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(54) **Compact lighting device, in particular for use in a dental lamp**

(57) A lighting device (10), in particular for use in a dental lamp, characterised in that it comprises one or more optical groups, each of which comprises an LED light source (11), a collimation group (12) and a reflector (13), the collimation groups (12) being arranged close to the respective LED light sources (11) and converging the light radiation coming from them in respective cones, the

vertices of which are located close to a common point, which defines the first focus of an ellipsoid, and which intersect the surface of the ellipsoid defining respective areas, at which the respective reflectors (13) are arranged, the surfaces of which come near to that of said ellipsoid.

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Description

[0001] The present invention refers to a compact lighting device, in particular for use in a dental lamp.

[0002] In many fields of activity in which particular precision of intervention on people or things is required, it is useful to be able to use a dedicated light source, which allows the object being operated on to be seen more clearly.

[0003] In particular, in the field of dentistry it is necessary to light the patient's oral cavity with a suitable lamp, generally applied to the end of an articulated arm, in turn fastened to a fixed structure, said lamp being able to be moved so as to aim the light beam emitted by it at the desired point. In particular, the mobile arm can be fixed to the body of a more complex dental apparatus, or else directly to a wall. In some special cases, moreover, it is possible to make lighting devices of a suitably small size, which can be worn directly by the dentist.

[0004] This type of lamp must respect a series of requirements, which meet different needs.

[0005] A first requirement of dental lamps is to concentrate the light beam, and this is due to the need to light up the patient's oral cavity in the best possible way, without bothering the eyes.

[0006] A second requirement of dental lamps is to provide a light radiation that possesses the characteristics of a white light and, more specifically that preferably has the following trichromaticity coordinates of the 4 extreme points:

1. $x = 0,310$; $y = 0,369$;
2. $x = 0,316$; $y = 0,322$;
3. $x = 0,414$; $y = 0,428$;
4. $x = 0,396$; $y = 0,377$;

with a high Color rendering index: $R_a > 85$.

[0007] Indeed, the light radiation must not alter the perception of colour of the surface of a patient's teeth by the dentist, because otherwise it could compromise the choice of colour of a possible dental prosthesis or of the joining cement necessary for a possible filling.

[0008] Moreover, the infrared component of the light radiation emitted must be low, with a power density $E < 350 \text{ W/m}^2$ on the work surface, to avoid the patient's body heating up.

[0009] Not only this, but the light radiation of dental lamps must at the same time not have ultraviolet components, i.e. radiations with wavelengths in the range 10nm - 280nm (UV-C), 280nm - 315nm (UV-B), 315 - 400 nm (UV-A), which would not be healthy for the patient.

[0010] Finally, considering the fact that more recent joining cements are often obtained from polymer-based formulations comprising optically activated hardening compounds, generally through radiations in the blue band, the light radiation must have a low emission in the wavelength range from 400 nm to 500nm to avoid the

polymerisation of the cement.

[0011] Another very important requirement nowadays concerns the reduction of the bulk of the device. Indeed, the structure that makes up the lighting device must not hinder and/or impede the mobility of the dentist in any way allowing him to aim the light beam where he considers most suitable with the minimum effort.

[0012] In order to achieve these purposes, according to the prior art, WO-A-02/06723, dental lamps have been developed comprising a plurality of light sources, in particular a plurality of LED light sources (light emitting diodes), in combination with optical devices, like for example a corresponding number of shaped lenses, arranged between the light source and the surface of the object to be lit up, hereafter also known as work surface, or else a suitably curved reflecting surface, arranged on the opposite side to the plurality of light sources with respect to the work surface. Indeed, if on the one hand, by choosing the suitable materials, it is possible to obtain LED light sources that emit light radiations having a well-defined frequency and wavelength, and consequently suitably totally without radiation components in the infrared or ultraviolet field, on the other hand the shaped lenses or the reflecting surface are able to converge the light emitted by all of these LED light sources in a well-defined area, which comprises the work surface.

[0013] Solutions similar to that of WO-A-02/06723 have also been described in WO-A-01/18445 and in US-A-5,722,762, which refer in particular to lighting devices that can be worn by the dentist like a pair of eyeglasses and that comprise a plurality of light sources, the emitted radiations of which are concentrated on the work surface through the combination with suitable optical devices.

[0014] The solutions according to the prior art do, however, have a series of limitations that make their use not optimal.

