of the first annular reflector 30. As before, such reflectors may be designed by choosing an appropriate 2D curve, i.e. an appropriate parabola or parabola segment, and rotating this curve around the optical axis 15 in order to generate the reflector shape. As will be recognized by the skilled person, this reflector arrangement implements a Kohler integrator, wherein the annular first reflector 30 images the luminous output of the

collimating arrangement 50 onto the second reflector 40, with the second reflector 40 imaging the infinite plane onto the annular first reflector 30.

[0035] Fig. 5 schematically depicts yet another embodiment of the lighting device 10 in which the annular first reflector 30 and the second reflector 40 are (truncated) conical reflectors that can be designed by rotating a straight or linear generatrix around the optical axis 15 to generate the respective reflectors. Although it can be seen from the arrows in FIG. 5 depicting the luminous output generated with such a conical reflector arrangement that a more divergent light beam, i.e. a light beam having a larger beam angle, compared to previous embodiments is generated, this embodiment nevertheless still exhibits an excellent optical efficiency and has the further advantage that the annular first reflector and a second reflector 40 can be manufactured in a particularly cost-effective manner, e.g. by folding flat metal sheets to obtain these reflectors.

[0036] At this point, it is noted that the annular first reflector 30 and the second reflector 40 not necessarily have to exhibit 'matching' shapes. In other words, it is also feasible to combine a conical reflector with a concave, e.g. parabolic, reflector. More specifically, the annular first reflector 30 may be a concave reflector and the second reflector 40 may be a conical reflector or alternatively the annular first reflector 30 may be a conical reflector and the second reflector 40 may be a concave reflector. As will be understood from the foregoing including the evaluation of the optical performance of the various embodiments of the lighting device 10 according to the present invention, such 'mixed' reflector geometries may generate optical performances lying in between the optical performance of the example embodiments of the lighting device 10 as schematically depicted in Fig. 3 and Fig. 4 on the one hand and the optical performance of the example embodiment of the lighting device 10 as schematically depicted in FIG. 5 on the other hand.

[0037] Also, it may be desirable in certain application domains to produce a more diffuse luminous output with the lighting device 10 according to embodiments of the present invention. This for example may be beneficial in applications where glare effects are to be suppressed or where the lighting device 10 is to produce a more diffuse luminous output for aesthetic reasons. This may be achieved by making at least one of the first reflective surface 35 and the further reflective surface 45 a scattering surface. Preferably, the first reflective surface 35 is non-scattering and the further reflective surface 45 is a scattering surface in such embodiments in order to limit the light losses and preserve the optical efficiency of the lighting device 10 to the largest extent possible. Such a scattering surface may be achieved in any suitable manner, e.g. using scattering particles on the surface or in any other manner well-known to the skilled person.

[0038] Fig. 6 schematically depicts a further embodiment of the lighting device 10 of the present invention in which such a diffuse luminous output is achieved by in-

cluding a diffuser 60 in the light exit aperture 31 delimited by the annular first reflector 30. Such a diffuser may be made of any suitable material, e.g. a diffusive optical grade polymer material, and may be fitted in the light exit aperture in any suitable manner, e.g. using a fixing arrangement such as clips, screws, clamps or the like, an adhesive, and so on. Alternatively, where the lighting device 10 comprises an optically transmissive plate in its housing aligned with the light exit aperture 31 of the optical arrangement, such an optically transmissive plate may be made diffusive in order to achieve the diffuser functionality of the lighting device 10.

[0039] In the foregoing embodiments, the collimating arrangement 50 has been implemented using a plurality of discrete collimating lenses 51, with each of these lenses being aligned with one of the light sources 25 as previously explained. However, it should be understood that such a collimating arrangement 50 may be implemented in any suitable manner. For example, FIG. 7 schematically depicts a perspective view of an embodiment of the lighting device 10 in which the collimating arrangement 50 is implemented by an annular collimating lens 53 arranged over the plurality of light sources 25 such that the annular collimating lens 53 is arranged in between the light sources 25 and the annular first reflector 30. In other words, the annular collimating lens 53 is arranged to collimate the light produced by the light sources 25 onto the first reflective surface 35 of the annular first reflector 30 as previously explained. Such an annular collimating lens 53 may be designed in any suitable manner. For example, the annular collimating lens 53 may be designed by rotating a 2D cross-sectional profile of a total internal reflection collimator, e.g. a collimating lens 51, around the optical axis 15 in order to obtain the annular collimating lens 53. The annular collimating lens 53 may be made of any of the suitable materials previously mentioned for the manufacture of the discrete collimating lenses 51.

