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(54) **ARTICULATED ARM FOR ILLUMINATING SURGICAL FIELDS**

(57) The object of the present invention is an articulated arm for surgical fields, comprising a first arm (2) able to be constrained to a surface or to a device (100) and mechanically articulated to a second arm, an operating light (4) connected to the second arm (3) to illuminate a surgical field wherein the operating light (4) has adjustable illuminance between a minimum value and a maximum value, at least one auxiliary light (7) fixedly connected to at least one from the first arm (2) and the

second arm (3), the auxiliary light (7) having adjustable illuminance between a minimum value and a maximum value, control members (12) being configured to adjust the illuminance of the operating light (4), wherein the control members (12) are active on the auxiliary light (7) so that the minimum value of the auxiliary light (7) is reached when the operating light (4) takes on a limit illuminance value greater than the minimum value thereof.

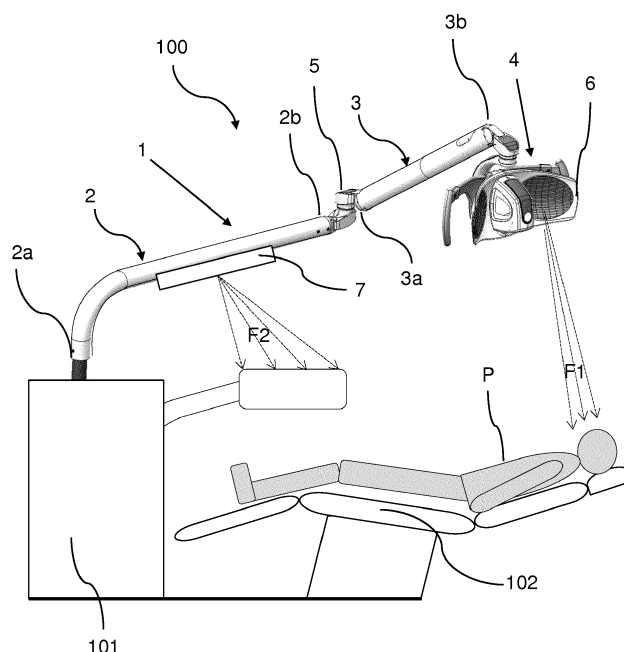


Fig. 1

Description

[0001] The present invention refers to an articulated arm for surgical fields, in particular for dental units.

[0002] Some technical fields have the special circumstance of needing the specialised operator to focus his/her attention and work on a predetermined surgical field, the latter meaning the area or physical space in which the operator works.

[0003] Examples of this kind of technical field are jewellery making, where the jeweller works with his/her tools in a strongly illuminated surgical field to allow perfect illumination of the jewel being made.

[0004] Another example of this type of technical field is surgery, wherein the surgeon works in a surgical field (also in this case strongly illuminated) in which the patient is positioned.

[0005] A further example is represented by dentistry, in which the surgical field coincides, basically, with the mouth of the patient.

[0006] In dentistry, operating lights are now in use that are capable of emitting illuminance even up to 100000 - 120000 lux, so that the mouth of the patient is strongly illuminated.

[0007] Indeed, it is known that the viewing capability of the surgeon improves as the illuminance of the surgical field improves, even if beyond a certain upper illuminance limit the improvement of visual acuity (ability to recognise shapes) tends to reduce to the point of having no influence whereas dazzling effects appear that compromise the viewing capability and the efficiency of ocular functions (like convergence, pupil contractions and the like).

[0008] Typically, the optimal illuminance range in dentistry is comprised between about 8000 lux and about 50000 lux. In particular, illuminance comprised between about 30000 lux and about 50000 lux makes it possible to illuminate the darkest areas present in the mouth of the patient, whereas an illuminance of about 8000 lux is indicatively the minimum level to correctly recognise a white tooth.

[0009] The illuminance levels described above therefore allow the surgeon to work in the best visual conditions, minimising the visual tiring and promoting concentration.

[0010] In the described example of dentistry, and in others still, it is thus essential for the operator, whether jeweller, surgeon or dentist, to have the lowest possible stress level during his/her work.

[0011] One of the circumstances linked to decreased work stress is, as stated, the strong illuminance of the surgical field, which allows the operator to not waste physical and mental energy to fully take in the state and the details of the surgical field.

[0012] The Applicant has noted that the use of greatly illuminating lights, like those described above, on the one hand improves the working comfort of the operator but, on the other hand, causes another stress to occur linked to the operation.

[0013] The Applicant has indeed noted that when the operator must look away from the surgical field to focus on the tool to be selected or in any case on devices located in the pre-operation field, he/she is subjected to an intense visual stress necessary to adapt his/her sight to a completely different illuminance condition from that of the surgical field.

[0014] In dentistry studies, the pre-operation field comprises an outer area closer to the surgical field (that indicatively extends for about 50 centimetres around the surgical field and includes the patient) which should be illuminated with illuminance of about 1000 lux, and an even more outer area (i.e. outside of the patient) that should be illuminated with illuminance of about 500 lux, typical of normal work environments.

[0015] In normal work situations of dental practices, the dentist is therefore subjected to continuous visual stresses that force him/her to refocus between light intensities of about 50000 lux and light intensities of about 1000 lux (when looking in the area immediately outside of the surgical field) or of about 500 lux (when looking in the area further outside).

[0016] The Applicant has noted that such a situation produces visual tiring of the operator during the intervention and also a temporary visual dazzling when the operator's moves his/her gaze from the pre-operation field to the surgical field.