[0015] Indeed, none of the known solutions allow the radiation emitted by the light sources to be concentrated in a truly optimal way, since there is always a certain percentage of the emitted radiation that escapes the optics that should ensure its concentration in a certain area.

[0016] Moreover, the devices used today are substantially bulky.

[0017] Indeed, since the position corresponding to the barycentre of the lamp is generally occupied by the apparatus of the light source, the rotation of the device about its barycentral horizontal axis is made possible thanks to one or two pins that are positioned laterally in a position outside of the head.

[0018] These two pins are generally joined together through a small arch.

[0019] Such a configuration substantially hinders and/or impedes the mobility of the dentist.

[0020] The general purpose of the present invention is to solve the aforementioned drawbacks of the prior art in an extremely simple, cost-effective and particularly functional manner.

[0021] Another purpose is to provide a compact light-

ing device capable of defining the shape and size of the spot of light that can be obtained on the work surface.

[0022] Moreover, according to the invention, a lighting device is provided that allows both the overall weight and the cooling requirements of the dental lamp to be limited.

[0023] Advantageously, moreover, the device according to the invention has a smaller bulk than those commonly used.

[0024] In view of the aforementioned purposes, according to the present invention, it has been thought of to make a lighting device, in particular for use in a dental lamp, having the characteristics outlined in the attached claims.

[0025] The structural and functional characteristics of the present invention and its advantages compared to the prior art shall become clearer from an examination of the following description, referring to the attached drawings, which show a lighting device, in particular for use in a dental lamp, made according to the innovative principles of the invention itself.

[0026] In the drawings:

- figure 1 shows a schematic perspective view of a preferred embodiment of the lighting device of the present invention;
- figure 2 is a schematic plan view of the lighting device of figure 1;
- figure 3 shows a schematic perspective view of another embodiment of the lighting device of the present invention; and
- figure 4 shows a schematic view from above of the embodiment of figure 3 of the lighting device of the present invention.

[0027] With reference to the drawings, the lighting device in question is wholly indicated with 10, and in the illustrated examples, according to the present invention, it comprises a pair of power LEDs 11, each associated with a primary collimation group 12 and a secondary reflector 13. The two LEDs 11 are also housed on the same dissipator 14.

[0028] The lighting device is symmetrical with respect to an axis, indicated with Z in a cartesian reference system shown in figures 1 and 2.

[0029] The primary collimation groups 12 have the task of converging the light radiation coming from the two LEDs 11 in two respective cones, the vertices of which converge in the first focus of an ellipsoid, and the surfaces of which intersect the surface of said ellipsoid defining two areas at which said secondary reflectors 13 are arranged. This optical arrangement allows a virtual image of the emission area of each LED to be defined, positioned at the first focus of the ellipsoid. In this way, by exploiting the optical properties of the ellipsoid, according to which fixing a point-shaped light source in the first focus of an ellipsoid, then its reflection passes to the second focus, the optical system according to the present invention, whilst still consisting of a light source that is not

point-shaped, allows the beam of light emitted by the light sources to be concentrated close to the second focus.

[0030] In particular, moreover, each reflector 13 is made by putting together a plurality of facets. Each of these facets projects the virtual image by exploiting the optical properties of the ellipsoid, even if the surface of the reflectors does not perfectly coincide with that of the ellipsoid. Consequently, the projection of the light beams coming from the LEDs does not pass perfectly to the second focus, but a concentration of the beam is obtained in any case.

[0031] This scheme therefore allows two or more light sources to be used, arranged a certain distance apart, symmetrically with respect to the axis Z, and consequently a certain distance from said axis Z, as if they were actually situated on it. The axis Z therefore constitutes the optical axis of the lighting device 10 as a whole, coinciding with that which would be the optical axis of a single reflector with elliptical curvature used instead of the two secondary reflectors 13 of the lighting device 10 as shown according to a preferred embodiment of the present invention.

[0032] By positioning the work plane between the first and the second focus of the ellipsoid, the light flow is able to be concentrated in a simple manner and a light image according to the specific needs defined previously can be obtained.

[0033] A further consequence of this arrangement of the components of the lighting device 10 according to the present invention is that of allowing the focalisation with respect to the reflector to be maintained by moving the group consisting of the two LED light sources 11 and the corresponding primary collimation groups 12 along the axis Z, defining the shape and size of the light spot on the work surface.