[0040] The lighting device 10 according to a set of embodiments of the present invention may be a light bulb, more preferably a spot light bulb. Non-limiting examples of such spot light bulbs include sizes such as E27, MR11, MR16, GU10, AR111, PAR30, PAR38, BR30, BR40, R20, R50, and so on. The lighting device according to a set of embodiments of the present invention may be advantageously included in a luminaire such as a holder of the lighting device, e.g. a ceiling light fitting, or an apparatus into which the lighting device is integrated, e.g. a cooker hood or the like.

[0041] It should be noted that the above-mentioned embodiments illustrate rather than limit the invention, and that those skilled in the art will be able to design many alternative embodiments without departing from the scope of the appended claims. In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim. The word "comprising" does not exclude the presence of elements or steps other than those listed in a claim. The word "a" or "an" preceding an element does not exclude the presence of a plurality

of such elements. The invention can be implemented by means of hardware comprising several distinct elements. In the device claim enumerating several means, several of these means can be embodied by one and the same item of hardware. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

Claims

1. A lighting device (10) comprising:

an array of light sources (25) on an annular carrier (20), said carrier delimiting a first aperture (21);
a first annular reflector (30) having a first light reflective surface (35) opposing the array of light sources and delimiting a light exit aperture (31) of the lighting device;
a second reflector (40) positioned in the first aperture and having a further light reflective surface (45) facing the first light reflective surface; and
a collimating arrangement (50) arranged to collimate the light of the light sources onto the first light reflective surface and the first annular reflector is arranged to reflect the collimated light onto the further light reflective surface, and the second reflector is arranged to further reflect the reflected light received from the first annular reflector through the light exit aperture.

2. The lighting device (10) of claim 1, wherein the collimating arrangement (50) comprises a plurality of collimating lenses (51), with each of said lenses arranged over one of said light sources.

3. The lighting device (10) of claim 1, wherein the collimating arrangement (50) comprises an annular collimating lens (53) arranged over the plurality of light sources.

4. The lighting device (10) of any of claims 1-3, wherein the further reflective surface of the second reflector (40) is a concave reflective surface.

5. The lighting device (10) of any of claims 1-4, wherein the first annular reflector (30) and the second reflector (40) are concave parabolic reflectors.

6. The lighting device (10) of claim 5, wherein the concave parabolic reflectors have a common focal point (32).

7. The lighting device (10) of claim 5, wherein a focal point (34) of the first annular reflector (30) coincides

with the further light reflective surface (45) and a focal point (44) of the second reflector coincides with the first light reflective surface (35) such that the first annular reflector (30) and the second reflector (40) define a Kohler integration arrangement.

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8. The lighting device (10) of any of claims 1-3, wherein the first annular reflector (30) and the second reflector (40) are conical reflectors having a straight generatrix in a sectional view. 10
9. The lighting device (10) of any of claims 1-8, wherein the first annular reflector (30) and the second reflector (40) are metal sheet reflectors. 15
10. The lighting device (10) of any of claims 1-9, wherein at least one of the first light reflective surface (35) and the further light reflective surface (45) is faceted.
11. The lighting device (10) of any of claims 1-10, wherein at least one of the first light reflective surface (35) and the further light reflective surface (45) is a scattering surface. 20
12. The lighting device (10) of any of claims 1-11, further comprising a diffuser (60) in the light exit aperture (31). 25
13. The lighting device (10) of any of claims 1-12, wherein the light sources (25) are solid state light sources. 30
14. The lighting device (10) of any of claims 1-14, wherein the lighting device is a light bulb.
15. A luminaire comprising at least one lighting device according to any of claims 1-14. 35