[0017] The Applicant has perceived that by providing an auxiliary light having much lower illuminance than that of the operating light but greater than the illuminance normally present outside of the surgical field, it is possible to illuminate the space immediately outside of the surgical field with greater illuminance than ambient lighting normally present.

[0018] The Applicant has also perceived that by coupling such an auxiliary light with one of the two arms of an articulated arm for surgical fields, like for example an articulated arm for dental units, it is possible to selectively illuminate, but with greater illuminance than ambient light, some areas of the pre-operation field, like for example a quiver, a tool tray and similar, by simply orienting an arm of the articulated arm.

[0019] The present invention therefore concerns an articulated arm for surgical fields, comprising a first arm able to be constrained to a wall, a ceiling or a device and mechanically articulated to a second arm, an operating light connected to the second arm to illuminate a surgical field in which said operating light has adjustable illuminance between a minimum value and a maximum value, at least one auxiliary light fixedly connected to at least one from said first arm and said second arm, said auxiliary light having adjustable illuminance between a minimum value and a maximum value, control members being configured to adjust the illuminance of the auxiliary light as a function of the illuminance of the operating light, wherein said control members are active on said auxiliary light so that said minimum value of the auxiliary light is reached when the operating light takes on a limit illuminance value greater than said minimum value thereof.

[0020] The variation of illuminance of the auxiliary light as a function of the current illuminance of the operating light makes it possible to optimise the focusing of the operator when his/her gaze and attention pass from the surgical field to the immediately surrounding area, or vice-versa, since as the illuminance of the surgical field decreases (or increases), the illuminance of the pre-operation field increases and/or decreases.

[0021] The illuminance of the auxiliary light reaches its minimum value, preferably corresponding to the average ambient illuminance value, when the illuminance of the operating light reaches a limit value greater than the minimum value of the illuminance of the operating light, so that the area illuminated by the auxiliary light is illuminated with light intensity equal to ambient light intensity typical of the area of the pre-operation field illuminated when the illuminance of the operating light reaches the limit value.

[0022] The operating light is indeed adjustable between a maximum illuminance value corresponding to an ideal illuminance value for performing operations on the surgical field, to a minimum illuminance value, less than the limit value, at which it is not suitable to carry out operations in the surgical field.

[0023] As an example, in dentistry applications the maximum illuminance value of the operating light can correspond to the ideal illuminance value for carrying out operations in the oral cavity of the patient, whereas the minimum illuminance value can correspond to an illuminance value such as not to accelerate the polymerisation of a filling compound (an operations that the dentist performs outside of the surgical field and therefore when not operating on the oral cavity of the patient) but which still allows the patient to be illuminated.

[0024] The limit illuminance value of the operating light can for example correspond to an illuminance value useful for performing particular operations in the surgical field, like for example (in dentistry) recognising the chromatic variations of the colour of the patient's teeth.

[0025] In the present description and subsequent claims, the term "adjust" or "adjustment" referring to the illuminance of a light is meant to indicate the possibility of varying the light intensity emitted by the light with continuity.

[0026] The term "illuminance" is meant to indicate the parts of luminous flux emitted by a light source (for example a light) that hits a surface.

[0027] The term "luminous flux" is meant to indicate the total amount of light in the visible spectrum emitted by the light source.

[0028] The term "lux" is meant to indicate the measurement of the illuminance on a surface of one square metre placed a certain distance from the light source. When referring to the operating light, lux values are to be considered to be measured on a surface placed 700 millimetres from the light. When referring to the auxiliary light, lux values are to be considered to be measured on a surface placed 500 millimetres from the light.

[0029] Preferably, the control members are configured to keep said auxiliary light at said minimum illuminance value when the operating light takes on illuminance values lower than said limit illuminance value.

[0030] In this way, the illuminance of the auxiliary light does not go down, even when the illuminance of the operating light falls below the limit value, below its own minimum value so that the area illuminated by the auxiliary light is still illuminated with light intensity at least equal to the typical ambient light of the area of the illuminated pre-operation field.

[0031] Therefore, it is ensured that the auxiliary light always makes a contribution to the illuminance of the pre-operation field even when the dentist is not directly operating on the surgical field (in other words when the illuminance of the operating light is below the limit value).

[0032] Concerning this, preferably the control members activate the controlled switching off of said operating light irrespective of the on or off state of said auxiliary light.

[0033] Similarly, preferably the control members activate the controlled switching off of said auxiliary light irrespective of the on or off state of said operating light.

[0034] In this way, the auxiliary light can be deactivated whenever the dentist wishes.

[0035] Preferably, the minimum illuminance value of the auxiliary light is comprised between 250 lux and 750 lux, preferably about 500 lux.

[0036] Preferably, the maximum illuminance value of the auxiliary light is comprised between 750 lux and 2500 lux, preferably about 1350 lux.

[0037] Such a maximum value of the illuminance of the auxiliary light makes it possible not to dazzle the patient (who could be in a position beneath the auxiliary light) and, in any case, ensures good visual comfort for the dentist in passing between the surgical field and the pre-operation field and vice-versa.

[0038] Preferably, the limit illuminance value of the operating light is comprised between 2000 lux and 10000 lux. Even more preferably, the limit illuminance value of the operating light is about 8000 lux.

[0039] Preferably, the limit illuminance value of the operating light is such as to allow operations in the surgical field.

[0040] Preferably, the control members are configured so that a percentage illuminance variation of the operating light, in the range comprised between the maximum illuminance value and the limit illuminance value, corresponds to a percentage illuminance variation of the auxiliary light by an amount equal to a correlation coefficient greater than one multiplied by the percentage illuminance variation of the operating light.