[0034] With reference in particular to figure 2, the LED light sources 11 are housed on the same dissipator 14, suitably equipped with fins 15 to increase the dissipation surface.

[0035] The material of the LEDs is suitably selected from those that emit a light radiation in the range of reference trichromaticity coordinates.

[0036] Finally, the lighting device 10 shall be installed inside a box-shaped body that may or may not comprise a screen at the area crossed by the light beam emitted by the secondary reflectors 13.

[0037] The whole thing shall then be installed at the free end of a mobile arm secured to a dentistry apparatus or to a wall.

[0038] Moreover, as can be seen in figures 3 and 4, the device 10 has a pin 18 suitable for allowing it to rotate about a barycentral horizontal axis 16.

[0039] Such a pin 18 is placed at the barycentre 21 of the device 10.

[0040] Such an arrangement is made possible because, as can be seen from figure 4, in the lighting devices according to the invention, the position corresponding to the barycentre 21 of the structure is not occupied

by the apparatus for generating the beams of light.

[0041] Indeed, it can be seen in figure 4 how the barycentre 21 is located outside of the area defined by the circular line 20 that contains the portion of structure dedicated to the apparatus for generating the beams of light.

[0042] Moreover, advantageously, with such an arrangement it is possible to position two handles 19 to move the device in a position further inside with respect to the devices of the prior art in which such handles are connected outside on the side of the structure.

[0043] Indeed, according to the invention the two handles 19 are arranged behind, and no longer at the side of, the reflectors 13 giving the structure substantial compactness.

[0044] From what has been described above with reference to the figures, it is clear how a compact lighting device according to the invention is particularly useful and advantageous. The purpose mentioned in the preamble of the description is thus achieved.

[0045] In conclusion, the compact lighting device according to the present invention has the following advantages with respect to the solutions of the prior art.

[0046] Firstly, the particular arrangement of the optical elements used allows a plurality of LED light sources to be used whose radiation is, however, emitted as if it came from a single point-shaped source, with the advantage of allowing optimal design of the reflecting surfaces.

[0047] On the other hand, by using two (or more) light sources, reflected by two (or more) reflection elements with faceted surface, the work surface is hit by two (or more) optical beams coming from two (or more) distinct axial directions, with the advantage of substantially reducing the shadows due to objects placed between the lighting device and the work surface.

[0048] An important characteristic of the lighting device according to the invention is the possibility of axial focalisation of the light sources with respect to the secondary reflectors.

[0049] Finally, the choice of suitable materials (relative to the light sources and/or to filters introduced inside the optical group and/or on the reflectors) allows a light radiation with the characteristics (trichromaticity coordinates, color rendering, absence of ultraviolet, low blue content) required in the field of dentistry to be obtained.

[0050] Of course, the shapes of the lighting device of the invention can be different from the one shown only as a non-limiting example in the drawings, just as the materials can also be different.

[0051] The scope of protection of the invention is therefore defined by the attached claims.

Claims

1. Lighting device (10), in particular for use in a dental lamp, **characterised in that** it comprises one or more optical groups, each of which comprises an LED light source (11), a collimation group (12) and

a reflector (13), said collimation groups (12) being arranged close to the respective LED light sources (11) and converging the light radiation coming from them in respective cones, the vertices of which are located close to a common point, which defines the first focus of an ellipsoid, and which intersect the surface of said ellipsoid defining respective areas, at which the respective reflectors (13) are arranged, the surfaces of which come near to that of said ellipsoid.

2. Lighting device according to claim 1 **characterised in that** it comprises a pin (18) for the rotation of said device (10) about a barycentral axis (16) of the device, in which said pin (18) is arranged at a barycentre (21).

3. Lighting device according to claim 2, **characterised in that** it comprises two handles (19) positioned substantially behind said reflectors (13).

4. Lighting device according to claim 1, **characterised in that** it comprises means for moving said LED light sources (11) and the corresponding primary collimation groups (12) with respect to said reflectors (13).

5. Lighting device according to claim 1, **characterised in that** said LED light sources (11) emit white light.

6. Lighting device according to claim 5, **characterised in that** said LED light sources (11) emit white light with the following trichromaticity coordinates of the 4 extreme points:

1. $x = 0,310$; $y = 0,369$;
2. $x = 0,316$; $y = 0,322$;
3. $x = 0,414$; $y = 0,428$;
4. $x = 0,396$; $y = 0,377$;

and with a colour rendering index $R_a > 85$.