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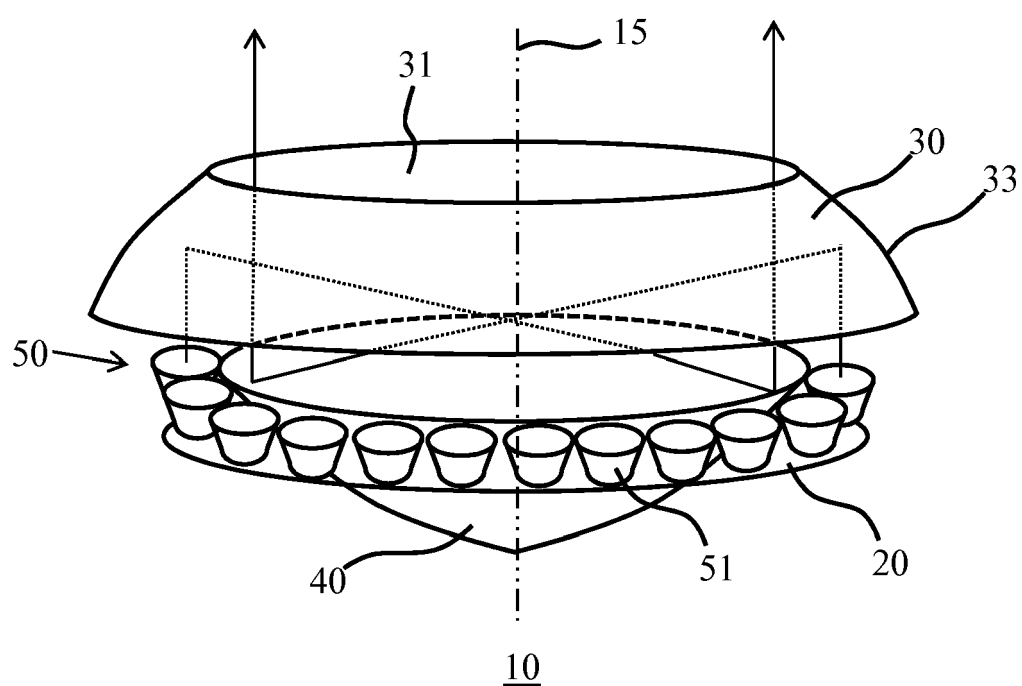


