

DESCRIPTION

TITLE: Lighting device and outdoor lamp post provided with such a device

FIELD OF THE INVENTION

5 The present invention concerns the field of lighting, and in particular to a lighting device as well as to an outdoor lamp post provided with such a device.

STATE OF THE ART

10 Lighting devices are known, for example from document US 2017/0079108 A1, which emit light in the spectrum visible to a human observer. Such lighting devices comprise, for example, a plurality of LEDs, also called light-emitting diodes, which make it possible to generate high-intensity lighting over a wide spectrum visible to the human eye while limiting electric power consumption of these lighting devices.

15 However, these lighting devices affect the biological rhythm of plants and animals. Thus, these lighting devices affect plant growth, causing artificial photosynthesis, not resulting from sunlight. In addition, these lighting devices are harmful to animals, such as insects, birds, fish and mammals. Indeed, these lighting devices disrupt their growth, sense of direction, phototaxis or chronobiological cycle, such as their circadian rhythm. Indeed, the generation of light by these lighting devices, particularly at night, forces the photosynthesis of plants and disturbs animals.

DISCLOSURE OF THE INVENTION

20 In particular, the purpose of the invention is to provide a lighting device, which allows comfortable lighting for humans while avoiding encouraging photosynthesis of plants and limiting disturbances to animals.

According to a first aspect, the invention provides a lighting device including at least three LEDs, each LED being only selected from the group comprising, preferably consisting of:

25 - a first LED emitting green light with a nominal wavelength between 513 nanometres and 543 nanometres,

- a second LED emitting amber light with a nominal wavelength between 583 nanometres and 605 nanometres, and

- a third LED emitting red-orange light with a nominal wavelength between 610 nanometres

30 and 635 nanometres,

the lighting device comprising M first LEDs, N second LEDs and P third LEDs, with $M \geq 1$, $N \geq 1$ and $P \geq 1$.

Thus, the lighting device allows comfortable lighting for humans while avoiding encouraging photosynthesis of plants and limiting disturbances to animals. More precisely, the use of three types of LEDs of different colours, preferably only three types of LEDs of different colours, makes it possible to obtain light from three colours, which is comfortable for humans, because humans are trichromatic. Furthermore, the overall colour of light emitted by the lighting device is golden to a human observer, and thus is close to the colour of light emitted by a high-pressure sodium lamp, widely used in urban lighting. The substitution of such a high-pressure sodium lamp by a lighting device in accordance with the invention does not change visual habits of the human observer accustomed to night-time urban outdoor lighting by high-pressure sodium lamps. Furthermore, the light emission spectrum of the lighting device avoids encouraging photosynthesis of plants, especially because it is located almost outside the absorption spectrum of chlorophyll *a* and mainly outside the absorption spectrum of chlorophyll *b*. Finally, the light emission spectrum of the lighting device limits disturbances to animals, in particular to insects.

According to a second aspect, the invention also provides an outdoor lamp post, including a mast carrying a head, the head comprising at least one lighting device as previously described.

Indeed, the overall colour of light emitted by the lighting device is gold, and is thus close to the colour of light emitted by a high-pressure sodium lamp, widely used in urban lighting. The substitution of such a high-pressure sodium lamp by a lighting device in accordance with the invention does not change visual habits of a human observer accustomed to night-time urban outdoor lighting by high-pressure sodium lamps. For example, an outdoor lamp post provided with the lighting device provides comfortable lighting for humans.

The invention is advantageously and optionally supplemented by the following characteristics, taken alone or according to any technically possible combinations thereof:

- The lighting device is such that:
- all of the M first LEDs have a relative light intensity between 0.39 and 0.43,
- all of the N second LEDs have a relative light intensity between 0.57 and 0.68, preferably between 0.62 and 0.68, and
- all of the P third LEDs have a relative light intensity equal to 1.0. Thus, the overall colour of light emitted by the lighting device is golden for a human observer, and is therefore comfortable for humans.

- The lighting device is such that:

- all of the M first LEDs have a relative light intensity equal to 0.41,
 - all of the N second LEDs have a relative light intensity equal to 0.65. Thus, the overall colour
 of light emitted by the lighting device is particularly golden for a human observer, and is
 5 therefore particularly comfortable for humans.

- Each of the N second LEDs emits amber light with a nominal wavelength between 583
 nanometres and 595 nanometres.

- Each of the P third LEDs emits red-orange light with a nominal wavelength between 620
 nanometres and 635 nanometres, preferably between 620 nanometres and 632 nanometres.