[0041] The percentage variation is calculated as the ratio between the current illuminance and the maximum illumi-

nance.

[0042] Preferably, a percentage illuminance variation of the operating light does not correspond to the same percentage illuminance variation of the auxiliary light; the percentage variation of the illuminance of the auxiliary light being correlated to the percentage variation of the illuminance of the operating light by a correlation multiplication coefficient greater than 1.

[0043] Preferably, such a correlation coefficient increases at a constant rate, when the illuminance of the operating light decreases, in the entire variation range comprised between the maximum value and the limit illuminance value of the operating light.

[0044] Below the limit illuminance value of the operating light, the correlation coefficient does not apply, in other words an illuminance variation of the operating light does not correspond to any variation of the illuminance of the auxiliary light.

[0045] Preferably, said auxiliary light is integrated inside a seat of said first arm or of said second arm.

[0046] Preferably, said auxiliary light is positioned at a lower portion of said first or second arm.

[0047] Preferably, auxiliary light is of the LED or OLED type.

[0048] The characteristics and advantages of the present invention will become clearer from the following detailed description of a possible embodiment, illustrated as an example and not for limiting purposes in the attached drawings, in which:

- figure 1 schematically shows a dental unit equipped with an articulated arm in accordance with the present invention,
- figure 2 shows an exploded view of a preferred embodiment of a component of the articulated arm of figure 1,
- figure 3 shows an exploded view of an alternative embodiment of the component of figure 2,
- figure 4 shows an exploded view of a further preferred embodiment of a component of the articulated arm of figure 1,
- figure 5 shows a view of the component of figure 4 in its assembled configuration; and
- figure 6 shows a block diagram of an operating scheme of an articulated arm in accordance with the present invention.

[0049] The articulated arm and the dental unit illustrated in the attached figures should be considered to be represented schematically, not necessarily to scale and not necessarily with the represented proportions between the various constituent elements.

[0050] Even if not explicitly highlighted, the single characteristics described in reference to the specific embodiments should be considered as accessory and/or interchangeable with other characteristics, described in reference to other embodiments.

[0051] The following description will refer explicitly, as a preferred embodiment of the invention, to an articulated arm used in dentistry and in particular to an articulated arm for a dental unit, without for this reason excluding the possibility that the articulated arm is connected to other devices, to a wall and/or used in other fields in which it is necessary to intervene in a predetermined surgical field.

[0052] In the present invention the term dental unit is meant to indicate a dental apparatus comprising a plurality of tools and equipment used in a dental practice, like for example a dental chair A, a dental quiver F, a dental light 6, a tool-holder, a dental fountain with attached cups and spittoon and the like (figure 1).

[0053] In the present invention the term surgical field is meant to indicate the area in which the dentist operates on the patient during a dental intervention, in other words the area that is located at the patient's mouth (figure 1).

[0054] In the present invention the term pre-operation field is meant to indicate the area located in the immediate vicinity of the surgical field, whether they are located on the patient or outside thereof, like for example the areas in which the dental quiver, the tool-holder and the like are present (figure 1).

[0055] In the attached figures reference numeral 1 wholly indicates an articulated arm for surgical fields in accordance with the present invention applied to a dental unit 100.

[0056] The articulated arm 1 comprises a first arm 2 that extends between a first end 2a and a second end 2b. The first end 2a of the first arm 2 is configured to be able to be constrained to a fixed portion 101, like for example a wall, a dental unit 100 (as shown in figure 1) or another device. Preferably, the first end 2a is constrained in an articulated manner to the fixed portion 101 (figure 1).

[0057] The articulated arm 1 comprises a second arm 3 that extends between a first end 3a and a second end 3b.

[0058] The articulated arm 1 also comprises an operating light 4 at the second end 3b of the second arm 3 (figure 1).

In the preferred embodiment of the invention, the operating light 4 comprises an optical diffusor 6 to direct a beam of light F1 towards the surgical field. The operating light 4 has variable illuminance with continuity between a maximum value comprised between about 100000 and about 60000 lux and a minimum value of about 3000 lux. The operating light 4 can be a halogen lamp, even if in the preferred embodiment of the invention it is an LED lamp. The illuminance of the operating light 4 can be varied by the dentist by acting on a suitable actuator.

[0059] The second end 2a of the first arm 2 and the first end 3a of the second arm 3 are articulated to one another so that the second arm 3 is mobile with respect to the first arm 2 and can be oriented in space to position the operating light 4 where necessary for the work of the dentist. Concerning this, the second end 2b of the first arm 2 and the first end 3a of the second arm 3 are articulated to one another through a hinge or a ball joint 5, so as to allow at least the

relative rotation of the second arm 3 with respect to the first arm 2 (figure 1). The operating light 4 arranged at the second end 3b of the second arm 3 is preferably mobile with respect to such an end and is constrained to it through one or more hinges, through ball joints or similar.

[0060] The articulated arm 1 also comprises an auxiliary light 7 fixedly connected to the first arm 2 and capable of emitting a second light beam F2. The auxiliary light 7 has lower illuminance than the illuminance of the operating light 6. In particular, the illuminance of the auxiliary light 7 is variable between a maximum value comprised between about 2500 lux and a minimum value of about 250 lux. Preferably, the illuminance of the auxiliary light 7 is variable between a maximum value of about 1350 lux and a minimum value of about 500 lux. The auxiliary light 7, in use, generates a beam of light oriented and diffused by a respective diffusor 8.

