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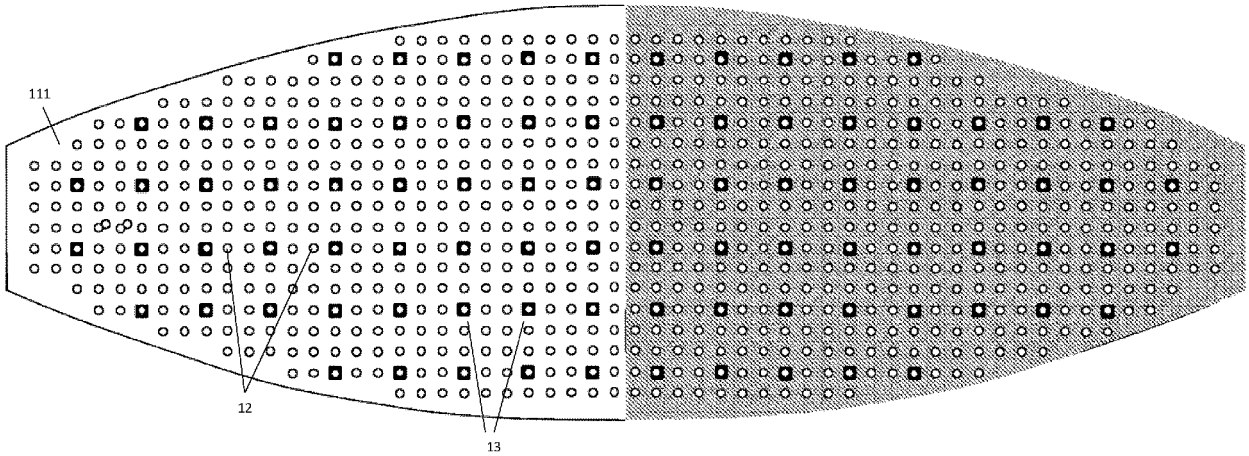
(54) **A LIGHT-BASED TREATMENT DEVICE FOR HEAD AND/OR SCALP**

(57) According to an aspect of the invention, a scalp care device is provided, which includes a casing, a mounting pad, an array of bristles and a plurality of light emitting elements. The mounting pad includes an inner surface and an outer surface, the inner surface facing the scalp when in use and the outer surface facing the casing. The array of bristles is arranged to section hair into parts, and each bristle comprises a base, a body and a distal portion, wherein the base is coupled to the inner surface of the mounting pad. The light emitting elements are operable in a suitable wavelength range for scalp treatment and distributed either on the inner surface of the mounting pad while surrounded by the bristles, or on the outer surface of the mounting pad. A controller is configured to control the light emitting elements to irradiate the sectioned parts.

Figure 2



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Description

FIELD OF THE INVENTION

[0001] The present invention relates to the field of treatment devices for head and/or scalp using light. It further relates to devices which treat scalp conditions such as flake formation and dandruff.

BACKGROUND OF THE INVENTION

[0002] Approximately 40% of adults suffer from persistent flakes on the scalp. These flakes can originate from dandruff, dry scalp skin or from inflammatory skin diseases like seborrheic dermatitis and psoriasis. The flakes are visible on the scalp and the hair and they shed on the shoulders, which poses an issue for many of those affected. In all cases of flakes, the epidermis of the skin is perturbed, with a high turnover rate and incomplete differentiation of keratinocytes, which causes the resulting corneocytes to shed not as separate cells but as clumps, known as flakes. In case of dandruff, the underlying cause is oily scalp in combination with the overpopulation of a commensal fungus known as Malassezia which feeds on sebum and produces free fatty acids that irritate the scalp and induce an immune response leading to aforementioned perturbation of the epidermis (Pople, 2019). In case of flakes from dry scalp, the low level of sebum cannot prevent loss of moisture from the epidermis, resulting in a compromised barrier function, an immune response and a similar perturbation of the epidermis (Proksch, 2020). Finally, in case of psoriasis, seborrheic dermatitis and various other skin diseases, the underlying inflammation is the cause of the perturbation of skin physiology associated with scales and flakes.

[0003] Professional light-based devices for the treatment and prevention of flakes using UV-A and UV-B, and visible wavelengths are known. The effect of illuminating keratinocytes at UV wavelengths is a regulation of cell proliferation and differentiation (Liebmann, 2010). Scalp devices for prevention of flakes for home use are known but scarce. These devices usually incorporate light emitting elements such as laser diodes or light emitting diodes. Scalp care devices are also known to include bristles. However, for purposes of simpler structural assembly and to increase the light flux incident on the scalp, the light emitting elements are usually disposed or clustered together. Hence, if at all bristles are included, they are disposed around the light units, serving mainly aesthetic purposes, and are especially not effective for separating hair so that the scalp can be irradiated, leading to a less efficient treatment. As a solution, the light emitting elements may be disposed in a separate unit, so that the head unit can properly accommodate the bristles. In this case, however, the user would need to carry an additional light unit with the device. The present invention presents a solution which utilizes the mounting space of the device to the fullest and yet allows effective reach of the light to the scalp. It is intended for home use, but not limited thereto.

[0004] Another object of the invention is to provide a discrete device which the user can use anywhere anytime. In most scalp care devices, since the light emitting elements disposed on the mounting pad are intended for scalp irradiation without obstruction, they are left uncovered. When the device is used, it then emits a color which corresponds to the light emitting elements. In some cases, this can even be harmful to the user, e.g. if irradiated near the eyes. The present invention presents a structural solution which not only utilizes the mounting space, but also allows the light emitting elements to be covered so that their glow is reduced when the device is used. The solution further optimizes the functional coupling between the mounting pad and the bristles, so that the mounting pad can be used for other purposes than merely as a mounting member.

SUMMARY OF THE INVENTION

[0005] The present invention is designed to solve at least one of the problems listed above.

[0006] According to an aspect of the invention, a scalp care device is provided, which includes a casing, a mounting pad, an array of bristles and a plurality of light emitting elements. The mounting pad includes an inner surface and an outer surface, the inner surface facing the scalp when in use and the outer surface facing the casing. The array of bristles is arranged to section hair into parts, and each bristle comprises a base, a body and a distal portion, wherein the base is coupled to the inner surface of the mounting pad. The light emitting elements are operable in a suitable wavelength range for scalp treatment and distributed either on the inner surface of the mounting pad and surrounded by the bristles, or on the outer surface of the mounting pad. A controller is configured to control the light emitting elements to irradiate the sectioned parts.

