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(54) **A LIGHTING DEVICE, FOR INSTANCE FOR GREENHOUSE LIGHTING, AND CORRESPONDING METHOD OF USE**

BELEUCHTUNGSVORRICHTUNG, ZUM BEISPIEL ZUR GEWÄCHSHAUSBELEUCHTUNG, UND ZUGEHÖRIGES VERFAHREN ZUR VERWENDUNG

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Description

Technical Field

[0001] The present description relates to lighting devices.

[0002] One or more embodiments may refer to lighting devices employing electrically powered solid-state light radiation sources, such as LED sources.

[0003] One or more embodiments may find application in greenhouse lighting.

Technological Background

[0004] Lamps such as High Pressure Sodium (HPS) lamps, which are employed to enhance the growth of plants, may exhibit various limits and drawbacks.

[0005] For example, plants are able to absorb only a small fraction of the light spectrum of such lamps.

[0006] Moreover, some lamps emit UV radiation which, if not properly filtered, may be harmful both to plants and to operators e.g. in a greenhouse.

[0007] In addition, some lamps may contain metals harmful to the environment, and moreover they may be fragile and have a short operating life.

[0008] LED sources may be a valid solution to replace such traditional light sources, e.g. because they have a high-intensity light emission in a wavelength range adapted to foster plant growth.

[0009] Moreover, the possibility is given to use LEDs with different light emission features, so as to influence the overall spectral features of the emitted radiation.

[0010] The possible use of LED light radiation sources for plant lighting, e.g. in the horticultural sector, is the object of various patents.

[0011] For example, patent KR 100879711 describes a mixing of radiations produced by LEDs in the ranges of 640 to 675 nm and 425 to 455 nm, with different ratios: 9:1, 8:2, 7:3 and 6:4.

[0012] US 6 921 182 B2 describes the use of orange, red and blue LED sets having different output angles.

[0013] US 8 944 631 B2 describes a LED lighting unit of a mixed type, employing various units with red and blue LEDs. Each unit comprises three blue LEDs in a triangle, and eight red LEDs in four sets, which are arranged in a rectangular configuration.

[0014] US 5 660 461 A describes a module comprising one or more U-shaped substrates, one substrate acting as a heatsink, and a cone-shaped reflector, being aligned so that the LED is located at the centre of the cone, the device comprising a plurality of modular units that are snapped together.

[0015] US 6 042 250 A discloses a reflector having a plurality of flutes, adapted to reflect the light emitted by a source arranged at the focal point of the reflector, so as to obtain a uniform distribution of the radiation. The reflector is adapted to operate with various kinds of sources without jeopardizing the uniformity or the desired level of lighting in an area where plants are grown.

[0016] US 8 174 688 B2 discloses a method for determining the number of different light sources provided in a lighting device having different RGB ratios.

[0017] More specifically, the invention relates to a lighting device according to the preamble of claim 1, which is known e.g. from US2014/215917 A1. Also documents CN 201 954 327 U, KR 100 906 226 B1 and WO 2011/044931 A1 are of interest for the invention.

Object and Summary

[0018] One or more embodiments aim at providing an improved lighting device, adapted to be used e.g. for greenhouse lighting.

[0019] According to one or more embodiments, said object is achieved thanks to a lighting device having the features specifically set forth in claim 1 that follows.

[0020] One or more embodiments may also concern a corresponding method of use.

[0021] The claims are an integral part of the technical teaching provided herein with reference to the embodiments.

[0022] One or more embodiments lead to the achievement of one or more of the following advantages:

- the possibility of obtaining a certain level of irradiance in the plane where plants are located, while ensuring a certain ratio between the radiometric power of blue and red radiation,
- the possibility of taking into account that the level of irradiance depends on the installation height of the lighting device and on the area of the lit surface (e.g. the plants may be arranged on tables which are raised from the floor, on a square surface), the possibility being given for the emitted radiation beam to correspond to a parallelogram shape (e.g. a square or a rectangular shape) with the further option to increase irradiance in the area where plants are placed while reducing it in the surrounding areas,
- the possibility of regulating the ratio between different sources (e.g. blue and red) in a specific way, e.g. 1:24, according to the needs.

[0023] Irradiance is a radiometric quantity of the International System, and it indicates the flux impinging on an orthogonal surface per unit of surface area; the unit of measure is watt per square meter (W/m^2).

Brief Description of the Figures

[0024] One or more embodiments will now be described, by way of non-limiting example only, with reference to the annexed Figures, wherein:

- Figure 1 is a view of a lighting device according to one or more embodiments (not in accordance with the invention as claimed), viewed from the front;

- Figure 2 is a view of the device in Figure 1, viewed in side elevation, and
- Figure 3 shows a modular lighting device according to one or more embodiments.