FIG. 1

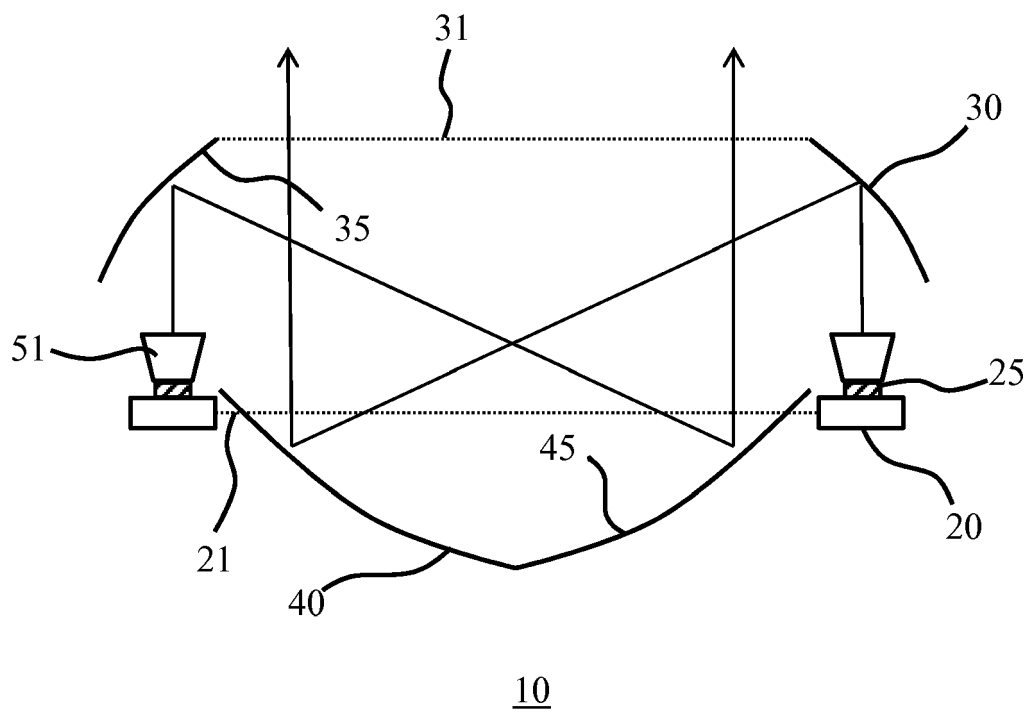


FIG. 2

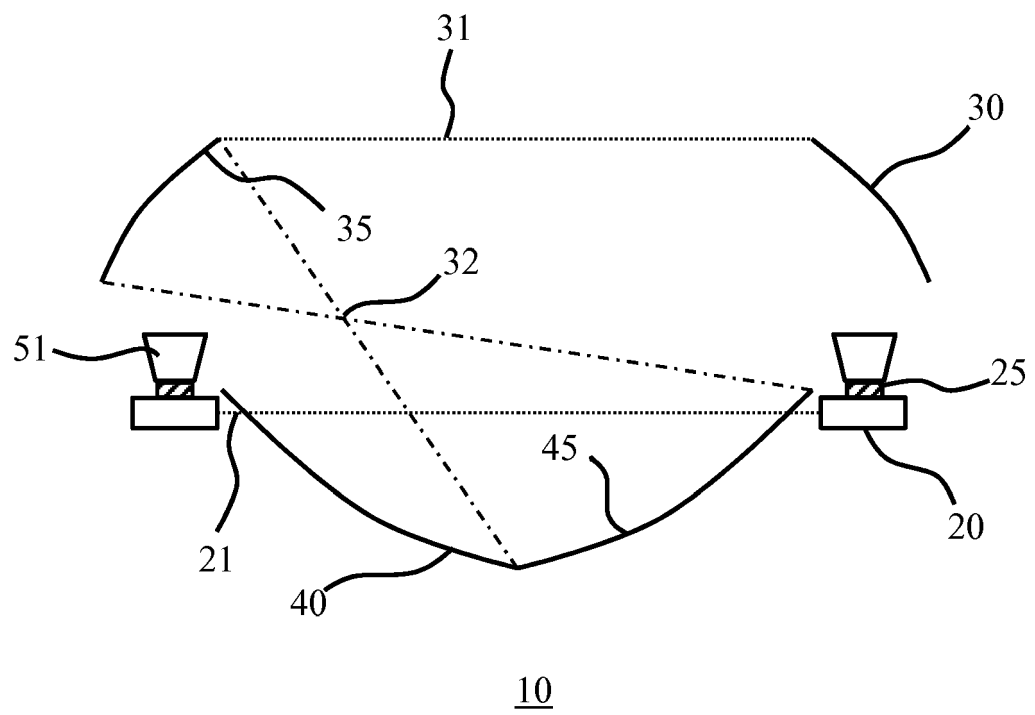


FIG. 3

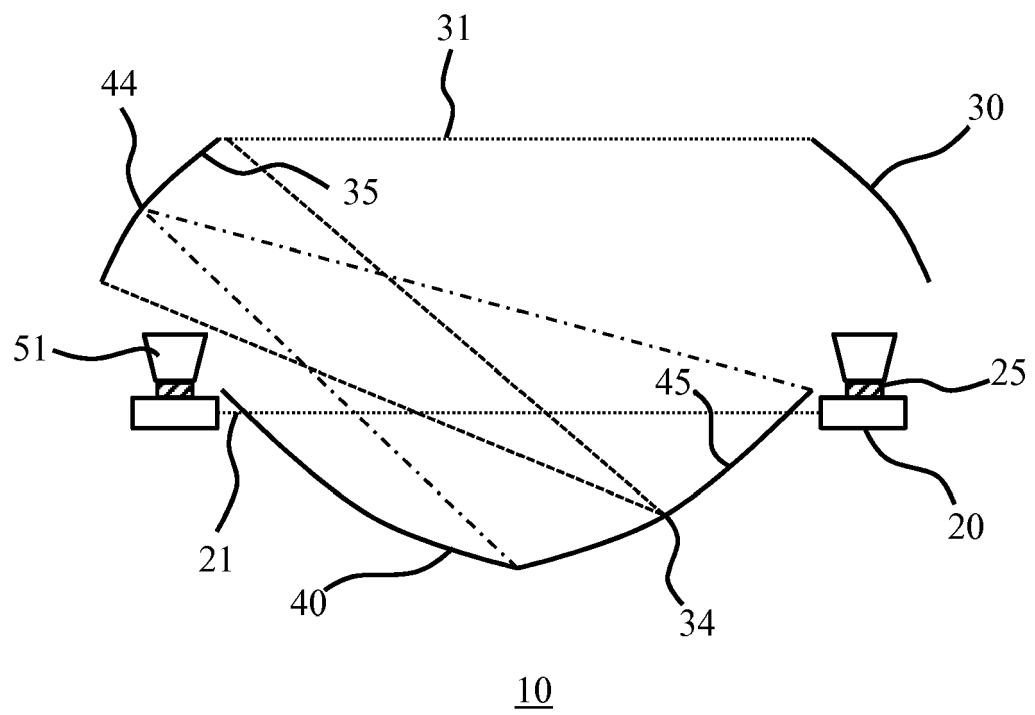


FIG. 4