[0007] According to another aspect of the invention, the mounting pad is curved or flexible.

[0008] According to another aspect of the invention, the mounting pad and/or the bristles are arranged to guide light emitted by the plurality of light emitting elements.

[0009] According to another aspect of the invention, the light emitting elements are further distributed on the bristles.

[0010] According to another aspect of the invention, the device further comprises a handheld or wearable portion.

[0011] According to another aspect of the invention, the plurality of light emitting elements are operable in a wavelength range 400-700 nm, preferably 440 to 460 nm, 600-700 nm and more preferably, 452 $\pm$ 7 nm.

[0012] According to another aspect of the invention, the plurality of light emitting elements are light emitting diodes, LEDs, and/or laser diodes, LDs.

[0013] According to another aspect of the invention, the device further comprises a skin parameter sensor, and the controller is configured to control at least one operation parameter of the plurality of light emitting elements based on a measurement of the skin parameter sensor. The at least one operation parameter is an intensity and/or wavelength of the light emitting elements. The skin parameter sensor can be a temperature, pressure, capacitance, imaging, or pigmentation sensor.

[0014] According to another aspect of the invention, the device further comprises a user interface unit and/or a wired or wireless communication means.

[0015] According to another aspect of the invention, the device further comprises at least one air vent on a surface of the casing.

[0016] According to another aspect of the invention, the bristles include a hollow spacing, and the light guiding elements are further distributed on the inner surface of the mounting pad in the hollow spacing. The bristles may be further arranged to guide air therethrough, and/or have flexibly conical distal portions.

[0017] These and other aspects, and further advantages, will be apparent from and elucidated with reference to the embodiment(s) described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

Fig. 1 shows a schematic of a scalp care device according to an embodiment of the invention, where the device is a wearable device.

Figs. 1a — 1c show different implementations of coupling light to the bristle, according to an embodiment of the invention.

Fig. 2 shows a layout of light emitting elements and bristles, according to an embodiment of the invention.

Fig. 3 shows a plurality of components of the scalp care device of Fig. 1 in a disassembled state.

Fig. 4 shows a schematic of a scalp care device according to an embodiment of the invention where the device is a wearable device.

Fig. 5 shows a schematic of a scalp care device according to an embodiment of the invention where the device is a handheld device.

Fig. 6 shows a schematic of a scalp care device according to an embodiment of the invention, where the device is a handheld device.

Fig. 7 shows further layouts of light emitting elements and bristles, according to an embodiment of the invention.

[0019] The figures depict embodiments of the disclosure for purposes of illustration only. One skilled in the art will readily recognize from the following description that alternative embodiments of the structures and methods illustrated herein may be employed without departing from the principles of the disclosure described herein.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0020] The matters exemplified in this description are provided to assist in a comprehensive understanding of various exemplary embodiments of the present invention disclosed with reference to the accompanying figures.

[0021] Accordingly, those of ordinary skill in the art will recognize that various changes and modifications of the exemplary embodiments described herein can be made without departing from the scope of the claimed invention. In particular, combinations of specific features of various aspects of the invention may be made. An aspect or embodiment of the invention may be further advantageously enhanced by adding a feature that was described in relation to another aspect or embodiment of the invention.

[0022] Further, the functionality associated with any particular means may be centralized or distributed, whether locally or remotely. A computer program may be stored/distributed on a suitable medium, such as an optical storage medium or a solid-state medium supplied together with or as part of other hardware, but may also be distributed in other forms, such as via the Internet or other wired or wireless telecommunication systems. It may be advantageous to set forth that the terms "include" and "comprise," as well as derivatives thereof, mean inclusion without limitation. In addition, reference to an element by the indefinite article "a" or "an" does not exclude the possibility that more than one of the element is present, unless the context clearly requires that there be one and only one of the elements. The indefinite article "a" or "an" thus usually means "at least one".

[0023] The expression "at least one of A, B and C" means "A, B, and/or C", and that it suffices if e.g. only B is present. Any reference signs in the claims should not be construed as limiting the scope.

[0024] The term "head unit" herein means a unit situated at a portion of the unit proximal to the scalp/head of the user when the device is in use.

[0025] The term "casing" herein means an outer section of a component of the device, e.g. an outer shell which functions to enclose an inner component or shell.

[0026] The term "couple" herein means both direct and indirect attachment of a component to another. Indirect coupling can be established by introducing a stack of layers between said components.

[0027] The term "facing" herein means that a first component directly faces a second component or external element and/or the first component is disposed in a certain direction facing towards the second component or the external element. The latter meaning does not exclude the presence of further components between the first and the second/external component.

[0028] Fig. 1 shows a 2D schematic of a scalp care device according to an embodiment of the invention.

[0029] The device comprises at least one head unit H.

The head unit H includes a casing 10. In the embodiment as shown in Fig. 1, the casing 10 may be part of a head unit of a wearable device and arranged to conform to the shape of the human head or scalp for providing complete light coverage to the areas of the scalp. In another embodiment, the casing 10 forms part of a top /head unit of a hand-held device, where a bottom part of the device is formed as a handle held by the user. The bottom part is then the handheld portion/unit.

[0030] The device further comprises a mounting pad 11. The mounting pad includes an inner surface 111 and an outer surface 112, the inner surface 111 facing the scalp when in use and the outer surface 112 facing the casing 10. In this embodiment, the mounting pad 11 is flexible, e.g. a flexible polymer and has a curved shape. In another embodiment, mounting pad 11 is a rigid body e.g. rigid polymer. In yet another embodiment, the mounting pad 11 comprises multiple parts adjoined using a rib. The inner surface 111 of the mounting pad 11 mounts an array of bristles 12, each bristle 12 comprising a base 101, a body 102 and a distal portion 103. The base 101 is (directly or indirectly) coupled to the inner surface of the mounting pad 11. The distal portion 103 contacts the scalp when the device is in use. It is known to the skilled person how the casing 10 and other features can be designed to conform to the shape of the mounting pad 11. The mounting pad 11 may comprise a single inner surface and a single outer surface as shown in Fig. 1 (i.e. the pad is formed from a single mounting layer), or it may comprise, as shown in Fig. 3, at least one intermediate surface/layer 114 where the innermost surface 111 faces the scalp and the outermost surface 112 (not shown in Fig. 3) faces the casing 10. In an embodiment, the bristles are transparent or semi-transparent, serving as light guides for light emitted from a plurality of light emitting elements 13. Fig. 1a shows an implementation to couple light to the bristle. In a first case, the bristle comprises a recess at the base 101, which allows light to be transported from the light emitting element 13 through the body towards the distal portion which contacts the scalp. Fig. 1a shows a prism reflecting light from the light emitting element 13 to the base 101. In the figure, the light emitting element 13 emits light in a downward direction. In a different arrangement described below, the light emitting element emits light in an upward direction, in which case, the prism (or any other light guide) is correspondingly aligned in the light beam path.

