

(21) Application No: 2203772.5

(22) Date of Filing: 18.03.2022

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(51) INT CL:
A61L 9/20 (2006.01) A61L 2/10 (2006.01)

(56) Documents Cited:
WO 2019/068189 A1 CN 205504689 U
CN 105674169 A US 20220040366 A1
US 20210289599 A1 US 20070053188 A1

(58) Field of Search:
INT CL A61L
Other: WPI, EPODOC

(54) Title of the Invention: **Ultraviolet germicidal irradiation lighting**
Abstract Title: **Ultraviolet germicidal irradiation (UVGI) lighting device with UV and visible light sources**

(57) An ultraviolet germicidal irradiation (UVGI) lighting device comprising: an ultra-violet light source 105; a housing 101 in which the UV light source is located; and a visible light source 109, distinct from the UV light source; wherein both light sources are arranged in the housing to project over an irradiation region. The device may be an uplighter and may further comprise a fan 111. The visible light source may emit light such that the observed wavelength is between 570-750 nm. Also claimed is a method for performing UVGI, comprising: providing a UV light source, a housing wherein the UV light source is configured to project over an irradiation region, and a visible light source arranged to project over the irradiation region; and selecting an appropriate colour of emitted visible light from the visible light source that, when combined with the emitted UV, appears to match a predefined desired colour.