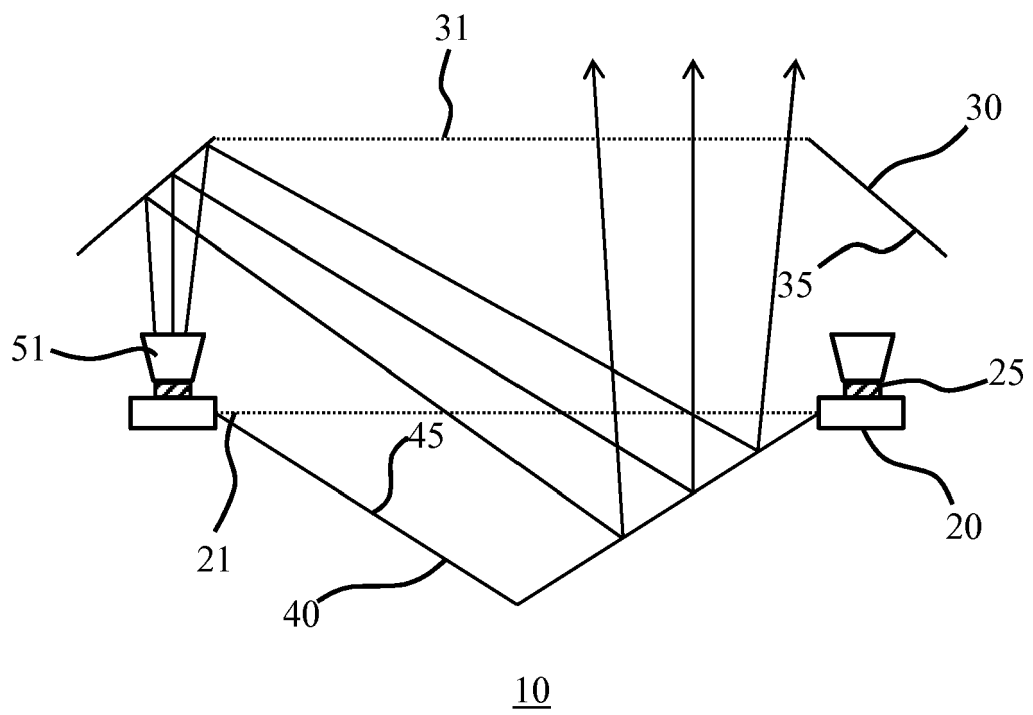


FIG. 5

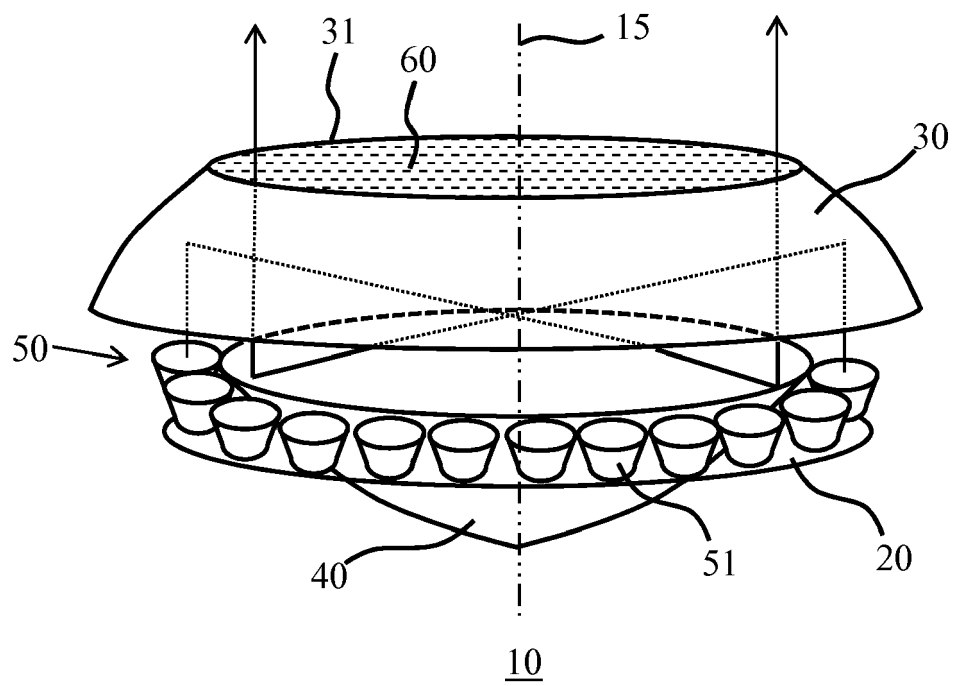


FIG. 6

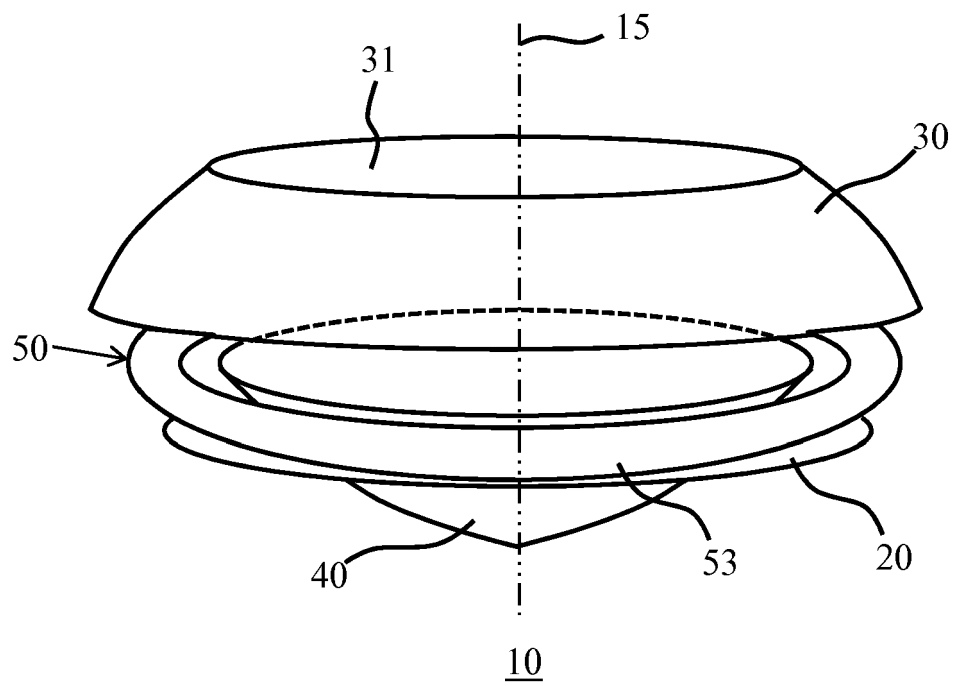


FIG. 7



EUROPEAN SEARCH REPORT

Application Number
EP 17 18 2632

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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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