[0061] The first arm 2 has a lower portion 2c, and an upper portion 2d, respectively facing, when the articulated arm is in use, towards the floor and towards the ceiling of the dental studio. Similarly, the second arm 3 has a lower portion and an upper portion also respectively facing, when the articulated arm is in use, towards the floor and towards the ceiling of the dental studio. The first arm 2 (and in some applications also the second arm 3) usually sits, when the articulated arm is in use, right above or in the immediate vicinity of the pre-operation field as defined above, in other words the area at which the dental quiver and/or the tool holder are located.

[0062] The auxiliary light 7 is positioned at the lower portion 2c of the first arm 2 so as to directly illuminate the pre-operation field.

[0063] Alternatively, the auxiliary light 7 is positioned at the upper portion 2d of the first arm 2, so that the pre-operation field (and also further areas of the dental studio) can be illuminated indirectly, with reflected light, by the auxiliary light 7.

[0064] In any case, the position of the auxiliary light 7 on the first arm 2 is that most suitable for illuminating the pre-operation field as a function of the position usually taken up by the articulated arm during the intervention.

[0065] In accordance with a preferred embodiment, the auxiliary light 7 is of the LED or OLED type. The type of LED or OLED light source ensures a high level of optical control, as well as excellent lumen/watt efficiency. As stated, the auxiliary light 7 comprises at least one screen or optical diffusor 8 configured to correct and/or rather distribute the beam of light F2 and illuminate, without however dazzling the patient P sitting on the chair 102 of the unit 100, the pre-operation field. The choice of optical properties of the diffusor 8 is, for example, a function of the opening angle of the light beam that is wished to be obtained or the level of reduction of the illuminance produced by the auxiliary light 7 to not dazzle the users.

[0066] In accordance with a preferred solution, the auxiliary light 7 is integrated inside a seat 9 formed in the first arm 2 (figures 2 and 3). In this way, the auxiliary light 7 can be positioned inside the first 2 arm and sit completely inside the arm with the optical diffusor 8 flush with the outer surface of the arm itself. Preferably, the seat 9 is equipped with members suitable for dissipating the heat developed by the auxiliary light 7, especially if the latter does not incorporate LED technology.

[0067] Alternatively, if it were wished to modify an articulated arm already available and make it conform to the present invention, the auxiliary light 7 is housed in a containment body 10 stably constrained to the first arm 2 (figures 4 and 5). Preferably, the containment body 10 is equipped with members suitable for dissipating the heat developed by the auxiliary light 7. The containment body 10 is preferably a metallic profile 11 on which the light 7 is installed. Such a metallic profile 11 comprises a first portion 11a intended to contact the first arm 2 and to stably constrained to it (for example through screws or similar) and a second portion 11b that houses the auxiliary light 7 exposing it to the environment outside of the profile, so as to be able to illuminate the surrounding environment. The second portion 11b of the metallic profile 11 is also provided with constraining members to be able to receive the optical diffusor 8 of the light 7 in engagement.

[0068] Preferably, the control of the illuminance of the auxiliary light 7 is carried out by control members 12 as a function of the illuminance taken on by the operating light 4 (controlled by the user).

[0069] The control members 12 are active on the auxiliary light 7 by varying the intensity of current provided to it as a function of the current intensity sent to the operating light 4. Suitable calibration curves make it possible to unequivocally relate the current intensity supplied to the auxiliary light 7 and to the operating light 4 with the respective illuminances. Therefore, hereinafter reference will be made without distinction to the current intensity provided to the lights or to the illuminance thereof.

[0070] As schematised in figure 7, the control members 12 send a signal AS representative of an illuminance level of the auxiliary light 7 as a function of a signal OS received by the operating light 4 representative of the illuminance emitted by it.

[0071] The signal AS is generated by correlating the signal OS with a TA preset table, or algorithm, in the control members 12.

[0072] In such a table TA each illuminance value of the operating light 4 corresponds to an illuminance value of the auxiliary light 7.

[0073] In the preferred embodiment of the invention, each percentage illuminance value, with respect to the maximum illuminance value, of the operating light 4 corresponds to a percentage illuminance value, with respect to the maximum illuminance value, of the auxiliary light 7. A range comprised between the maximum value and a limit illuminance value

(greater than the minimum value) of the operating light 4 is associated with a correlation coefficient. Such a correlation coefficient is multiplied by the percentage illuminance value of the operating light 4 to give, as a result, the percentage illuminance value of the auxiliary light.

[0074] The correlation coefficient is a number greater than 1 and increases uniformly, in the range of applicability thereof, progressively as the illuminance values of the operating light 4 decrease.

[0075] Below the limit illuminance value of the operating light 4, the illuminance value of the auxiliary light 7 remains constant and equal to the limit illuminance value of the operating light 4.

[0076] The following table illustrates a possible example of correlation between the illuminance of the operating light 4 and the illuminance of the auxiliary light 7.

illuminance operating light (lux)	percentage illuminance operating light	correlation coefficient	illuminance auxiliary light (lux)	percentage illuminance auxiliary light
80000	100	-	1350	100
50000	62	1.23	1025	76
25000	31	1.71	715	53
15000	19	2.26	580	43
8000	10	3.70	500	37
3000	4	-	500	37

[0077] In the example of the table given above, the illuminance values of the operating light 4 are respectively: maximum value 80000 lux, minimum value 3000 lux, limit value 8000 lux. The illuminance values of the auxiliary light 7 are respectively: maximum value 1350 lux, minimum value 500 lux.