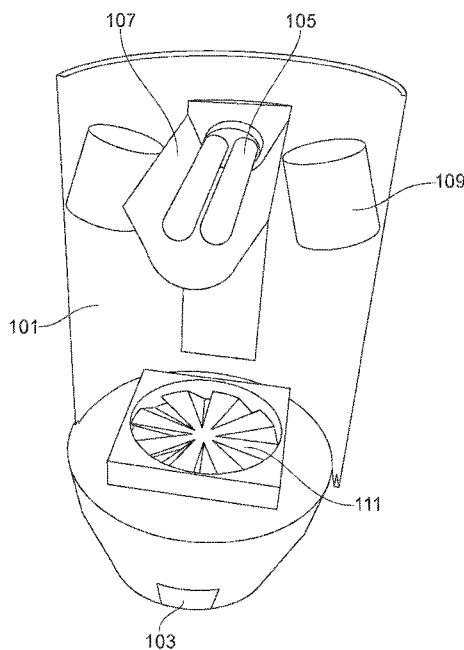


FIG. 1

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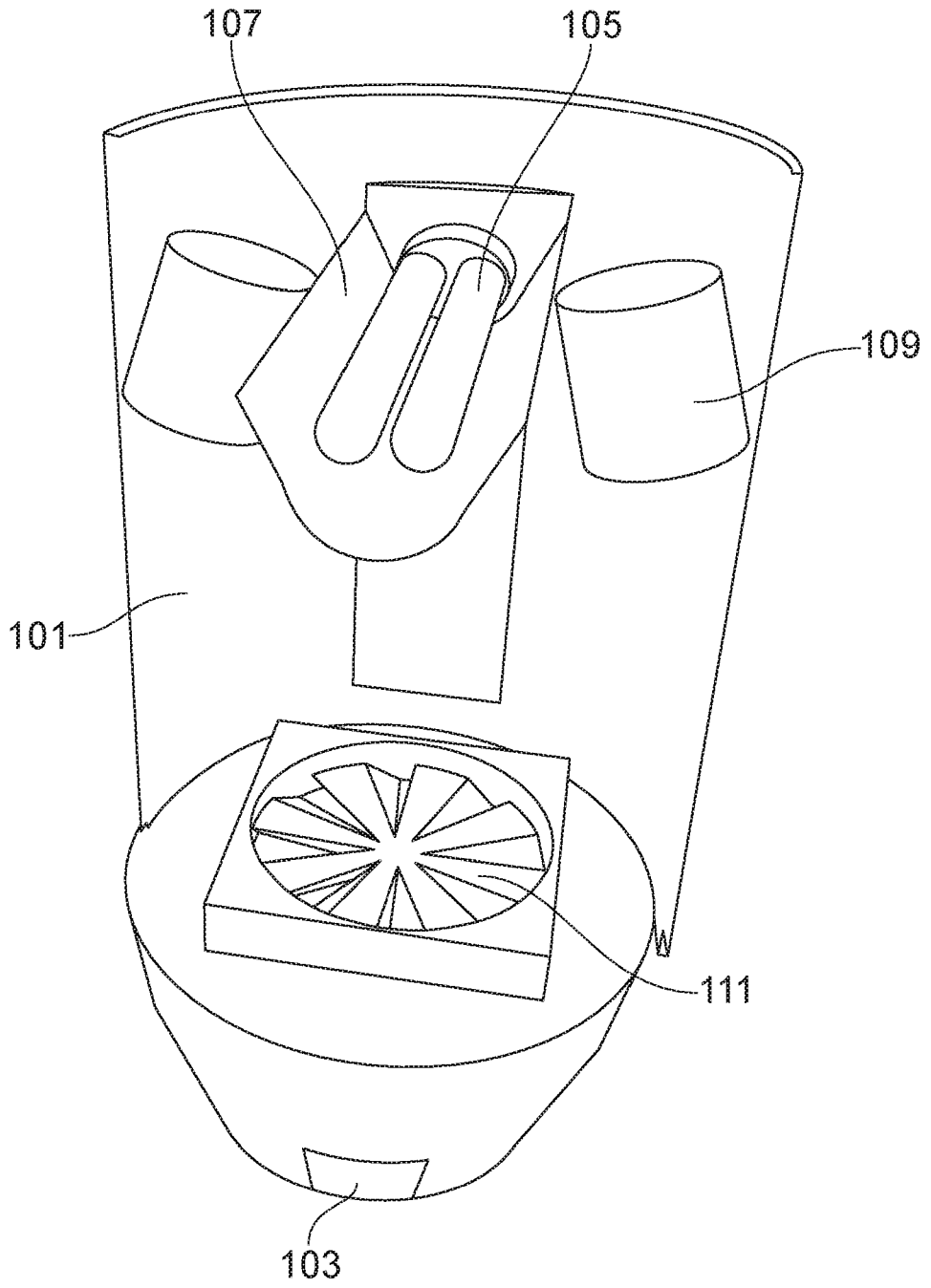


