(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 453 281 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
13.03.2019 Bulletin 2019/11

(51) Int Cl.:
A45D 2/00 *(2006.01)* ***A45D 1/04*** *(2006.01)*

(21) Application number: **17190266.1**

(22) Date of filing: **10.09.2017**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(71) Applicant: **Koninklijke Philips N.V.**
5656 AE Eindhoven (NL)

(72) Inventors:
- **SPOORENDONK, Wouter Hendrik Cornelis**
  5656 AE Eindhoven (NL)
- **BRADA, Ype Bernardus**
  5656 AE Eindhoven (NL)
- **ZJIROECHA, Nikolaj Vasiljevitsj**
  5656 AE Eindhoven (NL)
- **COSTECALDE, Laurentine**
  5656 AE Eindhoven (NL)

(74) Representative: **Steenbeek, Leonardus Johannes et al**
Philips Intellectual Property & Standards
High Tech Campus 5
5656 AE Eindhoven (NL)

(54) HAIR STYLING DEVICE

(57) In a hair styling device (S) comprising a light engine (LE) to deliver optical energy to hair, the hair styling device (S) is arranged to allow moist (M) escaping from the hair in response to optical energy being applied to the hair, to escape from the hair styling device (S). A ventilator may move the moist away from the light engine. A processor may control the light engine (LE), in which case the ventilator may also serve to cool the processor and/or the light engine (LE). The hair styling device (S) may comprise clamping members (S1, S2) arranged for allowing hair to be guided between and styled by the clamping members, at least one of the clamping members (S1, S2) being provided with the light engine (LE). At least one of the clamping members (S1, S2) may be provided with openings for allowing moist (M) to escape, or with openings for allowing air (A) to enter so as to convey the moist (M) out of the hair styling device (S). The clamping members (S1, S2) may have non-conforming shapes to allow the moist (M) to escape from the hair styling device (S). A hair treatment area comprising the light engine (LE) may have a gap (G) through which the hair (H) can be guided, the gap (G) being sufficiently wide to allow the moist (M) to escape. A width of the gap (G) may be between 0.3 and 5 mm, and preferably between 1 and 2 mm.

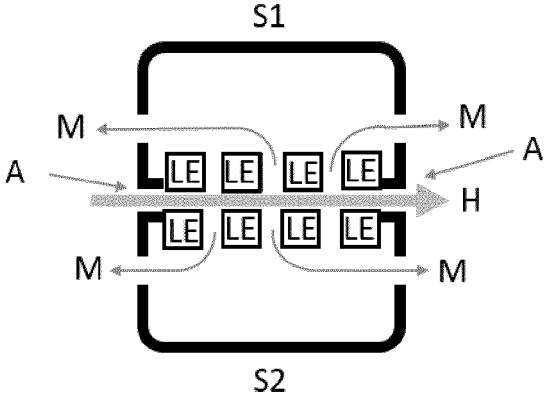

Fig. 2b

EP 3 453 281 A1

Description

FIELD OF THE INVENTION

[0001] The invention relates to a hair styling device for e.g. hair crimping, curling, perming and straightening.

BACKGROUND OF THE INVENTION

[0002] EP2861096 discloses a hair shaping device for use for hair shaping comprising a number of radiation sources for hair shaping, and a control device for the emission of radiation.

SUMMARY OF THE INVENTION

[0003] It is, inter alia, an object of the invention to provide an improved hair styling. The invention is defined by the independent claims. Advantageous embodiments are defined in the dependent claims.

[0004] Hair damage, particularly due to the application of heat, is a major concern of consumers. It is therefore highly desired to style the hair without significant heating of the cuticle of hair.

[0005] In one aspect of the invention, in a hair styling device comprising a light engine to deliver optical energy to hair, the hair styling device is arranged to allow moist escaping from the hair in response to optical energy being applied to the hair, to escape from the hair styling device. Preferably, the light engine is the sole energy source for hair styling. A ventilator may move the moist away from the light engine. A processor may control the light engine, in which case the ventilator may also serve to cool the processor and/or the light engine. The hair styling device may comprise clamping members arranged for allowing hair to be guided between and styled by the clamping members, at least one of the clamping members being provided with the light engine. At least one of the clamping members may be provided with openings for allowing moist to escape, or with openings for allowing air to enter so as to convey the moist out of the hair styling device. The clamping members may have non-conforming shapes to allow the moist to escape from the hair styling device. A hair treatment area comprising the light engine may have a gap through which the hair can be guided, the gap being sufficiently wide to allow the moist to escape. A width of the gap may be between 0.3 and 5 mm, and preferably between 1 and 2 mm.

[0006] Embodiments of the invention are based on the following considerations. During photo-thermal hair reshaping, vapor from heated hairs will compromise the hair stylings result. Accumulated vapor at the light emitting treatment area will alter the behavior of emitted photons. Photons might be redirected or absorbed at an earlier stage. This will affect (lower) the eventual hair temperature. Furthermore, if water accumulates at the treatment area it is once again absorbed by the hairs. In turn, the hair immediately loses its style due to a re-moisturizing effect and will not be able to reach required hair styling temperature due to extra cooling. It is therefore an object of embodiments of the present invention to come up with solutions to photo-thermally reshape hairs without being bothered by water vaporization at the treatment surface. Two options are envisioned: active and passive air transport of the vapor, and/or non-conformal clamping to allow the moist to escape.