10 - Each LED has a bandwidth between 10 nanometres and 70 nanometres. Thus, the limited
 bandwidth of each LED avoids encouraging photosynthesis of plants and limits disturbances
 to animals. Preferably, the bandwidth is the spectral bandwidth at 50% of the light peak, also
 known as FWHM for "Full Width at Half Maximum".

- Each LED has a bandwidth between 10 nanometres and 40 nanometres, preferably between
 15 16 and 30 nanometres. Thus, the particularly limited bandwidth of each LED particularly avoids
 encouraging photosynthesis of plants and particularly limits disturbances to animals.

- The lighting device is such that $P \leq M \leq N$, preferably such as $P \leq M < N$. Indeed, LEDs
 emitting high-power amber light are expensive compared to LEDs emitting green light and
 LEDs emitting red-orange light. Thus, it is advantageous to use a greater number of LEDs
 20 emitting amber light of lower power in order to limit cost of the lighting device.

- The lighting device is such that $N = 2 \times M$ and/or $N = 2 \times P$. Thus, the distribution of the LEDs
 is facilitated with a view to the emission of a homogeneous light by the lighting device.

- The lighting device is such that $M = P$ and $N = 2 \times M$. Thus, the distribution of the LEDs is
 particularly facilitated with a view to the emission of a homogeneous light by the lighting device.

25 - The lighting device is such that $M = P = 7$ and $N = 14$. Thus, such a lighting device has a
 good compromise between manufacturing and assembly costs and homogeneity of light
 emitted by the lighting device.

- The lighting device is such that the LEDs are coplanar. Thus, the arrangement of the LEDs
 is facilitated with a view to the emission of a homogeneous light by the lighting device.

- The lighting device is such that the LEDs are oriented in parallel to each other. Thus, the arrangement of the LEDs is facilitated with a view to the emission of a homogeneous light by the lighting device.
- The lighting device is such that the LEDs emit in main directions parallel to each other. Thus, the arrangement of the LEDs is facilitated with a view to the emission of a homogeneous light by the lighting device.
- The lighting device includes a support, the LEDs being arranged on the support. Thus, the design and handling of the lighting device are simplified.
- The lighting device is such that the LEDs are evenly distributed on the support, preferably the LEDs being symmetrically distributed with respect to the centre of the support.
- For each second LED, at least one first LED and at least one third LED are the LEDs closest to the second LED. Thus, light emitted by the lighting device has a colour distribution with improved homogeneity.
- The lighting device is configured to emit light at a colour temperature between 2200 and 2330 Kelvin, preferably between 2230 and 2330 Kelvin, more preferably equal to 2280 Kelvin. Thus, the overall colour of light emitted by the lighting device is particularly golden for a human observer, and is therefore particularly comfortable for humans.
- The outdoor lamp post is configured to provide outdoor lighting, preferably at night.
- The outdoor lamp post is configured to provide outdoor lighting in an urban environment.
- The outdoor lamp post comprises three aligned, preferably adjoined, lighting devices. Thus, the light flux emitted by each lighting device can be limited and the production of the lighting device is modular, which reduces the overall cost of the outdoor lamp post.
- The outdoor lamp post is configured to emit a light flux between 7500 and 8000 lumens, preferably equal to 7800 lumens. Thus, the light flux is high and sufficient, for example, for night-time urban outdoor lighting.
- The mast includes a height between 4 and 8 metres, preferably equal to 8 metres. Thus, the lighting area provided by the outdoor lamp post is large.
- The head includes a housing. Thus, the housing makes it possible to protect the lighting device from the elements or damage.

- The support is housed in the housing.
- The housing is based on aluminium.
- The housing houses a power supply unit.

DESCRIPTION OF THE FIGURES

5 Further characteristics, purposes and advantages of the invention will be apparent from the following description, which is purely illustrative and not limiting, and which should be read in conjunction with the appended drawings, given by way of non-limiting examples and in which:
Figure 1 is a schematic side view of an embodiment of an outdoor lamp post;
Figure 2 is a schematic perspective view of an embodiment of a head of the outdoor lamp post
10 represented in Figure 1;
Figure 3 is a schematic bottom view of an embodiment of a lighting device of the head represented in Figure 2;
Figure 4 shows a graph representing the light emission spectrum of a lighting device in accordance with the invention, especially of the lighting device represented in Figure 3, the
15 graph having as an abscissa the wavelength in nanometres and having as an ordinate the relative light intensity.

Throughout the figures, similar elements are designated by identical references.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 represents an embodiment of an outdoor lamp post 1. The outdoor lamp post 1
20 includes a mast 2 and a head 3. The mast 2 carries the head 3. The head 3 includes at least one lighting device 4.