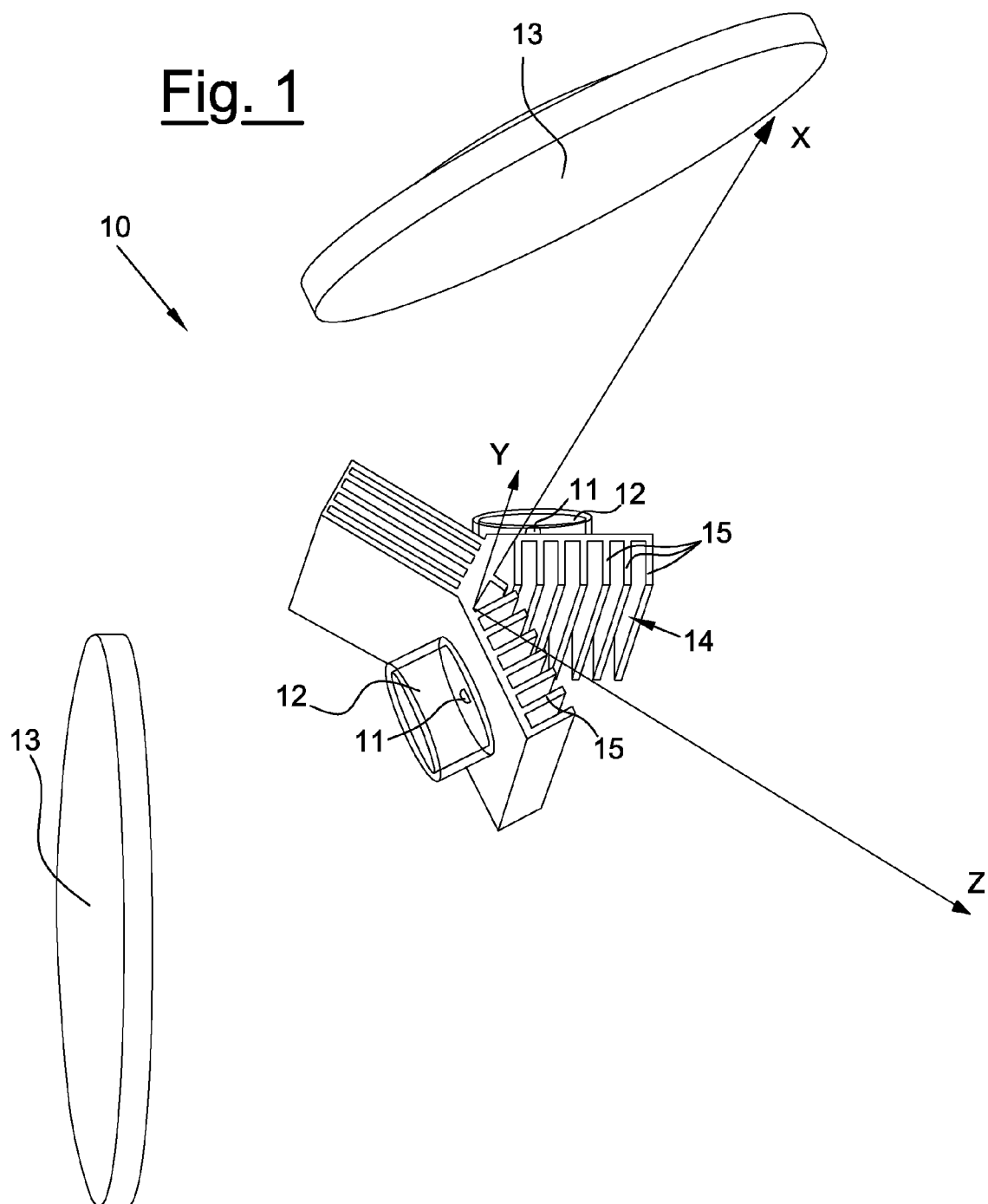
7. Lighting device according to claim 1, **characterised in that** said reflectors (13) are made up of a plurality of facets adjacent to one another.