FIG. 1

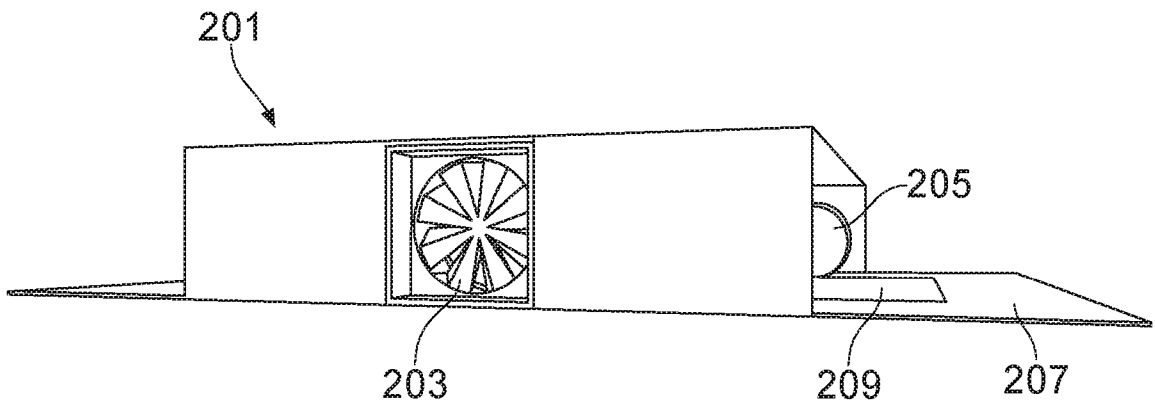


FIG. 2

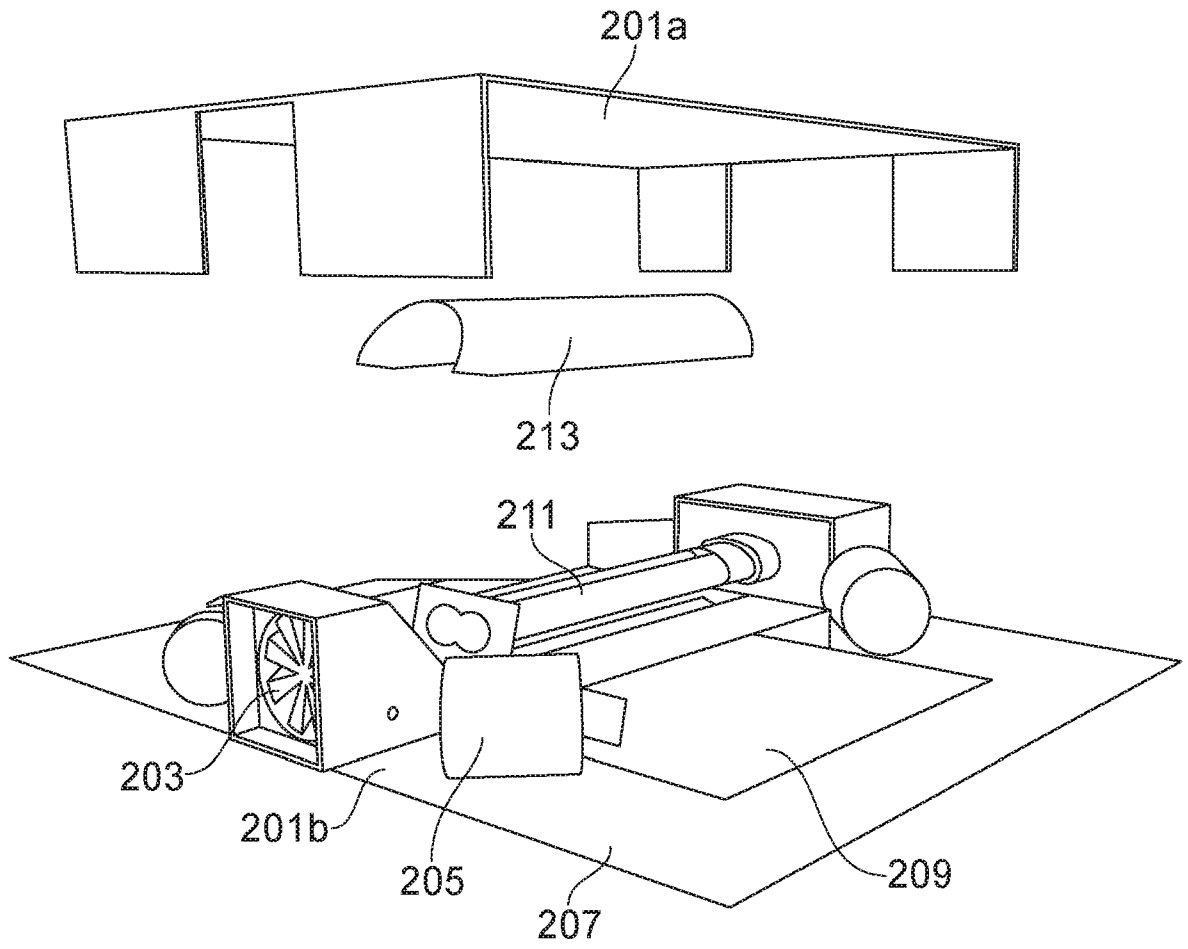


FIG. 3

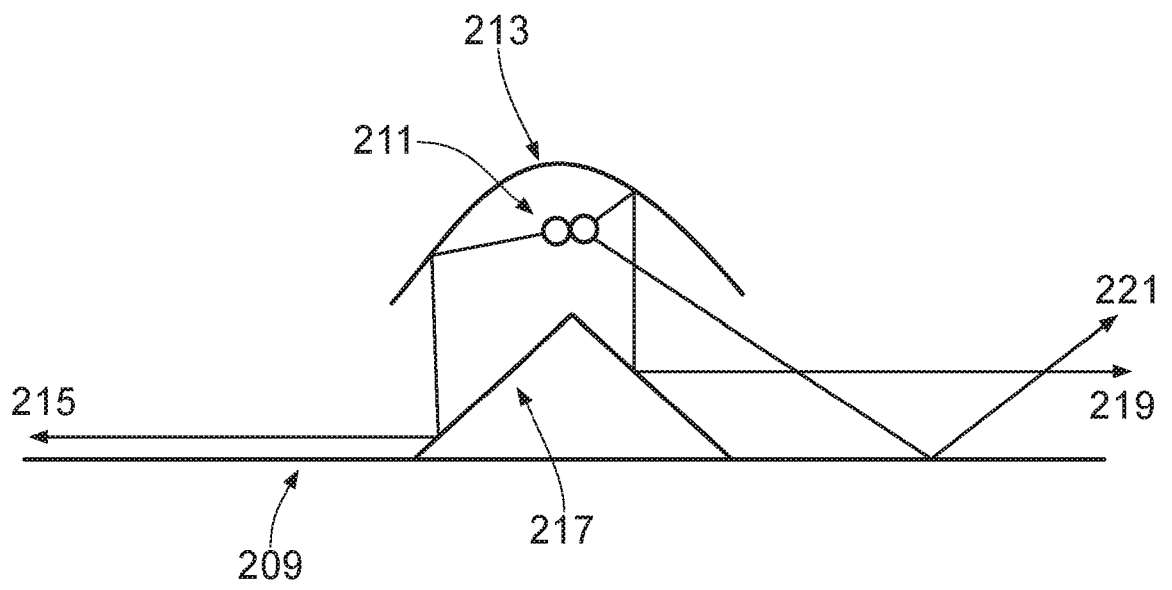


FIG. 4

ULTRAVIOLET GERMICIDAL IRRADIATION LIGHTING

The present invention relates generally to ultraviolet germicidal irradiation lighting devices and a method of performing ultraviolet germicidal irradiation and finds particular, although not exclusive, utility in UVGI uplighters.

Ultraviolet germicidal irradiation (UVGI) is known to be used to disinfect air. Although HVAC installations can incorporate UV lamps within themselves, such that air from a room is moved into the HVAC installation before being irradiated and subsequently returned to the room, construction of such HVAC installations is a major exercise. There are many environments in which air purification UVGI systems would be beneficial, though full HVAC installations would be inconvenient.

Self-contained upper-room ultraviolet fixtures are known to project UV light over an irradiation region, which is typically adjacent to the ceiling of that room such that it is spaced from the room's occupants. Convection ensures that eventually all air within the room is subject to disinfection by the UV light. As conventional UV lights tend to have a blue-ish colour to the light emitted therefrom, the ceilings of rooms in which such upper-room ultraviolet fixtures are in use are often tinted blue. In work environments, this is often overlooked; however, in domestic and/or hospitality settings, such blue colours can be undesirable.

According to a first aspect of the present invention, there is provided a UVGI lighting device, comprising: an ultraviolet light source configured to emit ultraviolet light; a housing in which the ultraviolet light source is located, the housing configured to project ultraviolet light from the ultraviolet light source predominantly over an irradiation region; a visible light source, distinct from the ultraviolet light source, configured to emit visible light and arranged within the housing to project visible light over the irradiation region.