[0078] Preferably, the auxiliary light 7 and the operating light 4 are controlled with a single adjuster device 13 (schematised in figure 6) by the dentist, so that the control carried out by the dentist on the illuminance of the operating light 4 immediately and automatically determines a corresponding (in the sense specified above) illuminance of the auxiliary light 7. Such a single adjuster device 13 can be a touch-screen control interface, a keypad, a foot pedal or similar.

[0079] The adjuster device 13 is also configured to generate and send a switching off signal SS1 to the control members 12 which, having received such a signal, send a switching off signal ST1 to the operating light 4.

[0080] Similarly, the adjuster device 13 is configured to generate and send a switching off signal SS2 to the control members 12 which, having received such a signal, send a switching off signal ST2 to the auxiliary light 7.

[0081] The adjuster device 13 is also configured to generate and send an activation signal AS1 to the control members 12. Upon receiving such a signal AS1, the control members 12 generate an activation signal TS both of the operating light 4 and of the auxiliary light 7, so that both of the lights switch on. The switching on of the lights determines the activation of the algorithm TA that correlates (as specified above) the illuminances of the two lights.

[0082] All of the aforementioned signals sent by the control members 12 are generated by one or more current intensity variators 14 (schematised in figure 6) active on the lights 4, 7.

[0083] The control members 12 are also configured to control the orientation of the light beam F2 emitted by the auxiliary light 7, to ensure optimal illuminance conditions of the pre-operation field. Concerning this, the control members 12 comprise an electric actuator (not illustrated) active on the optical diffusor 8 to orient it.

[0084] Preferably, the electric circuits of the auxiliary light 7 are integrated with those of the operating light 4. Advantageously, the same power supply and/or control cables are used for both lights.

[0085] Of course, those skilled in the art can bring numerous modifications to the variants described above in order to satisfy contingent and specific requirements, like for example foreseeing two physically distinct but cooperating auxiliary lights or integrating the auxiliary light in the second arm, all in any case covered by the scope of protection as defined by the following claims.

Claims

1. Articulated arm for surgical fields, comprising a first arm (2) suitable for being constrained to a surface or to a device (100) and mechanically articulated to a second arm, an operating light (4) connected to the second arm (3) to illuminate a surgical field wherein said operating light (4) has adjustable illuminance between a minimum value and a maximum value, at least one auxiliary light (7) fixedly connected to at least one from said first arm (2) and said second arm (3), said auxiliary light (7) having an adjustable illuminance between a minimum value and a maximum

value, control members (12) being configured to adjust the illuminance of the auxiliary light (7) as a function of the illuminance of the operating light (4), wherein said control members (12) are active on said auxiliary light (7) so that said minimum value of the auxiliary light (7) is reached when the operating light (4) takes on a limit illuminance value greater than said minimum value thereof.

2. Articulated arm according to claim 1, wherein said control members (12) are configured to keep said auxiliary light (7) at said minimum illuminance value when the operating light (4) takes on illuminance values below said limit illuminance value.
3. Articulated arm according to claim 1 or 2, wherein said minimum illuminance value of the auxiliary light (7) is comprised between 250 lux and 750 lux, preferably about 500 lux.
4. Articulated arm according to any one of the previous claims, wherein said maximum illuminance value of the auxiliary light (7) is comprised between 750 lux and 2500 lux, preferably about 1350 lux.
5. Articulated arm according to any one of the previous claims, wherein said limit illuminance value of the operating light (4) is comprised between 2000 lux and 10000 lux.
6. Articulated arm according to any one of the previous claims, wherein said control members (12) are configured so that a percentage illuminance variation of the operating light (4), in the range comprised between the maximum illuminance value and the limit illuminance value, corresponds to a percentage illuminance variation of the auxiliary light (7) equal to a correlation coefficient greater than one multiplied by the percentage illuminance variation of the operating light (4).
7. Articulated arm according to claim 6, wherein said correlation coefficient increases, in the entire variation range comprised between the maximum value and the limit illuminance value of the operating light (4), as the illuminance of the operating light (4) decreases.
8. Articulated arm according to any one of the previous claims, wherein said control members (12) activate the controlled switching off of said operating light (4) irrespective of the on or off state of said auxiliary light (7).
9. Articulated arm according to any one of the previous claims, wherein said auxiliary light (7) is integrated inside a seat (9) of said first arm (2) or of said second arm (3).
10. Articulated arm according to any one of the previous claims, wherein said at least one auxiliary light (7) is positioned at a lower portion (2c, 3c) of said first or second arm (2, 3).
11. Articulated arm according to any one of the previous claims, wherein said auxiliary light (7) is of the LED or OLED type.
12. Dental unit comprising an articulated arm according to one or more of claims 1 to 11.