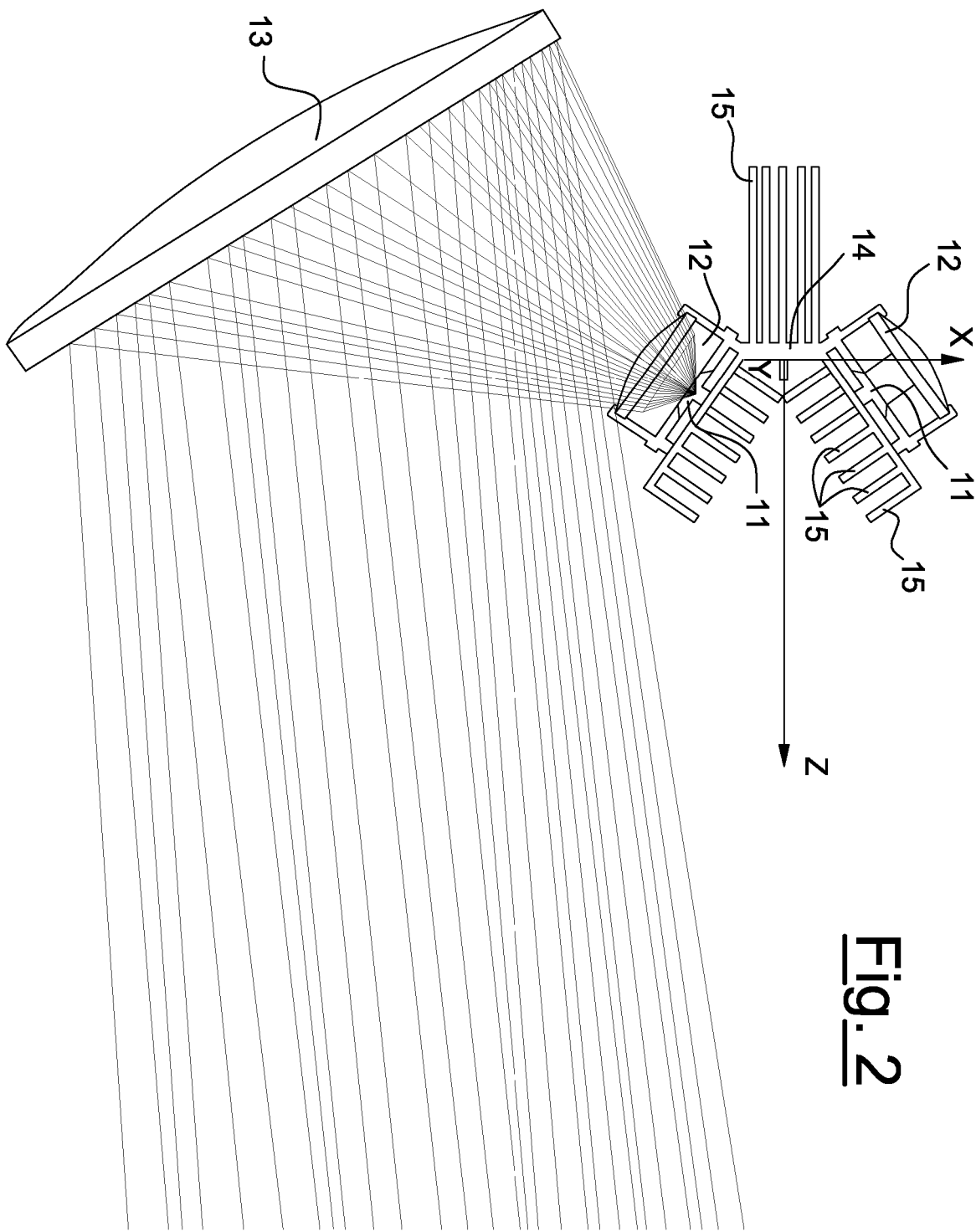
8. Lighting device according to claim 1, **characterised in that** said collimation groups (12) consist of a plurality of lenses.