In this way, the net effect of the combination of the ultraviolet light and the visible light would be to mask the undesirable blue light from the UV light source.

The UVGI lighting device may be an uplighter; that is, a lighting device intended to throw illumination upwards. In particular, the lighting device may be freestanding, and may be configured to be placed on the floor and/or ground; however, in alternative arrangements, the lighting device may be configured to be attached to a support structure, such as a stand, wall and/or ceiling.

Uplighters are specifically designed to obscure the light source from view by a room's occupants during normal use, such that illumination within a room is provided by reflected light from the surfaces within the room. Accordingly, accidental viewing of the ultraviolet light source is prevented.

5 The ultraviolet light source may comprise a mercury-vapor lamp, a pulsed-xenon lamp and/or any other suitable UV light source.

 The ultraviolet light may comprise radiation having a wavelength between 100 and 400 nm, in particular between 100 and 280 nm. For instance, the ultraviolet light may comprise at least / only UV-C light. The ultraviolet light may have a peak spectral
10 intensity between 220 and 290 nm, in particular between 225 and 270 nm, for example at approximately 230 nm, 255 nm and/or 265 nm. The peak spectral intensity may be the strongest spectral intensity; however, in some arrangements there may be other more intense emission lines at different frequencies, though at least one peak may be provided in the range specified.