[0031] Alternately as shown in Fig. 1b, light from the light emitting element is coupled to the body of the bristle through e.g. surface coupling or a dedicated inlet in the body and transported to the distal portion.

[0032] The distal portion of the bristles may take various shapes — e.g. flat, rounded (concave/convex), ball tip etc. The bristles may be distributed at a spacing of 0.5-5 mm, preferably 1-2 mm from each other and at lengths of 10-20 mm, preferably 15 mm. They are made of polymers/plastics such as but not limited to PMMA, SLR or PC (polycarbonates).

[0033] Light emitting elements 13 may be any suitable structure for emitting light, like light emitting diodes LED, laser diodes LD etc., in a suitable wavelength region known for a therapeutic effect and are mounted via a suitable substrate on the mounting pad 11. In an embodiment, the light emitting elements 13 are a combination of LEDs and LDs. In an embodiment, the light emitting elements are operable in a UV wavelength range 400-470 nm, preferably 440 to 460 nm and more preferably, 452 $\pm$ 7 nm. In another embodiment, the light emitting elements are operable in a VIS-IR wavelength range 600-700 nm. In yet another embodiment, the light emitting elements are operable in all three wavelength regions.

[0034] The device may further have a heat sink S for efficient energy transfer. In Fig. 3, the heat sink is shown attached to the intermediate surface 114 of the mounting pad 11. The casing 10 includes at least one vent for allowing air exchange between the device and the outside environment.

[0035] The plurality of light emitting elements 13 are distributed on the inner 111 or outer 112 surfaces of the mounting pad 11. When distributed on the inside surface 111, a light emitting element is surrounded by a plurality of bristles, i.e. in an enclosed (i.e. on all sides or directions) formation. This is shown in Fig. 2. The pattern repeats uniformly on the full expanse of the inner surface 111. For example, in a 2x2 array of bristles, the bristles may surround a centrally located light emitting element, i.e. a single light emitting element is surrounded by 4 bristles. Here, the two bristles in a first row of the array are arranged adjacent to one side of the light emitting element, and the other two bristles in a second row are arranged adjacent to an opposite side of the light emitting element. As another example, in a 5x5 array, a centrally positioned bristle at the 3rd row, 3rd column is substituted by a light emitting element, i.e. the light emitting element is surrounded by the bristles which form the remaining elements of the array. Here, a single light emitting element is surrounded by 24 bristles, or at least 9 bristles. In both cases, the light emitting elements are surrounded by, or are positioned in between the bristles, on the full expanse of the inner surface 111. In other words, the bristles are symmetrically placed about a central axis on the mounting pad, the light emitting element situated on the central axis. As mentioned, the light emitting elements may be LEDs, e.g. Osram GD PSLM31.14, and may be distributed at a separation of a few millimeters, e.g. 5-30 mm, preferably 10 - 15 mm.

[0036] When distributed on the outer surface 112, as shown in Fig. 1, the light emitting elements are typically arranged in a linear manner. When arranged on a flexible mounting pad 11, the linearly arranged light emitting elements 13 conform to the shape of the mounting pad 11. Further, the mounting pad 11 comprises a recess on its inner and outer surfaces to allow light the light emitting element to be channelized towards the base of the bristle.

[0037] Such evenly distributed configuration allows the

bristles to part the hair so that the adjacently located light emitting element can irradiate the parted hair. This ensures uniform illumination and effective reach of the light to the scalp.

[0038] Each light emitting element 13 is further disposed inside a light source housing unit 15, as shown in Fig. 1c. In this case, the outer and inner surfaces of the mounting pad include at least one inlet for channeling the emitted light towards the base 101 of a bristle. In an embodiment, where the light emitting element is disposed on the outer surface of the mounting pad, an outlet O in the light source housing unit (and a corresponding inlet in the outer surface of the mounting pad, which may be the same as the outlet of the light source housing unit 15 as shown in Fig. 1c) allows light from the light emitting element 13 to be directed towards an inlet I on an inner surface 111 of the mounting pad 11 towards the base of the bristle. A light guiding element such a mirror or prism (as described above, in Fig. 1a) may be fitted within a spacing between the inner and outer surfaces of the mounting pad to deflect the light towards the base 101 of an adjacent light emitting element 13. Similarly, where the light emitting element is disposed on the inner surface of the mounting pad, an outlet O in the light source housing unit (and a corresponding inlet in the inner surface of the mounting pad) allows light from the light emitting element 13 to be directed towards a further inlet I on an inner surface 111 of the mounting pad 11 at the base of the bristle. The light which is coupled to the base 101 is directed towards the distal portion 103 and onto the scalp via the body 102. Thus, the mounting pad is optimized for light guiding assembly in addition to functioning as a mounting member. The skilled person knows how to provide additional light channels in the head unit when the mounting pad has intermediate surfaces.

[0039] The light guiding element can also serve as a light diffuser to adjust the intensity of light or a light filter to filter out undesired spectral wavelengths.

[0040] In an embodiment, the outer surface of the mounting pad is recessed, inside which recess the light source unit 15 is fitted. In this case, the separate outlet O and the corresponding inlet may be omitted, and the light is directly coupled to the inlet I on the inner surface of the mounting pad 11, and towards the base of bristle 12. Similarly, where the light emitting element is disposed in a recess on the inner surface of the mounting pad, the emitted light is directly coupled to the further inlet I.

[0041] In an embodiment, the device comprises a plurality of head units. A first head unit is stacked on a second head unit. The second head unit is rotatable with respect to the first head unit via a plurality of pivot joints located on the first head unit. In this arrangement, the first and the second head units can be respectively used to irradiate a top and a back side of the head.