[0025] It will be appreciated that, for clarity of illustration, the views in the various Figures may not be drawn to the same scale.

Detailed Description

[0026] In the following description, numerous specific details are given to provide a thorough understanding of exemplary embodiments. One or more embodiments may be practiced without one or several specific details, or with other methods, components, materials, etc. In other instances, well-known structures, materials, or operations are not shown or described in detail to avoid obscuring various aspects of the embodiments. Reference throughout this specification to "one embodiment" or "an embodiment" means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment. Thus, the possible appearances of the phrases "in one embodiment" or "in an embodiment" in various places throughout this specification are not necessarily all referring to the same embodiment. Furthermore, particular features, structures, or characteristics may be combined in any suitable manner in one or more embodiments.

[0027] The headings provided herein are for convenience only, and therefore do not interpret the extent of protection or the scope of the embodiments.

[0028] In the Figures, reference 10 denotes a lighting device comprising one (single) support board 12 (e.g. similar to a Printed Circuit Board, PCB) mounting an array of electrically powered light radiation sources 14.

[0029] In one or more embodiments these sources are LED light radiation sources 14, e.g. High Power LEDs. The LEDs may be of the type marketed under the trade mark OSLON® Square by companies belonging to the same corporation as the Applicants'.

[0030] In one or more embodiments the LED light radiation sources may constitute a square package. This shape enables a side-by-side arrangement of the light radiation sources, in a densely clustered array.

[0031] In one or more embodiments, board (PCB) 12 may be arranged on a support member 16 having the function of a heatsink, adapted to dissipate the heat produced by sources 14 in operation, e.g. so that the LED junction temperature remains within a peak value according to specifications.

[0032] In one or more embodiments, such an assembly may exhibit low thermal resistance, making it possible to achieve high efficiency, e.g. with high current driving.

[0033] In one or more embodiments as exemplified herein, light radiation sources 14 are arranged in a matrix array, e.g. a square array. Figures depict, by way of example, a square 5x5 matrix.

[0034] In one or more embodiments, the LEDs 14 in the array may have the same package but different emission features.

[0035] E.g., in one or more embodiments, array 14 may comprise a first and a second sets of LEDs, respectively emitting a blue and a red radiation.

[0036] In one or more embodiments, the emission of blue radiation may have a spectrum (with a rather narrow peak) centred at 444 nm, while the emission of red radiation may have a spectrum (again, with a rather narrow peak) centred at 660 nm.

[0037] In one or more embodiments, the ratio between blue and red radiometric power may be approximately 0.05 in favour of the red radiation.

[0038] In one or more embodiments, such a result may be achieved by using blue and red sources in a ratio of 1:24.

[0039] For example, in an arrangement as exemplified in Figure 1 (not in accordance with the invention as claimed), such a result may be achieved by arranging a blue LED 140 centrally in the array (a square 5x5 array in the presently considered example), and by surrounding the blue LED with a plurality of red LEDs 142.

[0040] In one or more embodiments, in order to take into account that the LEDs arranged centrally in the array (e.g. blue LED 140 in Figure 1) may experience a heavier thermal load than the surrounding LEDs, a pitch e.g. of 1 mm may be adopted (instead of smaller, e.g. 0.5 mm, pitches that are theoretically possible) so as to facilitate the thermal management of array 14.

[0041] In one or more embodiments (see e.g. Figure 2), the array of sources 14 may be coupled to a reflector 18 having e.g. the shape of a truncated pyramid.

[0042] In one or more embodiments, reflector 18 may reflect the rays most tilted with respect to the optical axis of array 14 (shown as a dash-dot line) towards the front emission area, while guiding them towards the lighting area (e.g. where plants are located).

[0043] In one or more embodiments, reflector 18 having the shape of a truncated pyramid may have a square cross-section, so as to generate a square beam corresponding to the arrangement of the plants on the tables, where they are usually placed in current horticultural applications.

[0044] In one or more embodiments, reflector 18 may originate a square lighting distribution on an area of 10 m^2 located approximately 3 m away from device 10. This leads to obtaining, on that area, a uniform irradiance profile, and therefore the uniformity of lighting which is required for the presently considered application.

[0045] In one or more embodiments, the ratio of the height of reflector 18 (i.e. the distance between the input plane and the output plane of reflector 18) to the side of said input plane, which is assumed as being square, may amount approximately to 3.5.

[0046] In one or more embodiments, at the output plane of reflector 18 there may be provided a cover 20, e.g. a flat cover, of a plastic material or glass, which is permeable to the radiation emitted by sources 14.