15 In this way, the wavelength of the UV light may be selected to match the germicidal effectiveness against a specific microbe.

 The light emitted from the ultraviolet light source may additionally comprise blue light; that is, light having a wavelength between 380 and 495 nm.

 The housing may comprise a cowl/cowling for blocking/absorbing light
20 transmission therethrough, and/or a reflector for reflecting light incident thereon. In this way, the housing may be used to direct light from the light sources.

 The reflector may comprise a parabolic reflector, such that light from the UV light source may be focussed into a roughly parallel beam of light.

 The irradiation region may comprise a three-dimensional volume in which the
25 intensity of the ultraviolet light is above some minimum threshold.

 The visible light source may comprise an electric light, for example an incandescent light bulb, an LED lamp, an arc lamp and/or a gas-discharge lamp.

 In the context of the present application, the visible light source should not be interpreted as the ultraviolet light source, even if the ultraviolet light source emits visible
30 light, which many do. In particular, the visible light source may be separate from the ultraviolet light source, for example adjacent to and/or spaced from the ultraviolet light source.

The visible light source may be configured to emit visible light such that the visible light's apparent colour to an observer would have a wavelength between 570 and 750 nm.

5 The visible light may comprise radiation, or be composed solely of radiation, having a wavelength between 380 and 800 nm, in particular between 420 and 680 nm, more particularly above 495nm, for example above 570nm. For instance, the visible light may comprise at least, only or predominantly green, yellow and/or red light, and may appear to have a net effective wavelength of between 495 and 800 nm, in particular between 570 and 750 nm (i.e. such that it appears green, yellow and/or red). In this
10 way, the visible light, when combined with light from the ultraviolet light source, may appear substantially any spectral colour.

The visible light source may comprise a plurality of coloured light sources.

The visible light source may be arranged within the housing to project visible light predominantly over the irradiation region; however, in alternative arrangements the
15 visible light may be projected outside the irradiation region. The device may include additional visible light sources having different colours (including blue) that project within and/or outside the irradiation region.

The UVGI lighting device may comprise a fan configured to draw air past the UV light. In this way, all air within the room may be subject to disinfection by the UV
20 light much more efficiently than relying on convection alone.

According to a second aspect of the present invention, there is provided a method of performing ultraviolet germicidal irradiation, the method comprising the steps of: providing an ultraviolet light source configured to emit ultraviolet light; providing a housing in which the ultraviolet light source is located, the housing
25 configured to project ultraviolet light from the ultraviolet light source predominantly over an irradiation region; providing a visible light source, distinct from the ultraviolet light source, configured to emit visible light and arranged within the housing to project visible light over the irradiation region; selecting an appropriate colour of visible light to emit from the visible light source that, when combined with light emitted from the
30 ultraviolet light source, appears to match a predefined desired colour.

The above and other characteristics, features and advantages of the present invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings, which illustrate, by way of example, the

principles of the invention. This description is given for the sake of example only, without limiting the scope of the invention. The reference figures quoted below refer to the attached drawings.

Figure 1 is cut-away view of a first UVGI device.

5 Figure 2 is a perspective view of a second UVGI device.

Figure 3 is an exploded view of the second UVGI device.

Figure 4 is a schematic representation of light paths within the second UVGI device.

The present invention will be described with respect to certain drawings but the invention is not limited thereto but only by the claims. The drawings described are only
10 schematic and are non-limiting. Each drawing may not include all of the features of the invention and therefore should not necessarily be considered to be an embodiment of the invention. In the drawings, the size of some of the elements may be exaggerated and not drawn to scale for illustrative purposes. The dimensions and the relative
15 dimensions do not correspond to actual reductions to practice of the invention.

Furthermore, the terms first, second, third and the like in the description and in the claims, are used for distinguishing between similar elements and not necessarily for describing a sequence, either temporally, spatially, in ranking or in any other manner. It is to be understood that the terms so used are interchangeable under appropriate
20 circumstances and that operation is capable in other sequences than described or illustrated herein. Likewise, method steps described or claimed in a particular sequence may be understood to operate in a different sequence.