[0042] The device includes a controller 14 which is configured to control the light emitting elements 13 to irradiate the parts of the scalp sectioned by the bristles 12. The controller 14 may be contained within the device (between the casing 10 and the outer surface 112) or attached to the casing 10 on an outside of the device. The controller 14 can be attached to the casing via a cable, in which case the wearable head unit is lighter.

[0043] The controller 14 may be configured to provide power to the plurality of light emitting elements, so that they are illuminated. The power may be supplied by disposable or rechargeable batteries carried in the casing 10. Alternatively, the casing 10 may plug into a standard wall outlet (e.g. 230 V outlet) for supplying electric power to the light generating sources. The controller 14 may further be configured to control the operation of the light emitting elements 13. In an embodiment, the controller controls the intensity (optical power density) and/or wavelength of light emission.

[0044] The controller 14 is further configured to provide power to and control the operation of additional operating systems within the device, such as sensor elements.

[0045] In an embodiment, the head unit comprises a skin parameter sensor 17. The controller is configured to control at least one operation parameter of the plurality of light emitting elements and/or bristles based on a measurement of the skin parameter sensor. In yet another embodiment, an operation parameter of the head unit, e.g. its stiffness around a user's head when in use, is controlled.

[0046] The skin parameter sensor 17 may be disposed within the head unit in a spacing between the casing 10 and the outer surface 112.

[0047] The at least one operation parameter of the plurality of light emitting elements includes intensity and/or optical power and/or wavelength of light emission. The at least one operation parameter of the bristle includes a length or height of the bristle and its stiffness.

[0048] In an embodiment, the skin parameter sensor 17 is a temperature sensor which measures temperature of the scalp in contact with the bristle 12. As blue light is absorbed by melanin in the skin, a high level of melanin e.g. found in people with darker skin might result in a significant light absorption and temperature rise. The controller 14 is configured to receive temperature measurements from the temperature sensor and based on the measurements, adjust the optical power or intensity of light emitted by the light emitting elements 13. In an embodiment, the controller reduces the optical power or even temporarily disables the light emitting elements 13 until a measured temperature drops below a predefined threshold value, to prevent overheating of scalp.

[0049] In an embodiment the skin parameter sensor 17 is a moisture sensor which measures hydration of the scalp in contact with the bristle 12. The controller 14 is configured to receive hydration measurements from the moisture sensor and based on the measurements, adjust the optical power or intensity of light emitted by the light emitting elements 13. In an embodiment, the controller reduces the optical power or even temporarily disables the light emitting elements 13 until a measured moisture content/hydration rises above a predefined threshold val-

ue. In an embodiment, the skin parameter sensor 17 is a force or pressure sensor which measures the pressure applied by the bristles on the scalp and/or head. The controller 14 is configured to receive force measurements from the sensor and based on the measurements, determine whether optimal contact between the bristle and the scalp is established. Based on the determination (a value higher or lower than an allowed force/pressure threshold), the controller adjusts the length of the bristle(s), e.g. by changing the spring coefficient of an elastic bristle. Alternately, the controller activates an actuator which induces a movement of bristles from a lower position (length/height) to a higher position (length/height) or vice-versa, the position referenced with respect to the inner surface of the mounting pad.

[0050] The controller may further adjust the force imparted by the head unit (a measure of its stiffness) on the user's head. In this embodiment, the entire head unit is formed from an elastic material.

[0051] Alternately or in addition, the controller displays a message to the user to manually change the stiffness of the head unit or the length of the bristles via a user controllable interface.

[0052] In an embodiment, the skin parameter sensor 17 is a capacitance sensor which detects contact of bristles with the scalp and/or head. The controller 14 is configured to receive capacitance measurements from the sensor and based on the measurements, activate the light emitting elements only in case of skin contact. Alternately or in addition, the controller adjusts the length of the bristles as mentioned above.

[0053] In an embodiment, the skin parameter sensor 17 is an imaging sensor which images the scalp to detect scalp areas with dandruff flakes. The controller connected to the imaging sensor then controls the light emitting elements 13 to irradiate the detected scalp areas.

[0054] As is clear to the skilled person from above, there is no limitation to the type of skin parameter sensor 17 which can be used in combination with the device.

[0055] In an alternate embodiment, if the intensity and/or optical power and/or wavelength is user adjustable, the controller transmits an alert signal to the user to adjust the operational parameters.

[0056] As mentioned above, the device may be a wearable or a handheld device.

[0057] The exemplary embodiment shown in Fig. 1 shows a wearable scalp care device in the form of a headband. The headband is designed to conform to the shape of the head of the user. The ends of the headband rest near the user's ears.

[0058] The controller 14 may be disposed inside or outside the casing 10 which is part of the head unit, as described above. Here, the wearable portion is integrated with the head unit.

[0059] In yet another embodiment, the controller 14 may be disposed on a remote platform, e.g. on a smart phone or a smart watch/wristband/armband via a software application. In this case, the device (wearable or hand-held) and the remote platform can be wirelessly coupled to each other via Bluetooth, NFC, Zigbee technology etc.

[0060] The alert signal may be a voice or a haptic message output via the device and/or the coupled remote device, or a text or voice message output via the coupled remote device. In an embodiment, the text message is also output on the device, e.g. on a wearable portion e.g. wristband of the device or a hand-held portion.

[0061] Fig. 3 is a schematic which shows a plurality of components of the head unit of Fig. 1 in a disassembled state.

[0062] In this embodiment, the mounting pad 11 comprises at least one intermediate surface/layer 114. The above-mentioned inner surface 111 which faces the direction towards scalp when the device is in use is the innermost surface and the outer surface 112 (not shown) which faces the casing 10 is the outermost surface.

[0063] The light emitting elements 13 are shown distributed on the inner surface 111 of the mounting pad 11. An array of bristles is further coupled to the inner surface 111 of the mounting pad 11. In this figure, the base portion is shown indirectly coupled to the inner surface 111 of the mounting pad via an intermediate (e.g. fabric, transparent polymer) layer. The layer transmits the light from the light emitting elements towards the base of the bristle and to the scalp. As described above, the base can be directly coupled to the inner surface 111 without the intermediate layer.

[0064] Fig. 4 shows a schematic of another embodiment of the scalp care device. The device is also a wearable scalp care device. Here, the wearable portion W is disposed separately from the head unit H/400, the latter including the casing 10, the mounting pad 11, the array of bristles 12 and the light emitting elements 13.