[0047] The choice of the sizes previously listed is however not mandatory.

[0048] Similarly, in one or more embodiments, reflector 18 may have a shape other than a truncated pyramid, having e.g. a different diverging ("flared") shape, e.g. conical or parabolic, or even a more complex shape.

[0049] In one or more embodiments, reflector 18 may have faceted surfaces, with concave or convex faces. Moreover, the possibility is given to adapt the shape of the emitted radiation to various lighting needs.

[0050] In one or more embodiments, cover 20 may be flat as shown, and/or may have pillow microstructures, a surface sculpting, for example with cylindrical elements, or a grained surface.

[0051] In one or more embodiments reflector 18 may have inner walls treated with an aluminization coating, so that they acquire reflective properties.

[0052] In one or more embodiments, reflector 18 may have lambertian scattering features, e.g. as in the case of a white material. One or more embodiments may envisage a roughened surface having diffusive properties. Indeed, a surface roughening treatment may generate a diffusive reflection depending on the material and on the roughness values, i.e. with the light diffusion with respect to the specular direction depending on the properties of the material and of the surface. A rough surface may scatter light at 5, 10, 20° with respect to the specular direction. Lambertian scattering follows the law of cosines and is typical of white materials, bulk and microstructured diffusers. By way of example only, with reference to one or more embodiments, with a reflector with lambertian surfaces having a reflectivity of 80% an average irradiance value may be obtained which is 40% less than the average irradiance value achievable with specular reflective surfaces.

[0053] In one or more embodiments, different areas of reflector 18 may have either the same or different optical properties, e.g. the reflector surface may have specular reflective properties in some areas and diffusive reflective properties in other areas.

[0054] In one or more embodiments, reflector 18 may be a TIR (Total Internal Reflection) collimator, wherein the rays impinging on the side walls of the collimator are reflected in conditions of total internal reflection.

[0055] In one or more embodiments, the output surface of such a collimator may have millimetre-sized or micrometre-sized structures (e.g. bumps, so-called pillows or prisms of different shapes: square, hexagonal, concave, convex etc.), or it may have a roughened surface.

[0056] In one or more solutions, as exemplified in Figure 1 (not in accordance with the invention as claimed), blue LED 140 may be arranged centrally in array 14.

[0057] In one or more embodiments the arrangement may be off-centred, as better detailed in the following with reference to the modular structure of Figure 3, e.g. with a blue LED 140 (in the following, for simplicity, we will assume the presence of only one blue source in the array, although this condition is not strictly mandatory) arranged in the middle of one of the four "quarters" into which an array, e.g. the square array of Figure 1, may be divided.

[0058] In this case a situation may ensue wherein the irradiance pattern produced by blue LED 140 is not homogeneous with respect to the pattern generated by the set of red LEDs 142.

[0059] In the case of a central location (Figure 1) a reduction of irradiance values may be detected in the middle of the arrangement.

[0060] If the blue LED is placed in the middle of one of the quarters of a square array, the lowest value (i.e. the "hole") of irradiance is off-centred with respect to the overall irradiance pattern.

[0061] In one or more embodiments it is possible to modify such an asymmetry as schematically shown in Figure 3, exemplifying the possibility of implementing a modular structure comprising several modules, each of which has a structure as shown in Figure 1.

[0062] Figure 3 refers, by way of example only, to a modular structure comprising four modules in mutual alignment.

[0063] Such a choice, of course, is by no way mandatory. E.g., it is possible to implement lighting devices including a rather high number of modules, e.g. 36 modules arranged in a square 6x6 array or in a rectangular 3x12 array, i.e. comprising three rows of 12 modules each: for a direct reference, the assembly shown in Figure 3 corresponds to a 1x4 matrix, i.e. one row comprising four modules.

[0064] The use of such a system of several modules (which may have a common cover 20) leads to the possibility of obtaining higher irradiance levels on the plane where plants are located.

[0065] Another advantage may derive from the fact that, since a module may achieve a square lighting pattern on a plane, by arranging two or more modules side by side a superposition of square lighting patterns may be obtained, thus increasing the overall irradiance homogeneity.

[0066] Moreover, a modular system may replace current systems employing HPS lamps also as regards power, by using a suitable number of LEDs or, more generally, by adapting the overall number of LEDs in the array. In this way, for example, existing lighting systems may be replaced without the need of changing installation conditions, e.g. within a greenhouse.

[0067] Moreover, as exemplified in Figure 3, the directions of offset from the centre of the array of off-centred LEDs 140 may be rotated from module to module, so that an overall homogeneity of the irradiance pattern may be achieved.