Moreover, the terms top, bottom, over, under and the like in the description and the claims are used for descriptive purposes and not necessarily for describing relative
25 positions. It is to be understood that the terms so used are interchangeable under appropriate circumstances and that operation is capable in other orientations than described or illustrated herein.

It is to be noticed that the term “comprising”, used in the claims, should not be interpreted as being restricted to the means listed thereafter; it does not exclude other
30 elements or steps. It is thus to be interpreted as specifying the presence of the stated features, integers, steps or components as referred to, but does not preclude the presence or addition of one or more other features, integers, steps or components, or groups thereof. Thus, the scope of the expression “a device comprising means A and

B” should not be limited to devices consisting only of components A and B. It means that with respect to the present invention, the only relevant components of the device are A and B.

5 Similarly, it is to be noticed that the term “connected”, used in the description, should not be interpreted as being restricted to direct connections only. Thus, the scope of the expression “a device A connected to a device B” should not be limited to devices or systems wherein an output of device A is directly connected to an input of device B. It means that there exists a path between an output of A and an input of B which may be a path including other devices or means. “Connected” may mean that
10 two or more elements are either in direct physical or electrical contact, or that two or more elements are not in direct contact with each other but yet still co-operate or interact with each other. For instance, wireless connectivity is contemplated.

Reference throughout this specification to “an embodiment” or “an aspect” means that a particular feature, structure or characteristic described in connection with
15 the embodiment or aspect is included in at least one embodiment or aspect of the present invention. Thus, appearances of the phrases “in one embodiment”, “in an embodiment”, or “in an aspect” in various places throughout this specification are not necessarily all referring to the same embodiment or aspect, but may refer to different embodiments or aspects. Furthermore, the particular features, structures or
20 characteristics of any one embodiment or aspect of the invention may be combined in any suitable manner with any other particular feature, structure or characteristic of another embodiment or aspect of the invention, as would be apparent to one of ordinary skill in the art from this disclosure, in one or more embodiments or aspects.

Similarly, it should be appreciated that in the description various features of the
25 invention are sometimes grouped together in a single embodiment, figure, or description thereof for the purpose of streamlining the disclosure and aiding in the understanding of one or more of the various inventive aspects. This method of disclosure, however, is not to be interpreted as reflecting an intention that the claimed invention requires more features than are expressly recited in each claim. Moreover, the description of any
30 individual drawing or aspect should not necessarily be considered to be an embodiment of the invention. Rather, as the following claims reflect, inventive aspects lie in fewer than all features of a single foregoing disclosed embodiment. Thus, the claims following

the detailed description are hereby expressly incorporated into this detailed description, with each claim standing on its own as a separate embodiment of this invention.

Furthermore, while some embodiments described herein include some features included in other embodiments, combinations of features of different embodiments are
5 meant to be within the scope of the invention, and form yet further embodiments, as will be understood by those skilled in the art. For example, in the following claims, any of the claimed embodiments can be used in any combination.

In the description provided herein, numerous specific details are set forth. However, it is understood that embodiments of the invention may be practised without
10 these specific details. In other instances, well-known methods, structures and techniques have not been shown in detail in order not to obscure an understanding of this description.

In the discussion of the invention, unless stated to the contrary, the disclosure of alternative values for the upper or lower limit of the permitted range of a parameter,
15 coupled with an indication that one of said values is more highly preferred than the other, is to be construed as an implied statement that each intermediate value of said parameter, lying between the more preferred and the less preferred of said alternatives, is itself preferred to said less preferred value and also to each value lying between said less preferred value and said intermediate value.

20 The use of the term “at least one” may mean only one in certain circumstances. The use of the term “any” may mean “all” and/or “each” in certain circumstances.

The principles of the invention will now be described by a detailed description of at least one drawing relating to exemplary features. It is clear that other arrangements can be configured according to the knowledge of persons skilled in the art without
25 departing from the underlying concept or technical teaching, the invention being limited only by the terms of the appended claims.