[0065] The wearable portion W can be looped around the neck, or another body part (e.g. arm) of the user. The head unit 400 includes a wrist portion 401, a palm portion 402 and a finger portion 403. The palm portion 402 comprises the mounting pad 11, casing 10 and a plurality of light emitting elements 13. The mounting pad 11 includes an inner surface 111 and an outer surface 112, where the inner surface 111 faces the scalp when in use and the outer surface 112 faces the casing 10. The finger portion 103 includes bristles or protrusions which emanate from the palm portion 402. When in use, these bristles or protrusions are directed towards the head or scalp of the user. The bristles in the finger portion 403 include additional light emitting elements 13. The head unit is arranged such that the light emitting elements positioned on the mounting pad in the palm portion 402 irradiate a central portion of the head/scalp, and the light emitting elements positioned on the bristles of the finger portion 303 irradiate the side scalp areas which lie at a distance from the central portion. The head unit can be attached to the head using a suitable attaching means e.g. hair clips, clamps, flexible band etc. The attaching means may be integrated or removably attachable to the head

unit.

[0066] The casing 10 is adjoined to a wrist portion 401, the latter connected to the wearable portion via a wired or wireless communication means. The wrist portion 401 may function as a pivot joint.

[0067] The controller 14 may be disposed in the wearable portion W in the embodiment of Fig. 4. In this case, the controller 14 transmits control signals either via the wired cable or wirelessly to control the operation of the light emitting elements 13 or any other operating element (e.g. sensors) situated in the head unit 400.

[0068] Alternatively, the controller 14 may be disposed on a remote platform e.g. a smartphone, separate from the device. As indicated, the controller can then be coupled wirelessly with the device.

[0069] Alternatively, the control unit 14 may be disposed in the head unit and is configured to couple the components arranged on the head unit (e.g. light emitting elements, sensors) to components arranged on the wearable portion (e.g. on/off switch, power supply, user interface etc.).

[0070] The skilled person understands that there are further possibilities for implementation of the control system.

[0071] The assembly of mounting pad on the casing, light emitting elements on the mounting pad with respect to the bristles, and other features of this embodiment are otherwise as described in the embodiment of Fig. 1.

[0072] Fig. 5 shows a schematic of yet another embodiment of the scalp care device.

[0073] In this embodiment, the device is hand-held. The device comprises a handheld portion HH which may be elongated. An end of the elongated handheld portion may be attached to casing 10 and in turn to the head unit H. The head unit H includes the casing 10, the mounting pad 11, the array of bristles 12 and the light emitting elements 13.

[0074] The casing 10 in this embodiment receives the outer surface 112 of the mounting pad 10 such that when attached to each other, an outer edge of the casing 10 is unobstructed or uncovered by the mounting pad 11. This uncovered section faces the scalp when the device is in use. The available surface area is utilized to the fullest by mounting additional light emitting elements 13 on the outer edge of casing 10.

[0075] The mounting pad 11 in the head unit has an inner surface 111 and an outer surface 112, the inner surface 111 facing the scalp when in use and the outer surface 112 facing the casing 10. The bristles 12 are mounted on the inner surface 111 of the mounting pad 11, as mentioned in the above embodiments. The light emitting elements 13 are distributed on the inner surface 111 surrounded by the bristles in a manner similar to Fig. 2 or on the outer surface 112 of the mounting pad (not shown).

[0076] The controller 14 and/or the power supply may be disposed in the handheld portion in the embodiment of Fig. 5. Alternatively, the controller 14 may be disposed on a remote platform e.g. a smartphone, separate from the device. Alternatively, the control unit 14 may be disposed in the head unit and is configured to couple the components arranged on the head unit (e.g. light emitting elements, sensors) to components arranged on the wearable portion (e.g. on/off switch, power supply, user interface etc.).

[0077] The remaining features of this embodiment are otherwise as described in the embodiment of Fig. 1 or 4.

[0078] In the embodiment of Fig. 5, the device is a handheld hair/scalp brush.

[0079] Fig. 6 shows a schematic of yet another embodiment of the scalp care device. Here, the device is a hand-held stick. Like in Fig. 5, an end of the handheld portion HH is (removably) attached to the casing of the head unit H. The head unit includes the casing 10, the mounting pad 11, the array of bristles 12 and the light emitting elements 13.

[0080] Fig. 6a shows a schematic where the light emitting elements are distributed on an inner surface of the mounting pad 11 as described in the above embodiments. The inset shows a top angular view of the head unit showing inner surface 111 of the mounting pad 11, with the bristles 12 mounted thereupon.

[0081] Figs. 6b and 6c show schematics where the light emitting elements are distributed on the bristles, on the distal portion and the base respectively. In an embodiment as shown in Fig. 6c-1, when distributed on the base, light from a single light emitting element may be coupled to multiple bristles. Although not shown, the light emitting elements can also be distributed on the body of the bristles, in a manner similar to the embodiment of Fig. 3.

[0082] As understood by the skilled person, the embodiments 6a-6c can be combined.

[0083] The remaining features of Fig. 6 embodiment are like the above described embodiments.

[0084] Fig. 7 shows further arrangements of the light emitting elements 13 with respect to the bristles 12. The light emitting elements are disposed on the inner surface of the mounting pad 11 (not shown).

[0085] Fig. 7a shows a light emitting element 13 disposed along a direction of motion of the bristle 12 when the device is in use. The arrangement allows the bristle to create hair separation as shown in the figure, after which the light emitting element emits light between the separated hair.

[0086] Fig. 7b shows a light emitting element 13 inside the bristle 12, proximal to base 101. In this case, the bristle 12 acts as a light guide. The bristle includes a spacing, inside which the light guiding element is mounted. Light is incident on the scalp through the distal portion of the bristle, while the hair is separated using the motion of the bristle. In an embodiment, the bristle 12 is arranged to act additionally as an air guiding element, so that air is blown over the scalp area via the distal portion of the bristle to create the light pathway. The inner surface 111 of the mounting pad 11 comprises orifices or nozzles positioned adjacent to the light guiding element through

which air can pass into the bristles via the base towards the distal portion. Similar orifices or nozzles are included in the distal portion of the bristle, so that the air can exit the bristles to the scalp. The air flow may be facilitated by the previously described air vent in casing 10 which functions as an air circulator in the device.