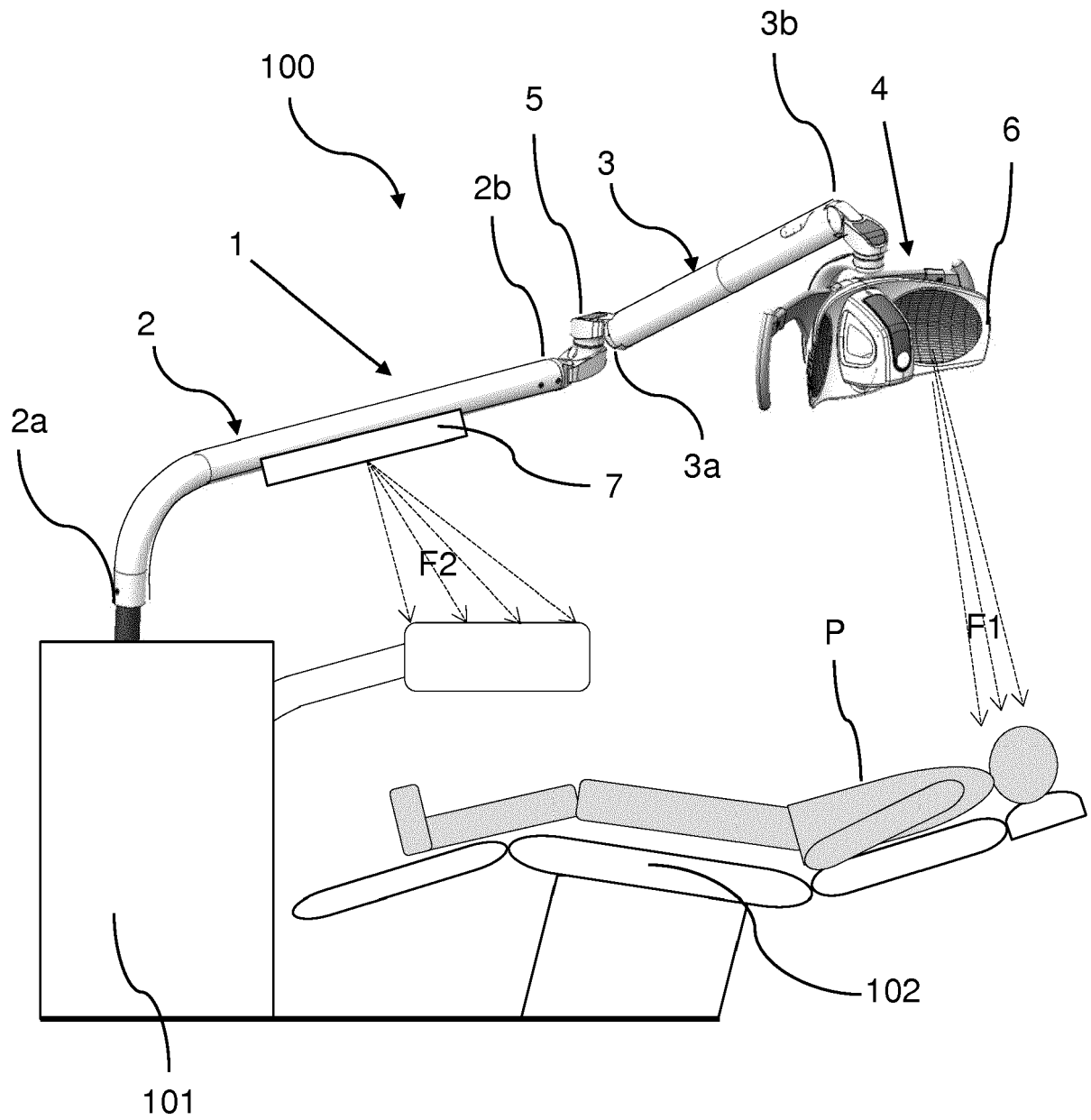
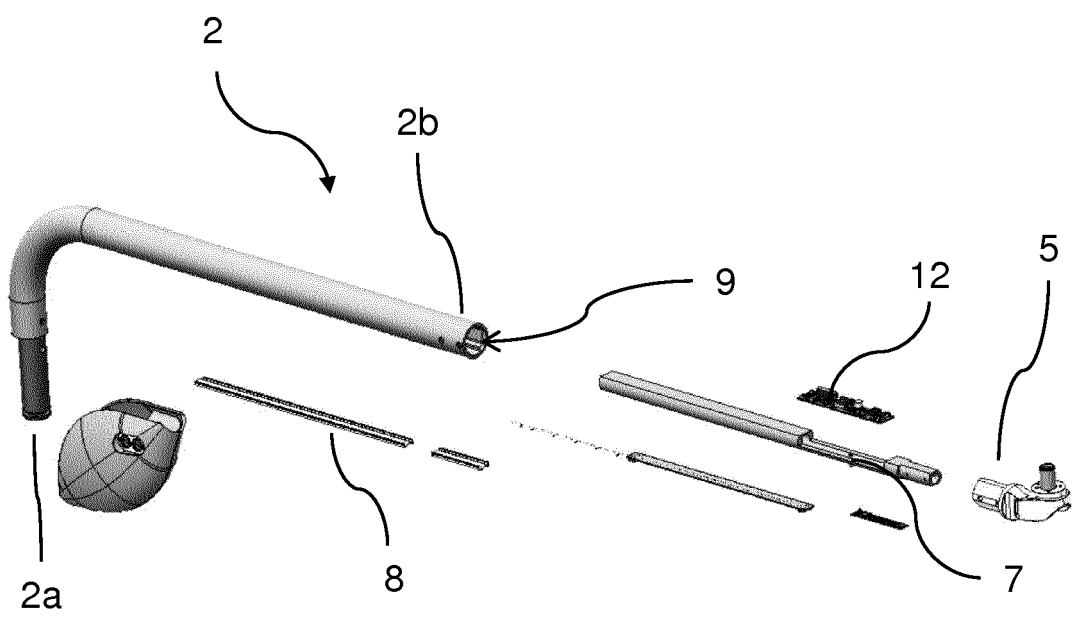
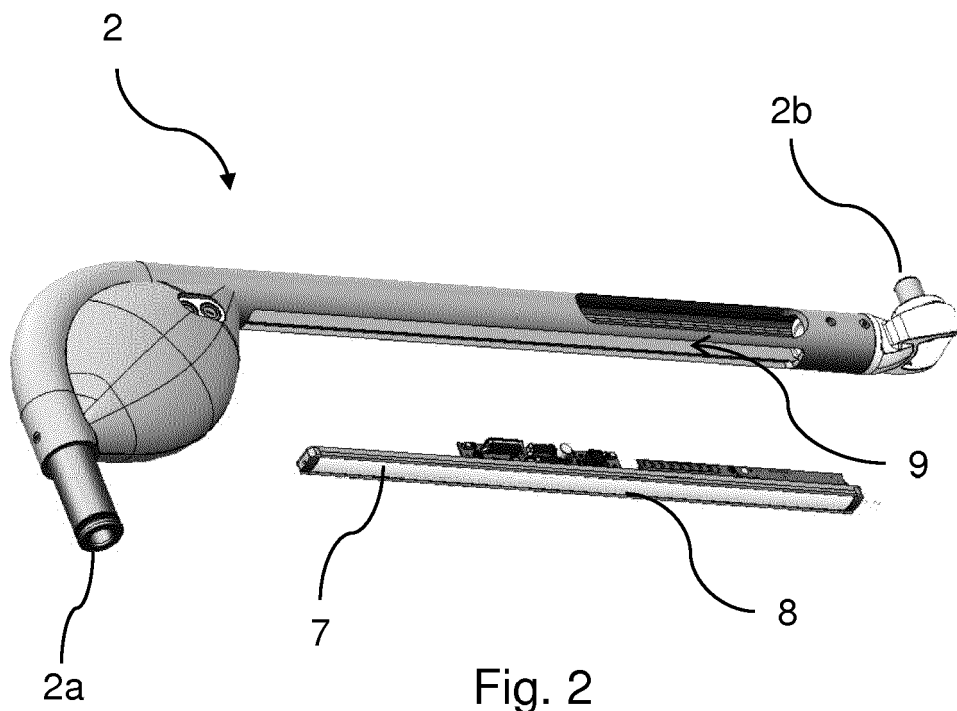