Advantageously, the outdoor lamp post 1 is configured to emit a light flux between 7500 and 8000 lumens, preferably equal to 7800 lumens.

Advantageously, the exterior lamp post 1 is configured to provide exterior lighting, preferably
25 at night.

Preferably, the outdoor lamp post 1 is configured to provide outdoor lighting in an urban environment.

Thus, night-time use of the outdoor lamp post 1 in an urban environment is possible.

Advantageously, the mast 2 includes a height between 4 and 8 metres, preferably equal to 8 metres.

Advantageously, the head 3 includes a housing 5. Preferably, the housing 5 is aluminium-based.

- 5 Advantageously, the housing 5 houses a power supply unit 6. The power supply unit 6 supplies the lighting device 4.

Advantageously, the housing 5 includes a tube 5a. Preferably, the tube 5a is engaged in the mast 2, in order to allow the head 3 to be held in position on the mast 2. The tube 5a is hollow in order to allow power supply cables extending through the mast 2 into the housing 5 to pass
10 into.

Advantageously, the power supply cables supply the lighting device 4 via the power supply unit 6.

Figure 2 shows an embodiment of the head 3. In this example, the head 3 includes three lighting devices 4.

- 15 Advantageously, the three lighting devices 4 are aligned. Preferably, the three lighting devices 4 are adjoined.

Figure 3 shows an embodiment of the lighting device 4.

The lighting device 4 includes at least three LEDs 7, 8, 9.

- Advantageously, each LED 7, 8, 9 is only selected from the group comprising:
20 - a first LED 7 emitting green light with a nominal wavelength between 513 nanometres and 543 nanometres,
- a second LED 8 emitting amber light with a nominal wavelength between 583 nanometres and 605 nanometres, and
- a third LED 9 emitting red-orange light with a nominal wavelength between 610 nanometres
25 and 635 nanometres.

Advantageously, the lighting device 4 comprises M first LEDs 7, N second LEDs 8 and P third LEDs 9, with $M \geq 1$, $N \geq 1$ and $P \geq 1$.

In other words, the lighting device 4 comprises exactly M first LEDs 7, exactly N second LEDs 8 and exactly P third LEDs 9, with $M \geq 1$, $N \geq 1$ and $P \geq 1$.

Preferably, each LED 7, 8, 9 is only selected from the group consisting of:

- a first LED 7 emitting green light with a nominal wavelength between 513 nanometres and 543 nanometres,
- a second LED 8 emitting amber light with a nominal wavelength between 583 nanometres and 605 nanometres, and
- a third LED 9 emitting red-orange light with a nominal wavelength between 610 nanometres and 635 nanometres.

Thus, each LED 7, 8, 9 is either a first LED 7, or a second LED 8, or a third LED 9.

For example, each of the M first LEDs 7 is an OSRAM OSOLON® SSL 80 LED, GT CS8PM1.13, preferably in accordance with its technical data sheet version 1.16.

Advantageously, each of the N second LEDs 8 emits amber light with a nominal wavelength between 583 nanometres and 595 nanometres.

For example, each of the N second LEDs 8 is an OSRAM OSOLON® SSL 80 LED, GY CS8PM1.23, preferably in accordance with its technical data sheet version 1.6.

Advantageously, each of the P third LEDs 9 emits red-orange light with a nominal wavelength between 620 nanometres and 635 nanometres, preferably between 620 nanometres and 632 nanometres.

For example, each of the P third LEDs 9 is an OSRAM OSOLON® SSL 80 LED, GR CS8PM1.23, preferably in accordance with its technical data sheet version 1.8.

Advantageously, the lighting device 4 is such that:

- all of the M first LEDs 7 have a relative light intensity between 0.39 and 0.43,
- all of the N second LEDs 8 have a relative light intensity between 0.57 and 0.68, preferably between 0.62 and 0.68, and
- all of the P third LEDs 9 have a relative light intensity equal to 1.0.

Preferably, the lighting device 4 is such that:

- all of the M first LEDs have a relative light intensity equal to 0.41,
- all of the N second LEDs have a relative light intensity equal to 0.65.

Advantageously, the lighting device 4 is configured to emit light at a colour temperature between 2200 and 2330 Kelvin, preferably between 2230 and 2330 Kelvin, more preferably equal to 2280 Kelvin.

Advantageously, each LED 7, 8, 9 has a bandwidth between 10 nanometres and 70 nanometres. Preferably, each LED 7, 8, 9 has a bandwidth between 10 nanometres and 40 nanometres, more preferably between 16 nanometres and 30 nanometres.