[0087] Fig. 7c shows a configuration where a bristle 12 has planar faces, e.g. rectangular, the faces adjoined at an angle to each other (e.g. L or V shaped). In an example where the faces are rectangular, the inner surface 111 of the mounting pad 11 is attached to two (e.g. short) edges of the rectangular faces, and the light emitting element 13 is situated adjacent to the intersection point of the faces, on the inner surface of the mounting pad 11. This allows a larger surface area (conical) to be irradiated by the light emitting element 13. The long edges confine the light to the conical area, thus increasing the optical power density on the irradiated scalp area.

[0088] Fig. 7d shows another configuration where a bristle 12 has planar faces, e.g. rectangular, disposed at a separation to each other. In an example where the faces are rectangular, two edges near the inner surface of the mounting pad (not shown) may be connected using a bridge face. The light emitting elements 13 are distributed on the bridge face. When the bridge is omitted, the light emitting elements 13 are distributed on the inner surface of the mounting pad. Like in Fig. 7c, the arrangement allows to confine the light to the area enclosed by the planar faces, increasing the optical power density on the irradiated scalp area.

[0089] Fig. 7e shows a light emitting element 13 disposed on the inner surface of the mounting pad 11 and inside the bristle 12, proximal to base 101, in a manner similar to Fig. 7b.

[0090] In an embodiment, the end surface of the distal portion 103 includes a tapered orifice conical in shape, with a conical angle 45-75 degrees, preferably 50-60 degrees. Such a design allows to spread the light beam to a wider angle of irradiation which in turn reduces the light flux incident on the hair.

[0091] In yet another embodiment, the distal portion of the bristle comprises a flexible (e.g. conical) part. The part is movable from a first substantially conical configuration, where the circular base of the cone is attached to the distal portion of the bristle and the apex of the cone contacts the scalp as shown in Fig. 7e, to a second substantially conical configuration, and vice-versa. In the second configuration, the conical configuration comprises two circular bases. A first circular base attached to the distal portion of the bristle has a smaller diameter than a second circular base in contact with the scalp when the device is in use. The flexible arrangement can be used to either focus (narrow angle of illumination) or defocus (wider angle of illumination) the light to the scalp, to vary the light flux incident on the scalp and the irradiated area.

[0092] By incorporating various bristle designs, it is possible to manipulate the light flux incident on the scalp, based on

[0093] The skilled person understands that the embodiments of Fig. 7 can be combined with each other and/or with any of the embodiments discussed above.

[0094] The controller 14 can be implemented in numerous ways, with software and/or hardware, to perform the various functions described herein. The controller 14 may comprise one or more microprocessors or digital signal processors (DSPs) that may be programmed using software or computer program code to perform the required functions and/or to control components of the controller to effect the required functions. The controller may be implemented as a combination of dedicated hardware to perform some functions (e.g. amplifiers, pre-amplifiers, analog-to-digital convertors (ADCs) and/or digital-to-analog convertors (DACs)) and a processor (e.g., one or more programmed microprocessors, controllers, DSPs and associated circuitry) to perform other functions. Examples of components that may be employed in various embodiments of the present disclosure include, but are not limited to, conventional microprocessors, DSPs, application specific integrated circuits (ASICs), field-programmable gate arrays (FPGAs), hardware for implementing a neural network and/or so-called artificial intelligence (AI) hardware accelerators (i.e. a processor(s) or other hardware specifically designed for AI applications that can be used alongside a main processor).

[0095] The controller can comprise or be associated with a memory unit. The memory unit can store data, information and/or signals (including image(s)) for use by the controller 14 in controlling the operation of the device and/or in executing or performing the methods described herein. In some implementations the memory unit stores computer-readable code that can be executed by the controller so that the controller performs one or more functions, including the methods described herein. In particular embodiments, the program code can be in the form of an application for a smart phone, tablet, laptop, computer or server. The memory unit can comprise any type of non-transitory machine-readable medium, such as cache or system memory including volatile and non-volatile computer memory such as random access memory (RAM), static RAM (SRAM), dynamic RAM (DRAM), read-only memory (ROM), programmable ROM (PROM), erasable PROM (EPROM) and electrically erasable PROM (EEPROM), and the memory unit can be implemented in the form of a memory chip, an optical disk (such as a compact disc (CD), a digital versatile disc (DVD) or a Blu-Ray disc), a hard disk, a tape storage solution, or a solid state device, including a memory stick, a solid state drive (SSD), a memory card, etc.

[0096] The alert signal may be output via an interface unit of the device comprising a user interface. The user interface may comprise any suitable output component(s), including but not limited to a display unit or display screen, one or more lights or light elements, one or more loudspeakers, a vibrating element, etc. The interface unit may further comprise transceivers which enable

a data connection to and/or data exchange with other devices, including any one or more of servers, databases, user devices, and sensors. It can operate using WiFi, Bluetooth, Zigbee, or any cellular communication protocol (including but not limited to Global System for Mobile Communications (GSM), Universal Mobile Telecommunications System (UMTS), Long Term Evolution (LTE), LTE-Advanced, etc.).

[0097] While the present disclosure has been described with the above described exemplary embodiments, various changes and modifications may be suggested to one skilled in the art. It is intended that the present disclosure encompasses such changes and modifications as falling in the scope of claims.

Claims

1. A light-based scalp care device comprising:

a casing (10);
a mounting pad (11) including an inner surface (111) and an outer surface (112), the inner surface (111) facing the scalp when in use and the outer surface (112) facing the casing (10);
an array of bristles (12) arranged to section hair into parts, each bristle comprising a base (101), a body (102) and a distal portion (103), wherein the base (101) is coupled to the inner surface of the mounting pad (11);
a plurality of light emitting elements (13) distributed (i) on the inner surface of the mounting pad (10) and surrounded by the bristles or (ii) on the outer surface of the mounting pad (10), and
a controller (14) configured to control the light emitting elements to irradiate the sectioned parts.

2. The scalp care device of claim 1, wherein the mounting pad (11) is flexible.

3. The scalp care device of any of the preceding claims, wherein the mounting pad (11) and/or the bristles (12) are arranged to guide light emitted by the plurality of light emitting elements (13).

4. The scalp care device of any of the preceding claims, wherein the light emitting elements (13) are further distributed on the bristles (12).