Fig. 1



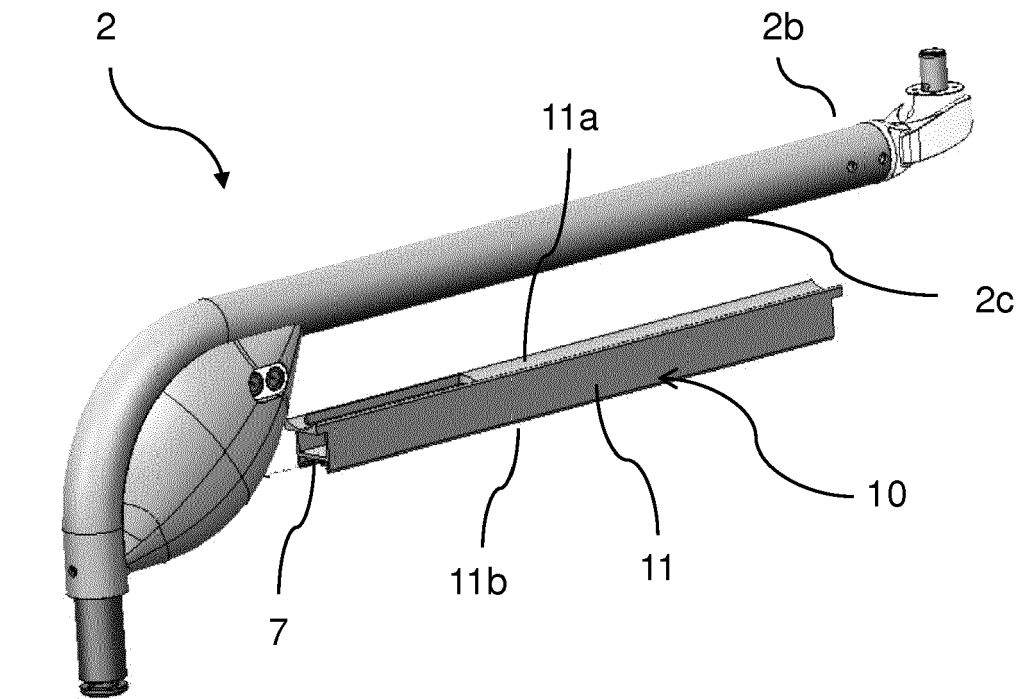


Fig. 4

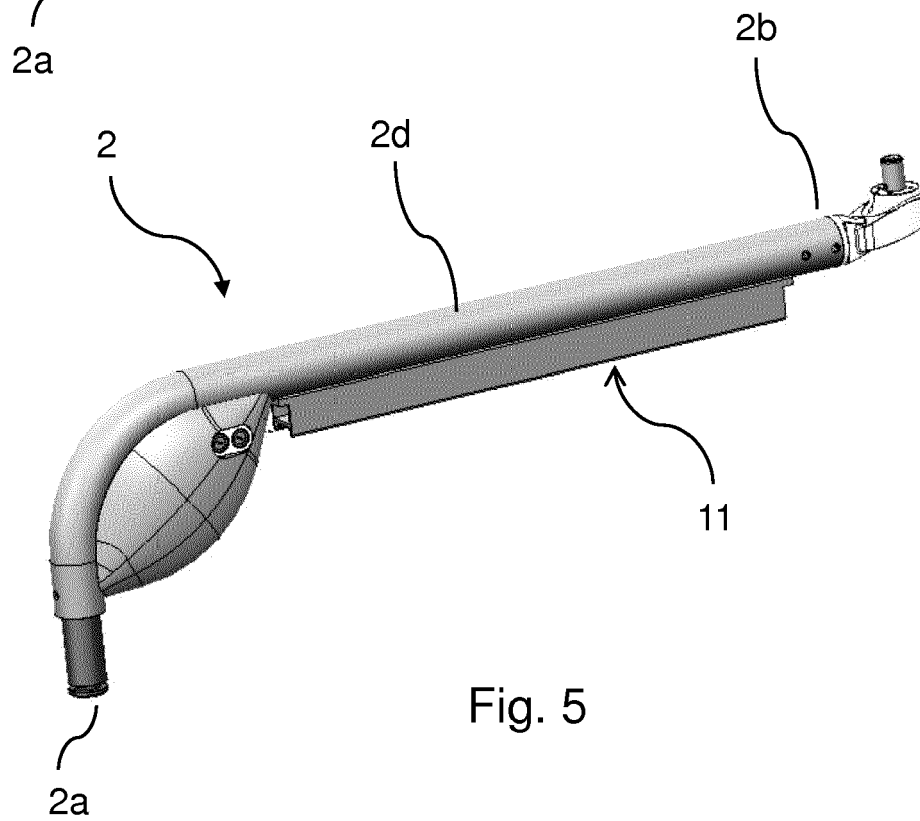
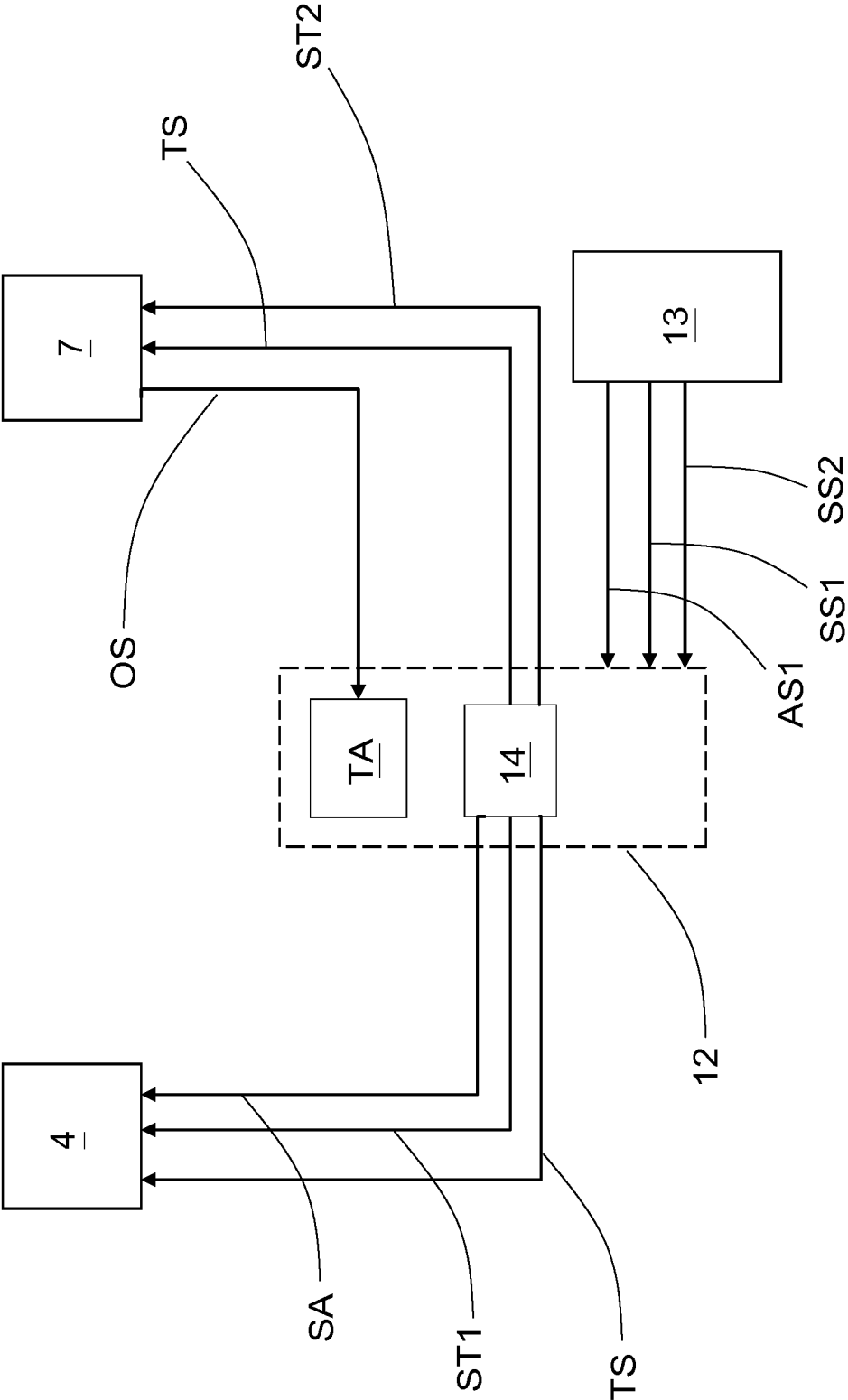


Fig. 5

Fig. 6





EUROPEAN SEARCH REPORT

 Application Number
 EP 16 17 9106

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 28 November 2016	Examiner Kroeders, Marleen
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.02 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 16 17 9106

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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