Figure 1 is cut-away view of a first UVGI device, based on the shape of typical PAR 64 electric lamp. Due to the potential dangers of UV light, the first UVGI device is suitable for use as an uplighter, to provide ambient light to occupants of a room.
30 Specifically, the first UVGI device includes an outer casing 101, shown cut-away in this figure, but having a substantially cylindrical shape. The upper end of the cylinder 101 is open to allow light to be emitted therefrom. The lower end of the cylinder 101 is

enclosed by a dome 103, inside which may be housed any necessary control electronics and/or electrical components.

A pair of mercury-vapor lamps 105 are provided in the centre of the lamp, though it is to be appreciated that any form of UV light source is possible. A parabolic reflector 107 is placed below the pair of mercury-vapor lamps 105, with the pair of mercury-vapor lamps 105 disposed approximately along the focal line of the parabolic reflector 107. It is to be noted that the parabolic reflector 107 does not have rotational symmetry due to the elongate shape of the pair of mercury-vapor lamps 105 requiring to be aligned along a focal line of the parabolic reflector 107. Accordingly, the UV light from the pair of mercury-vapor lamps 105 will be focussed into an approximately parallel beam.

In alternative arrangements in which a UV light source is provided having a less elongate shape, a rotationally symmetric parabolic dish may be used instead of the parabolic reflector 107, as the alternative UV light source could be modelled as a point source.

To mask the blue glow of the pair of mercury-vapor lamps 105, two LED spotlights 109 are also placed within the housing, adjacent to the pair of mercury-vapor lamps 105. The two LED spotlights 109 may have colours that complement the blue colour of the pair of mercury-vapor lamps 105; that is, red and green, respectively. The intensities of each of the two LED spotlights 109 (and optionally the pair of mercury-vapor lamps 105) may be controlled via conventional digital multiplexing means.

A fan 111 is located below the pair of mercury-vapor lamps 105 to encourage air flow past the pair of mercury-vapor lamps 105.

Figure 2 is a perspective view of a second UVGI device for installation adjacent to the ceiling of a room, or at least substantially above the occupants of a room. The second UVGI device comprises an outer case 201 with a fan 203 built into the side thereof. The outer case 201 is open at its left and right sides as shown in the figure. Inside the right side can be seen a single one or a plurality of LED spotlights 205.

The base of the outer case 201 extends sideways out beyond the side openings in the form of two screens 207, to prevent any light from inside the outer case 201 travelling directly down to the occupants below. On top of each screen 207 is a reflector 209, such that any light incident on the screens 207 is reflected upwards instead of being absorbed by the screen 207.

Figure 3 is an exploded view of the second UVGI device showing the outer case split into an upper 201a removed from the base 201b. All four of the plurality of LED spotlights 205 can be seen, two arranged adjacent to each opening. Again, the two LED spotlights 205 at each opening mask the blue glow of the pair of mercury-vapor lamps 211. The two LED spotlights 205 at each opening may have colours that complement the blue colour of the pair of mercury-vapor lamps 211; that is, red and green, respectively. The intensities of any of the LED spotlights 205 (and optionally the pair of mercury-vapor lamps 211) may be controlled via conventional digital multiplexing means.

10 A parabolic reflector 213 is also shown, lifted away from the pair of mercury-vapor lamps 211 for clarity, for directing the UV light emitted from the pair of mercury-vapor lamps 211, as will be discussed in more detail below.

The fan 203 is arranged to blow air from the room directly over the pair of mercury-vapor lamps 211, to improve circulation and effectiveness of the sterilisation.

15 Figure 4 is a schematic representation of light paths within the second UVGI device. A first light ray 215 passes from the pair of mercury-vapor lamps 211 to the left of the figure, is reflected by the parabolic reflector 213 directly down toward an angled reflector 217, and then passes horizontally outward.

20 A second light ray 219 passes from the pair of mercury-vapor lamps 211 to the right of the figure, is reflected by the parabolic reflector 213 directly down toward the angled reflector 217, and then passes horizontally outward.

A third light ray 221 passes from the pair of mercury-vapor lamps 211 downward to the right of the figure, misses the parabolic reflector 213 and reflects up from the reflector 209.