[0068] For example, referring to the viewpoint of Figure 3, blue LEDs 140 (one for each array in the presently considered embodiment) are shown as located in positions respectively rotated by 90° which, advancing from left to right in Figure 3, may be roughly identified as South-West, North-West, North-East and South-East positions.

[0069] In one or more embodiments, light radiation sources 140, 142 may therefore be arranged in a plurality of arrays (e.g. the four arrays of Figure 3), wherein:

- each array in the plurality of arrays comprises at least one light radiation source of the first set (e.g. a blue LED 140) arranged off-centre in a respective direction (D1, D2, D3, D4 - always referring to Figure 3) from the centre of the array, and
- the arrays of the plurality of arrays are arranged with different orientations of the respective directions D1, D2, D3, D4, e.g. with orientations mutually rotated by 90°.

[0070] One or more embodiments may admit various modifications in the implementation.

[0071] For example, one or more embodiments may envisage a ratio of blue to red sources which is different from 1:24.

[0072] Moreover, in a modular system as exemplified in Figure 3, different modules may have all the same ratio of blue to red sources, or may have different ratios. This approach offers the possibility of "fine-tuning" the irradiance level e.g. of blue light, or of modifying, according to the application needs, the irradiance homogeneity.

[0073] In one or more embodiments, in a (5x5) array of 25 sources as exemplified in the Figures, the presence of a higher number of blue sources may be envisaged, e.g. so as to obtain a ratio of 2:23. In this case the location of blue sources may satisfy specular symmetry or rotational symmetry conditions, once again through a rotation (e.g. by 90°) of the mounting positions, as previously exemplified with reference to Figure 3.

[0074] For example, an arrangement featuring a rotational symmetry may be employed when, according to particular application needs, a single-color lighting is desired (e.g. only red lighting). In this case, switching off blue sources does not originate a lack of uniformity in the radiation.

[0075] The above considerations lead to the realization that a certain ratio of the radiometric power of the first set to the radiometric power of the second set of light radiation sources (e.g. a ratio of approximately 0.05) may be achieved irrespective of a given ratio of the number of light sources in the first set 140 to the number in the second set 142 (e.g. 1:24).

[0076] In other words, a ratio of radiometric powers amounting to 0.05 may be achieved with a ratio of the number of sources other than 1:24.

[0077] For example, while in one or more embodiments the radiometric power of the LEDs may be left unvaried by an optional dimming function, in one or more embodiments the radiometric power of blue and red LEDs may be changed selectively through a selective dimming action, e.g. in order to balance the blue to red radiometric power ratio.

[0078] This may be done without changing the ratio of the number of sources in both sets.

[0079] In one or more embodiments, a dimming function may be used e.g. to simulate the circadian rhythm of the plants which occurs in a natural environment.

[0080] E.g. during the morning or the evening the red light may be more intense, thus simulating the light of the Sun, which in the morning and in the evening is closer to the horizon, and therefore sun rays must pass a large portion of the atmosphere and are subjected to Rayleigh scattering, proportional to the factor $(1/\lambda)^4$, wherein λ is the wavelength of the radiation. During the day the blue light is more intense than in the morning or in the evening; a dimming function may therefore simulate the variation of the blue and the red light components along 24h in a greenhouse.

[0081] Of course, without prejudice to the basic principles, the implementation details and the embodiments may vary, even appreciably, with respect to what has been described herein by way of non-limiting example only, without departing from the extent of protection.

[0082] The extent of protection is defined by the annexed claims.

Claims

1. A lighting device (10) including a substrate (12) with an array (14) of electrically-powered light radiation sources, wherein the sources in said array (14) are arranged in a first set (140) and a second set (142) to emit a blue radiation and a red radiation, respectively,
   characterized in that said light radiation sources (140, 142) are arranged in a plurality of arrays, wherein:

   - each array in said plurality of arrays includes at least one light radiation source in said first set (140) arranged off-centre in a respective direction (D1, D2, D3, D4) with respect to the centre of the array (14), and
   - the arrays of said plurality of arrays (14) are arranged with said respective directions (D1, D2, D3, D4) having different orientations.

2. The lighting device of claim 1, wherein said blue radiation and said red radiation are around 444 nm and 660 nm, respectively.

3. The lighting device of claim 1 or claim 2, wherein said light radiation sources (140, 142) are arranged side-by-side to form a densely clustered array (14) .

4. The lighting device of claim 3, wherein said light radiation sources (140, 142) have square packages.

5. The lighting device of any of claims 1 to 4, wherein:

- the ratio of the radiometric power of said first set (140) to the radiometric power of said second set (142) of light radiation sources is about 0.05, and/or
- the ratio of the numbers of light radiation sources in said first set (140) and in said second set (142) is about 1:24.