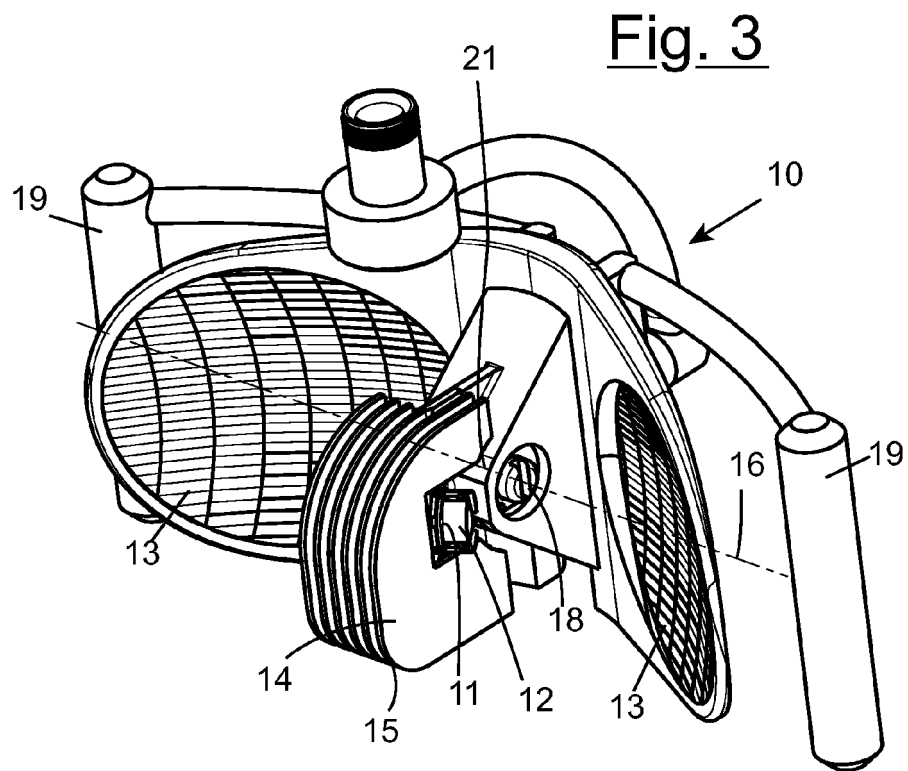
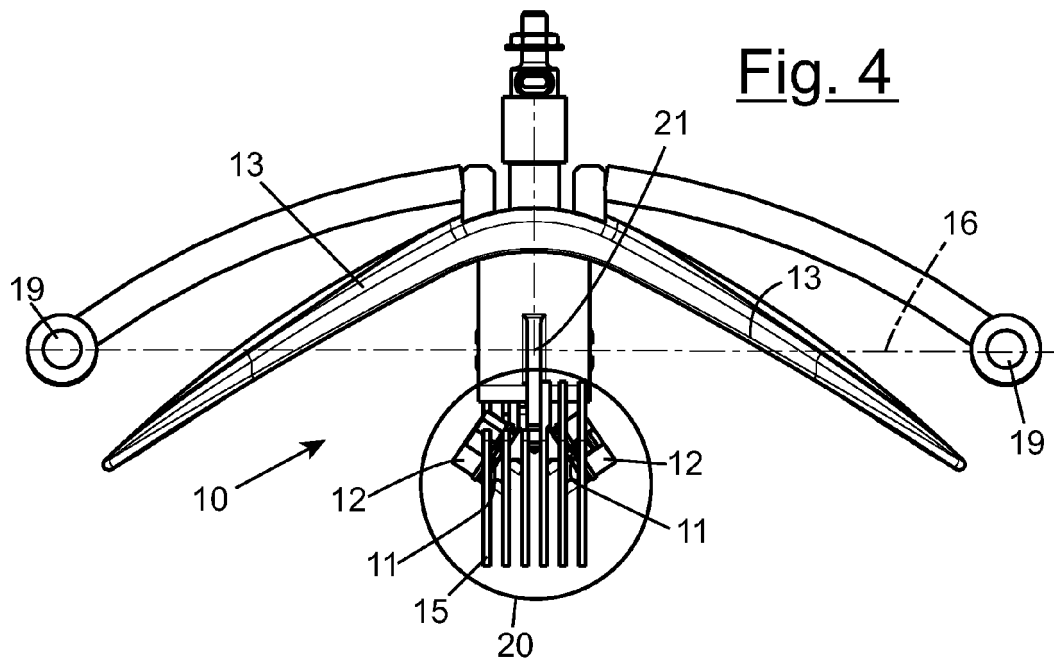
9. Lighting device according to claim 1, **characterised in that** it comprises heat dissipators (14).

10. Lighting device according to claim 1, **characterised in that** it also comprises optical filters.

Fig. 1







REFERENCES CITED IN THE DESCRIPTION

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