Preferably, the lighting device 4 is such that $P \leq M \leq N$, more preferably such that $P \leq M < N$.

- 5 Preferably, the lighting device 4 is such that $N = 2 \times M$ and/or $N = 2 \times P$. More preferably, the lighting device 4 is such that $M = P$ and $N = 2 \times M$. Even more preferably, the lighting device 4 is such that $M = P = 7$ and $N = 14$. Thus, for example, the lighting device 4 comprises exactly: 7 first LEDs 7, 14 second LEDs 8 and 7 third LEDs 9.

- 10 Advantageously, the lighting device 4 comprises a support 10. Preferably, the LEDs 7, 8, 9 are disposed on the support 10.

Preferably, the support 10 is housed in the housing 5.

Advantageously, the lighting device 4 is such that the LEDs 7, 8, 9 are coplanar.

Advantageously, the lighting device 4 is such that the LEDs 7, 8, 9 are oriented in parallel to one another.

- 15 Advantageously, the lighting device 4 is such that the LEDs 7, 8, 9 emit in main directions parallel to each other.

- Advantageously, the lighting device 4 is such that the LEDs 7, 8, 9 are evenly distributed on the support 10. Preferably, the LEDs 7, 8, 9 are symmetrically distributed with respect to the centre of the support, in particular without taking the type of LED, i.e. first LED 7, second LED
20 8 or third LED 9 into account.

Preferably, for each second LED 8, at least one first LED 7 and at least one third LED 9 are the LEDs closest to the second LED 8.

- Figure 4 shows a graph representing the light emission spectrum of the lighting device 4. The light emission spectrum of the lighting device 4 is thus not significant, for example with a
25 relative light intensity greater than 0.2, or even greater than 0.1, neither in ultraviolet rays with a wavelength less than 380 nm, nor in violet rays with a wavelength between 380 nanometres and 450 nanometres, nor in blue rays with a wavelength from 450 nanometres to 500 nanometres, nor in red rays with a wavelength from 650 nanometres to 750 nanometres, nor in infrared rays with a wavelength greater than 750 nanometres.

Advantageously, the light emission spectrum of the lighting device 4 avoids encouraging photosynthesis of plants, especially because it is located almost outside the absorption spectrum of chlorophyll *a* and mainly outside the absorption spectrum of chlorophyll *b*. Furthermore, the light emission spectrum of the lighting device 4 limits disturbances to animals, in particular insects.

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CLAIMS

1. A lighting device (4) including at least three LEDs (7, 8, 9), characterised in that each LED (7, 8, 9) is only selected from the group consisting of:
 - a first LED (7) emitting green light with a nominal wavelength between 513 nanometres and 543 nanometres,
 - a second LED (8) emitting amber light with a nominal wavelength between 583 nanometres and 605 nanometres, and
 - a third LED (9) emitting red-orange light with a nominal wavelength between 610 nanometres and 635 nanometres,
- 10 the lighting device (4) comprising M first LEDs (7), N second LEDs (8) and P third LEDs (9), with $M \geq 1$, $N \geq 1$ and $P \geq 1$.
2. The lighting device (4) according to claim 1, wherein:
 - all of the M first LEDs (7) have a relative light intensity between 0.39 and 0.43,
 - all of the N second LEDs (8) have a relative light intensity between 0.62 and 0.68, and
 - 15 - all of the P third LEDs (9) have a relative light intensity equal to 1.0.
3. The lighting device (4) according to claim 2, wherein:
 - all of the M first LEDs (7) have a relative light intensity equal to 0.41,
 - all of the N second LEDs (8) have a relative light intensity equal to 0.65.
4. The lighting device (4) according to any one of claims 1 to 3, wherein each of the P third LEDs (9) emits red-orange light with a nominal wavelength between 620 nanometres and 635 nanometres.
- 20 5. The lighting device (4) according to any one of claims 1 to 4, wherein each LED (7, 8, 9) has a bandwidth between 10 nanometres and 70 nanometres.
6. The lighting device (4) according to any one of claims 1 to 5, wherein the LEDs (7, 8, 9) are coplanar.
- 25 7. The lighting device (4) according to any one of claims 1 to 6, wherein $P \leq M \leq N$.
8. The lighting device (4) according to claim 7, wherein $M = P$ and $N = 2 \times M$.
9. The lighting device (4) according to any one of claims 1 to 8, which is configured to emit light at a colour temperature between 2200 and 2330 Kelvin.

10. An outdoor lamp post (1), including a mast (2) bearing a head (3), the head (3) comprising at least one lighting device (4) according to any one of claims 1 to 9.