6. The lighting device of any of the previous claims, wherein said light radiation sources (140, 142) are arranged in at least one parallelogram matrix.

7. The lighting device of claim 6, wherein said light radiation sources (140, 142) are arranged in at least one square matrix.

8. The lighting device of claim 1, wherein:

- said plurality of arrays includes four arrays (14), and
- said four arrays (14) are arranged with said respective directions (D1, D2, D3, D4) having orientations mutually rotated by 90°.

9. The lighting device of any of the previous claims, including a flared reflector (18) to direct light radiation from said light radiation sources (140, 142) towards a lighting area.

10. The lighting device of claim 9, including a frusto-pyramidal reflector (18).

11. The lighting device of claim 9 or claim 10, including a flared reflector (18) to direct light radiation from said light radiation sources (140, 142) towards a parallelogram-shaped lighting area.

12. The lighting device of any of claims 9 to 11, including, at the output of said reflector (18), a cover (20) of a material permeable to the radiation of said light radiation sources.

13. The lighting device of any of the previous claims, wherein said light radiation sources (140, 142) include LED sources.

14. A method of using a lighting device according to any of claims 1 to 13, the method including varying the ratio between the radiometric powers of the radiation emitted by said first set (140) and the radiation emitted by said second set (142) of light radiation sources.

15. The method of claim 14, including varying cyclically the ratio between the radiometric powers of the radiation emitted by said first set (140) and the radiation emitted by said second set (142) of light radiation sources.

Patentansprüche

1. Beleuchtungsvorrichtung (10) umfassend ein Substrat (12) mit einem Feld (14) von elektrisch angetriebenen Lichtstrahlungsquellen, wobei die Quellen in dem Feld (14) in einem ersten Satz (140) und einem zweiten Satz (142) angeordnet sind, um blaue Strahlung bzw. rote Strahlung auszustrahlen,
dadurch gekennzeichnet, dass die Lichtstrahlungsquellen (140, 142) in einer Vielzahl von Feldern angeordnet sind, wobei:

- jedes Feld in der Mehrzahl von Feldern mindestens eine Lichtstrahlungsquelle in dem ersten Satz (140) umfasst, die exzentrisch angeordnet ist in einer jeweiligen Richtung (D1, D2, D3, D4) in Bezug auf das Zentrum des Feldes, und
- die Felder der Vielzahl von Feldern (14) mit unterschiedlichen jeweiligen Richtungen (D1, D2, D3, D4) angeordnet sind.

2. Beleuchtungsvorrichtung nach Anspruch 1, wobei die blaue Strahlung bzw. die rote Strahlung etwa 444 nm und 660 nm beträgt.

3. Beleuchtungsvorrichtung nach Anspruch 1 oder Anspruch 2, wobei die Lichtstrahlungsquellen (140, 142) nebeneinander angeordnet sind, um ein dichtgruppiertes Feld (14) zu bilden.

4. Beleuchtungsvorrichtung nach Anspruch 3, wobei die Lichtstrahlungsquellen (140, 142) quadratische Pakete aufweisen.

5. Beleuchtungsvorrichtung nach einem der Ansprüche 1 bis 4, wobei:
das Verhältnis der radiometrischen Leistung des ersten Satzes (140) zur radiometrischen Leistung des zweiten Satzes (142) der Lichtstrahlungsquellen etwa 0,05 beträgt, und/oder

- das Verhältnis der Anzahl der Lichtstrahlungsquellen in dem ersten Satz (140) und in dem zweiten Satz (142) etwa 1:24 beträgt.

6. Beleuchtungsvorrichtung nach einem der vorhergehenden Ansprüche, wobei die Lichtstrahlungsquellen (140, 142) in zumindest einer parallellogrammartigen Matrix angeordnet sind.

7. Beleuchtungsvorrichtung nach Anspruch 6, wobei die Lichtstrahlungsquellen (140, 142) in zumindest einer quadratischen Matrix angeordnet sind.

8. Beleuchtungsvorrichtung nach Anspruch 1, wobei

- die Mehrzahl von Feldern vier Felder (14) beinhaltet und

- die vier Felder (14) mit jeweiligen Richtungen (D1, D2, D3, D4) angeordnet sind, wobei die jeweiligen Richtungen zueinander um 90° rotierte Orientierungen aufweisen.

9. Beleuchtungsvorrichtung nach einem der vorhergehenden Ansprüche, umfassend einen aufgeweiteten Reflektor (18), um Lichtstrahlung von den Lichtstrahlungsquellen (140, 142) in Richtung eines Beleuchtungsbereiches zu richten.