5. The scalp care device of any of the preceding claims, further comprising a handheld or wearable portion.

6. The scalp care device of any of the preceding claims, further comprising a wired or wireless communication means.

7. The scalp care device of any of the preceding claims, wherein the plurality of light emitting elements (12) are operable in a wavelength range 400-700 nm, preferably 440 to 460 nm, 600-700 nm and more preferably, 452 $\pm$ 7 nm.

8. The scalp care device of any of the preceding claims, wherein the plurality of light emitting elements are light emitting diodes, LEDs, and/or laser diodes, LDs.

9. The scalp care device of any of the preceding claims, further comprising a skin parameter sensor (17), and wherein the controller is configured to control at least one operation parameter of the plurality of light emitting elements based on a measurement of the skin parameter sensor.

10. The scalp care device of claim 8, wherein the at least one operation parameter is an intensity and/or wavelength of the light emitting elements.

11. The scalp care device of claim 8 or 9, wherein the skin parameter sensor is a temperature, pressure, capacitance, imaging, or pigmentation sensor.

12. The scalp care device of any of the preceding claims, further comprising a user interface unit.

13. The scalp care device of any of the preceding claims, further comprising at least one air vent on a surface of the casing (10).

14. The scalp care device of any of the preceding claims, wherein the bristles include a spacing, and the light guiding elements are further distributed on the inner surface of the mounting pad in the spacing.

15. The scalp care device of any of the preceding claims, wherein the bristles are arranged to guide air therethrough, and/or have flexibly conical distal portions.

Figure 1

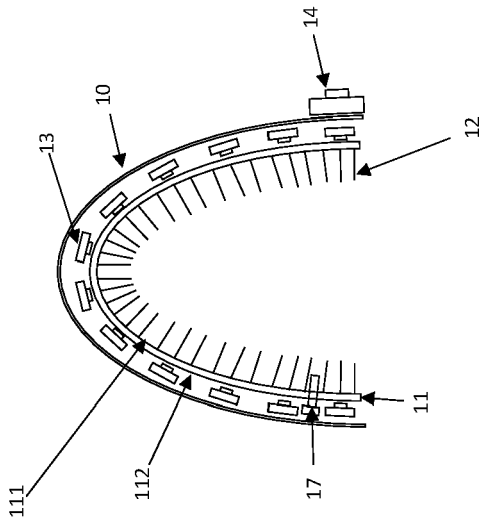


Figure 1a

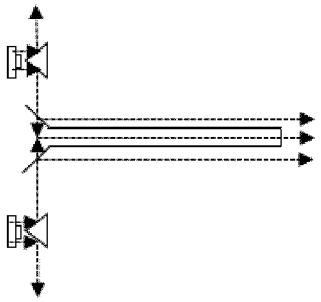


Figure 1b

Figure 1c

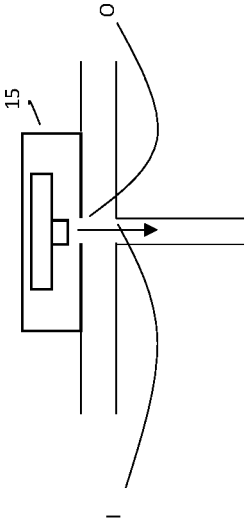
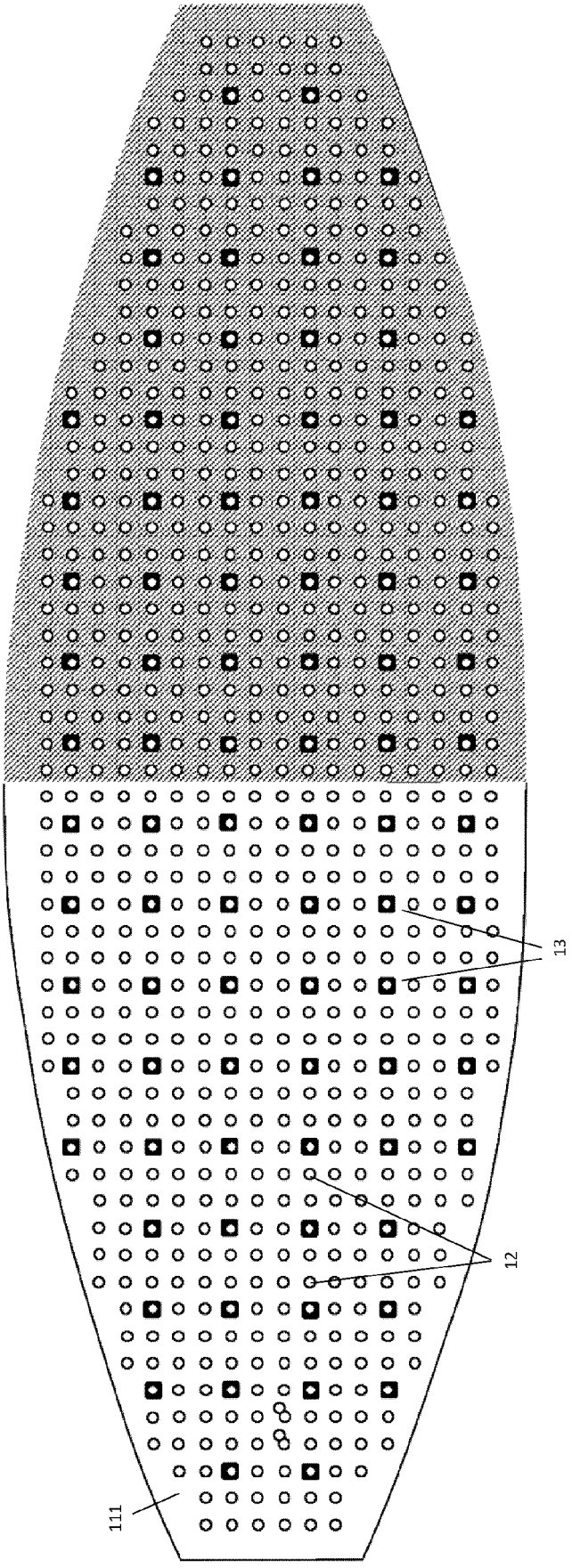