25

CLAIMS

1. A UVGI lighting device, comprising:
 - an ultraviolet light source configured to emit ultraviolet light;
 - 5 a housing in which the ultraviolet light source is located, the housing configured to project ultraviolet light from the ultraviolet light source predominantly over an irradiation region;
 - a visible light source, distinct from the ultraviolet light source, configured to emit visible light and arranged within the housing to project visible light over the irradiation region.
- 10 2. The UVGI lighting device of claim 1, wherein the device is an uplighter.
3. The UVGI lighting device of claim 1 or claim 2, wherein the visible light source is configured to emit visible light such that the visible light's apparent colour to an
15 observer would have a wavelength between 570 and 750 nm.
4. The UVGI lighting device of any preceding claim, further comprising a fan configured to draw air past the UV light.
- 20 5. A method of performing ultraviolet germicidal irradiation, the method comprising the steps of:
 - providing an ultraviolet light source configured to emit ultraviolet light;
 - providing a housing in which the ultraviolet light source is located, the housing configured to project ultraviolet light from the ultraviolet light source predominantly
25 over an irradiation region;
 - providing a visible light source, distinct from the ultraviolet light source, configured to emit visible light and arranged within the housing to project visible light over the irradiation region;
 - selecting an appropriate colour of visible light to emit from the visible light source that,
30 when combined with light emitted from the ultraviolet light source, appears to match a predefined desired colour.

CLAIMS

1. A UVGI lighting device, comprising:
an ultraviolet light source configured to emit ultraviolet light;
5 a housing in which the ultraviolet light source is located, the housing configured to project ultraviolet light from the ultraviolet light source predominantly over an irradiation region;
a visible light source, distinct from the ultraviolet light source, configured to emit visible light and arranged within the housing to project visible light over the irradiation region;
a parabolic reflector configured to reflect the ultraviolet light; and
10 an angled reflector configured to reflect the ultraviolet light.
2. The UVGI lighting device of claim 1, wherein the device is an uplighter.
3. The UVGI lighting device of claim 1 or claim 2, wherein the visible light source
15 is configured to emit visible light between 570nm and 750nm, such that the visible light's apparent colour to an observer would have a wavelength between 570 and 750 nm.
4. The UVGI lighting device of any preceding claim, further comprising a fan configured to draw air past the UV light.
20
5. A method of performing ultraviolet germicidal irradiation, the method comprising the steps of:
providing an ultraviolet light source configured to emit ultraviolet light;
providing a parabolic reflector configured to reflect the ultraviolet light;
25 providing an angled reflector configured to reflect the ultraviolet light;
providing a housing in which the ultraviolet light source is located, the housing configured to project ultraviolet light from the ultraviolet light source predominantly over an irradiation region;
providing a visible light source, distinct from the ultraviolet light source, configured to
30 emit visible light and arranged within the housing to project visible light over the irradiation region; and

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selecting an appropriate colour of visible light to emit from the visible light source that, when combined with light emitted from the ultraviolet light source, appears to match a predefined desired colour.

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Application No: GB2203772.5

Examiner: Sophie Brown

Claims searched: 1-5

Date of search: 12 August 2022

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-5	US 2022/0040366 A1 (MAA et al.) see in particular [0012], [0014]-[0015], [0024], [0049]; Figure 3
X	1-5	US 2007/0053188 A1 (NEW et al.) see in particular [0024]-[0029]; Figures 1-3
X	1-5	WO 2019/068189 A1 (BOMBARDIER INC) see in particular [0066], [0070]-[0071]; Figure 2
X	1-5	CN 105674169 A (QUANZHOU SHIXIN INTELLIGENT LIGHTING TECH INST CO LTD) see in particular [0007], [0046]-[0047]; Figure 1
X	1-5	CN 205504689 U (QUANZHOU SHIXIN INTELLIGENT LIGHTING TECH RES INST CO LTD) see in particular [0007], [0046]-[0047]; Figures 1-3
X	1-5	US 2021/0289599 A1 (MEIR et al.) see in particular [0056], [0058]-[0062]; Figures 2, 5

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^X :

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Worldwide search of patent documents classified in the following areas of the IPC

A61L

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC



International Classification:

Subclass	Subgroup	Valid From
A61L	0009/20	01/01/2006
A61L	0002/10	01/01/2006