10. Beleuchtungsvorrichtung nach Anspruch 9, umfassend einen pyramidenstumpfförmigen Reflektor (18).

11. Beleuchtungsvorrichtung nach Anspruch 9 oder 10, beinhaltend einen aufgeweiteten Reflektor (18), um Lichtstrahlung von den Lichtstrahlungsquellen (140, 142) In Richtung des parallellogrammförmigen Beleuchtungsbereichs zu richten.

12. Beleuchtungsvorrichtung nach einem der Ansprüche 9 bis 11, beinhaltend eine Beschichtung (20) eines Materials, das durchlässig ist für die Strahlung der Lichtstrahlungsquellen, an dem Ausgang des Reflektors (18).

13. Beleuchtungsvorrichtung nach einem der vorhergehenden Ansprüche, wobei die Lichtstrahlungsquellen (140, 142) LED-Quellen beinhalten.

14. Verfahren zur Verwendung einer Beleuchtungsvorrichtung nach einem der Ansprüche 1 bis 13, wobei das Verfahren das Variieren des Verhältnisses zwischen den radiometrischen Leistungen der Strahlung, die durch den ersten Satz (140) ausgestrahlt wurde, und der Strahlung, die durch den zweiten Satz (142) der Lichtstrahlungsquellen ausgesendet wurde, beinhaltet.

15. Verfahren nach Anspruch 14, beinhaltend das zyklische Variieren des Verhältnisses zwischen den radiometrischen Leistungen der Strahlung, die durch den ersten Satz (140) ausgestrahlt wurde, und der Strahlung, die durch den zweiten Satz (142) der Lichtstrahlungsquellen ausgesendet wurde.

Revendications

1. Un dispositif d'éclairage (10) comprenant un substrat (12) avec un réseau (14) de sources de rayonnement lumineux alimentées électriquement, les sources dudit réseau (14) étant agencées en un premier ensemble (140) et un second ensemble (142) pour l'émission d'un rayonnement bleu et d'un rayonnement rouge, respectivement,

caractérisé en ce que lesdites sources de rayonnement lumineux (140, 142) sont agencées en une pluralité de réseaux, où :

- chaque réseau de ladite pluralité de réseaux comprend au moins une source de rayonnement lumineux dudit premier ensemble (140) agencée de façon décentrée dans une direction respective (D1, D2, D3, D4) par rapport au centre du réseau (14), et
- les réseaux de ladite pluralité de réseaux (14) sont agencés avec lesdites directions respectives (D1, D2, D3, D4) qui présentent des orientations différentes.

2. Le dispositif d'éclairage de la revendication 1, dans lequel ledit rayonnement bleu et ledit rayonnement rouge sont situés autour de 444 nm et 660 nm, respectivement.

3. Le dispositif d'éclairage de la revendication 1 ou de la revendication 2, dans lequel lesdites sources de rayonnement lumineux (140, 142) sont agencées côte à côte pour former un réseau densément regroupé (14).

4. Le dispositif d'éclairage de la revendication 3, dans lequel lesdites sources de rayonnement lumineux (140, 142) ont des boitiers carrés.

5. Le dispositif d'éclairage de l'une des revendications 1 à 4, dans lequel :

- le rapport entre la puissance radiométrique dudit premier ensemble (140) et la puissance radiométrique dudit second ensemble (142) de sources de rayonnement lumineux est d'environ 0,05, et/ou
- le rapport entre le nombre de sources de rayonnement lumineux du premier ensemble (140) et celui dudit second ensemble (142) est d'environ 1:24.

6. Le dispositif d'éclairage de l'une des revendications précédentes, dans lequel lesdites sources de rayonnement lumineux (140, 142) sont agencées en au moins une matrice en parallélogramme.

7. Le dispositif lumineux de la revendication 6, dans lequel lesdites sources de rayonnement lumineux (140, 142) sont agencées en au moins une matrice carrée.

8. Le dispositif d'éclairage de la revendication 1, dans lequel :

- ladite pluralité de réseaux comprend quatre réseaux (14), et

- lesdits quatre réseaux (14) sont agencés avec lesdites directions respectives (D1, D2, D3, D4) qui présentent des orientations mutuellement tournées de 90°.

9. Le dispositif d'éclairage de l'une des revendications précédentes, comprenant un réflecteur évasé (18) destiné à diriger le rayonnement lumineux provenant desdites sources de rayonnement lumineux (140, 142) en direction d'une zone à éclairer.

10. Le dispositif d'éclairage de la revendication 9, comprenant un réflecteur en tronc de pyramide (18).

11. Le dispositif d'éclairage de la revendication 9 ou de la revendication 10, comprenant un réflecteur évasé (18) destiné à diriger le rayonnement lumineux provenant desdites sources de rayonnement lumineux (140, 142) en direction d'une zone à éclairer en forme de parallélogramme.