Figure 2



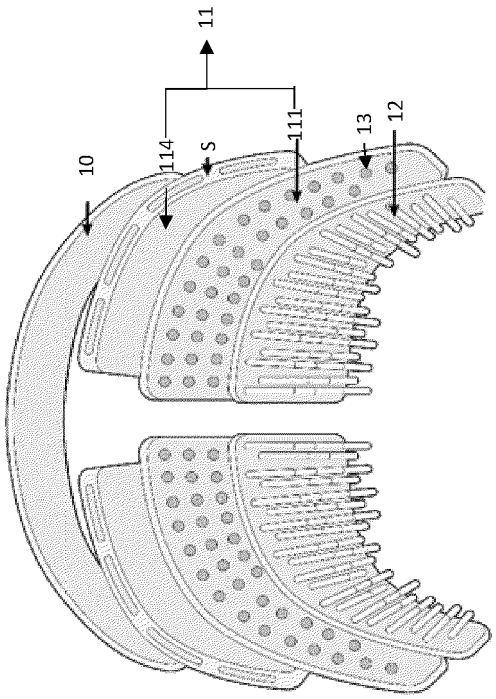


Figure 3

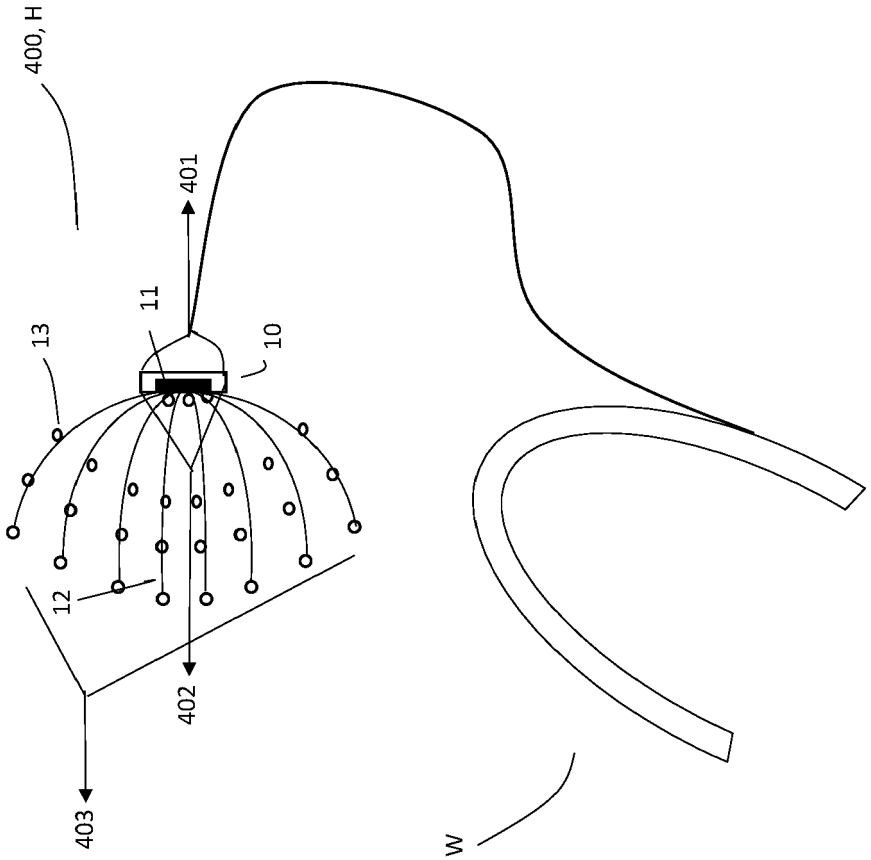


Figure 4

Figures 5 and 6

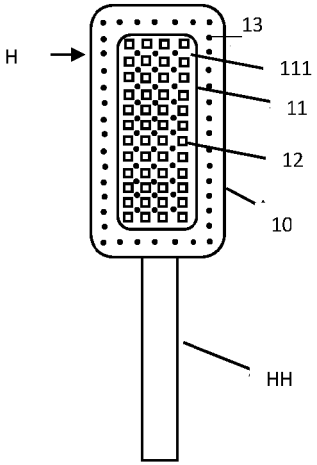


Figure 5

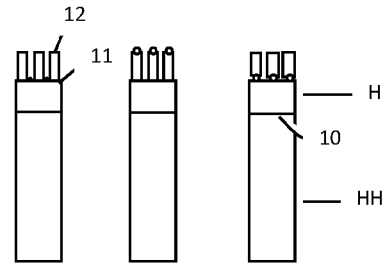
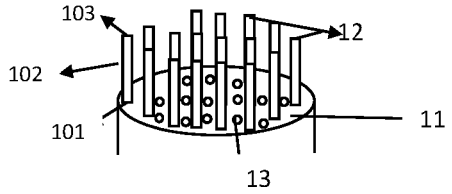


Fig 6a Fig 6b Fig 6c



Inset of figure 6a

Fig 6c-1

Figure 7

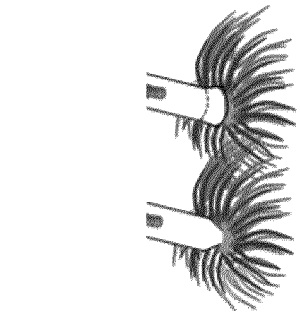


Fig 7e

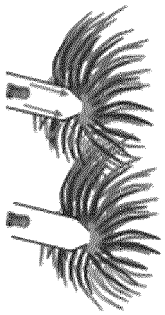


Fig 7b

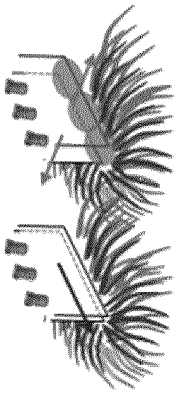


Fig 7d

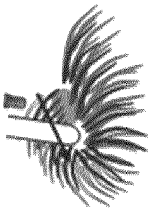


Fig 7a

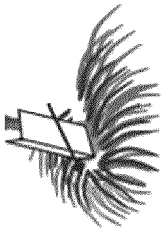


Fig 7c

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EUROPEAN SEARCH REPORT

Application Number
EP 21 19 3367

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A	US 2007/271714 A1 (ADAM HORST R [US] ET AL) 29 November 2007 (2007-11-29) * paragraph [0077] - paragraph [0124] * * figures *	9	
A	US 10 426 397 B2 (WITHINGS [FR]) 1 October 2019 (2019-10-01) * column 3, line 20 - column 5, line 38 * * figures *	9	
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1 The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	11 February 2022	Fortune, Bruce

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11-02-2022

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