12. Le dispositif d'éclairage de l'une des revendications 9 à 11, comprenant, en sortie dudit réflecteur (18), un capot (20) d'un matériau perméable au rayonnement desdites sources de rayonnement lumineux.

13. Le dispositif d'éclairage de l'une des revendications précédentes, dans lequel lesdites sources de rayonnement lumineux (140, 142) comprennent des sources LED.

14. Un procédé d'utilisation d'un dispositif d'éclairage selon l'une des revendications 1 à 13, dans lequel le procédé comprend la variation du rapport entre les puissances radiométriques du rayonnement émis par ledit premier ensemble (140) et du rayonnement émis par ledit second ensemble (142) de sources de rayonnement lumineux.

15. Le procédé de la revendication 14, comprenant la variation cyclique du rapport entre les puissances radiométriques du rayonnement émis par ledit premier ensemble (140) et du rayonnement émis par ledit second ensemble (142) de sources de rayonnement lumineux.

FIG. 2

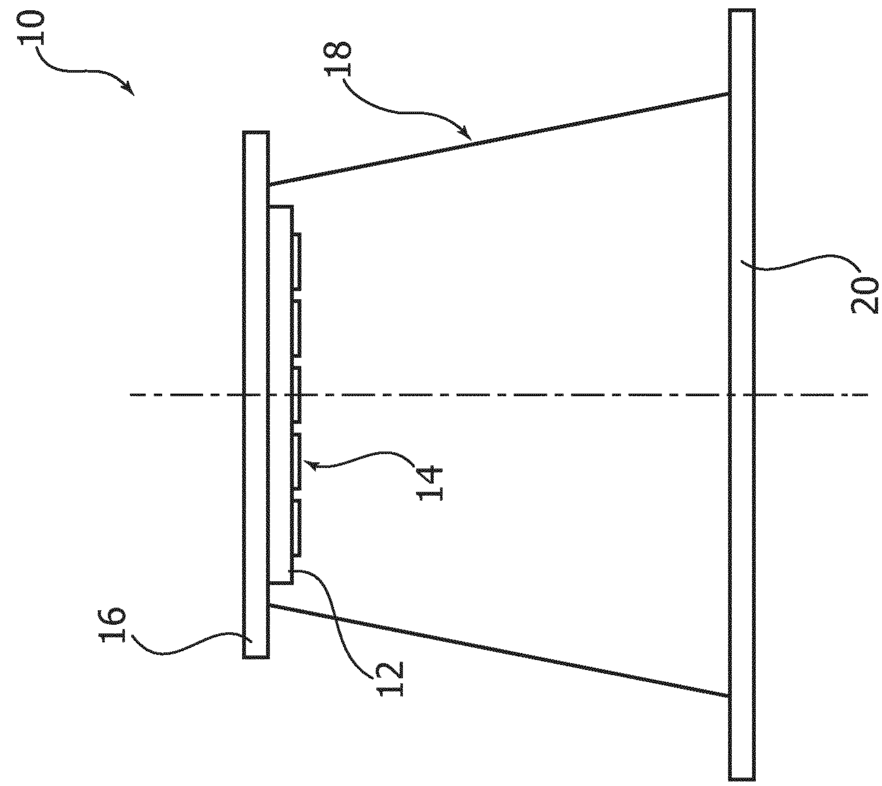


FIG. 1

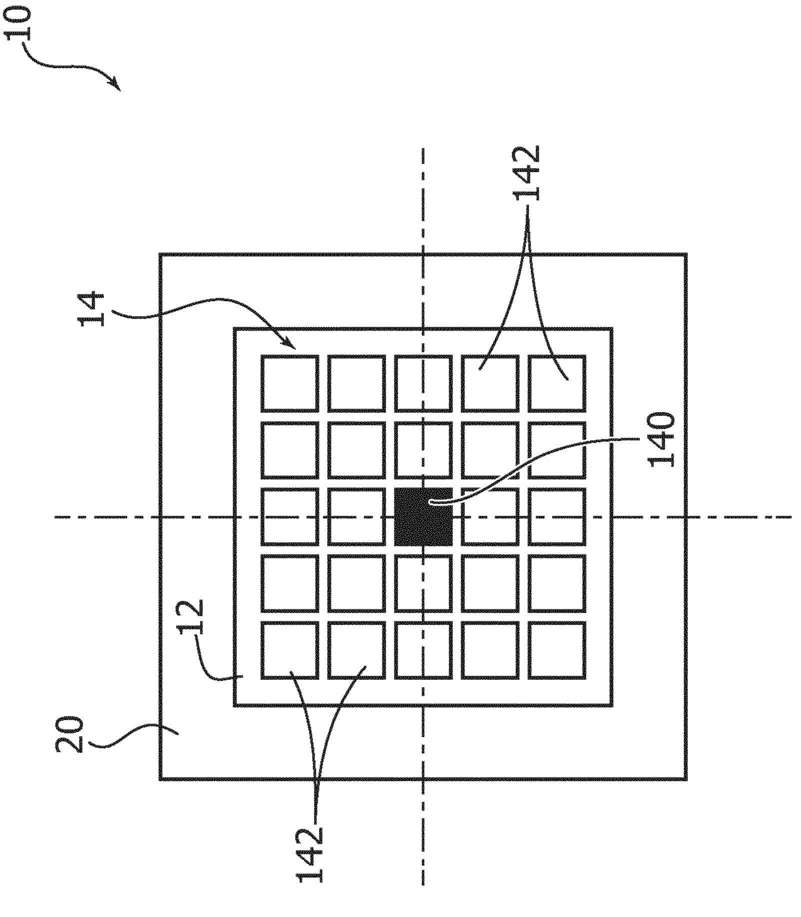
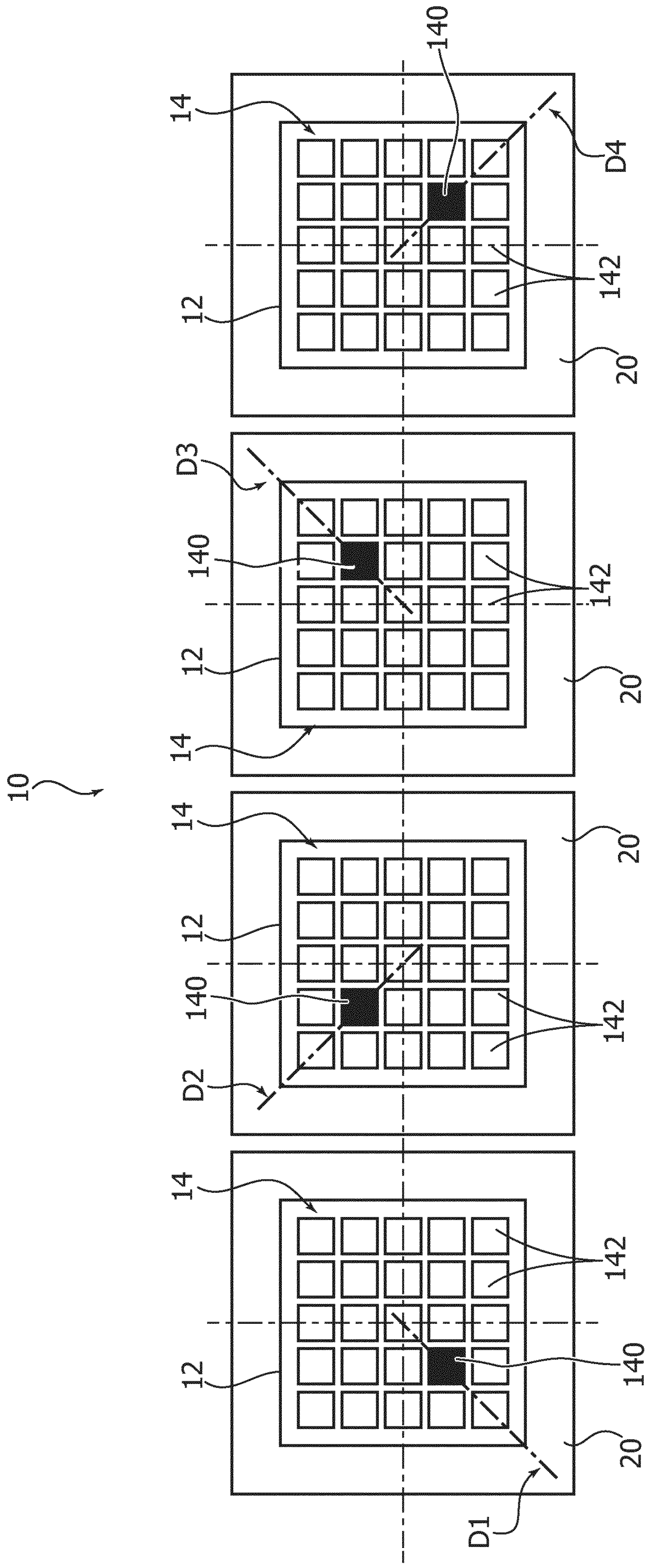


FIG. 3



REFERENCES CITED IN THE DESCRIPTION

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