[0007] These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

Fig. 1 shows an embodiment of a hair styling device in accordance with the present invention;
Figs. 2a - 2c show 3 possible cross-sections of the embodiment of Fig. 1 in accordance with a first aspect of the invention;
Figs. 3a - 3d show 4 possible cross-sections of the embodiment of Fig. 1 in accordance with a second aspect of the invention; and
Figs. 4a - 4b show 2 possible hair curling devices in accordance with the invention.

DESCRIPTION OF EMBODIMENTS

[0009] Fig. 1 shows an embodiment of a hair styling device S in accordance with the present invention. The embodiment is a hair straightener having two members S1, S2 between which hair can be clamped. At least one of these members is provided with a light engine LE to provide optical radiation to style the hair. The light engine LE is preferably of the type disclosed in applicant's earlier application EP3216368 (Attorney's ref. 2016PF00294), incorporated herein by reference, which comprises:

a pulse-driven light emitting diode (LED) or an array of LEDs configured to deliver optical energy to hair, wherein:

an output wavelength is in the range 400 - 900 nm, with good results in the range 400 - 650 nm, and preferably in the range 450 - 550 nm,
a pulse width is in the range 50 - 300 ms, preferably between 50 and 200 ms, such as in the range 100 - 200 ms, or between 50 and 100 ms,

a LED pulse driver circuit to drive the LEDs,
a control system to control the LED pulse driver, particularly controlling pulse electrical parameters including voltage, pulse duration, and pulse duty cycle,
a hair contacting interface configured to contact the hair and hold the hair in a pre-configured shape, e.g. planar, cylindrical, during pulsed light exposure provided by the LED.

[0010] Light selectively heats up the hair, in particular the melanin of the hair, by absorption within a certain range of wavelengths (preferably between 400 and 900 nm and more preferably between 400 and 550 nm) and within a short period of time (preferably shorter than 300 ms). After the exposure of a light pulse, the hair temperature will increase depending on its volume, absorption rate and initial temperature.

[0011] Embodiments of the invention are based on the following considerations. For hair reshaping, the hair needs to be heated to temperatures around 140 to 180 °C. This glass transition temperature depends on water content of the hair. Hair mainly consist of water, keratin and melanin. The boiling point for water is around 100 °C; this is lower than the hair styling temperature. To reach the glass temperature of hair, temperatures above 100 °C are needed. At this temperature water quickly evaporates. Water vapor triggers convection that can lead to condensed water droplets into the hair reshaping system.

[0012] In prior art heat styling, this water evaporation from the hair has no side effects on hair styling. The hot plates applying the heat towards the hair are not bothered by condensed water since they are well above 100 °C. Condensed water is immediately atomized again when it settles at the treatment area.

[0013] This immediate atomization of condensed water is not the case for photo-thermal hair reshaping. Firstly, the treatment area is not heated above 100 °C, and water will therefore not be atomized and remain at the light emitting treatment area. Water will alter the photon behavior, and therefore the treatment effectivity is decreased. Furthermore, if water accumulates at the treatment area it is once again absorbed by the hairs. In turn, the hair immediately loses its style due to a re-moisturizing effect, and will not be able to reach required hair styling temperature due to extra cooling. Secondly, during photo-thermal hair reshaping, hair is heated in a much shorter timeslot (< 0.3 sec) compared to conventional heat styling (> 0.3 s). The overall moisture loss is lower compared to conventional heat styling. However, within the treatment time (relative) the moisture loss can be larger. For this reason, attention is needed to ensure that the moist can escape.

[0014] It is an object of embodiments of the present invention to come up with a photo-thermal hair reshaping of which the styling performance is not affected by moist accumulation.

[0015] In accordance with a first aspect, active moist transportation is provided by air flow. Atomized water is lighter than air and can therefore easily be transported via air. By creating a high/low air pressure field, e.g. by a fan, an air flow can be realized to actively transport atomized water away for the hair and the light engine. Between two clamping members, air flow can be created single-sided or double-sided.

[0016] For instance, when the air flow is realized from one side, the light engine is located at the opposed clamping member. A first clamping member is 'transparent' to moist by means of a grid and/or holes in the construction to transport moist away by air flow. A second clamping member contains the light engine LE, providing a single-sided heat treatment. An exemplary embodiment is shown in Fig. 2a. In the example of Fig. 2a, the lower clamping member S2 of the hair straightener S is provided with a light engine LE, while the upper clamping member S1 is provided with holes through which moist M can escape. Hair H is guided between the clamping members S1, S2 of the hair straightener S. The escaping of moist M from the hair styling device S may be stimulated by a ventilator (not shown), which ventilator may also serve to cool the light engine (LE) and/or a processor (not shown) used to control the light engine LE.

[0017] As shown in the example of Fig. 2b, air flow A and hair illumination does not have to be opposed. It can also be done together at the same clamping member. The light engine LE (treatment area) is split into several smaller parts LE with air flow in-between. This can be done single-sided as well as double sided. The direction of the air A traveling through the device S is of importance. It can be in both directions, but the function will change. Sucking air A into the system at the treatment area will guide "cold" (room temperature) air along the hairs H and along the light engines LE and their heat sinks. The latter will be beneficial for the cooling of the electronics. The hot air with moist M is blown-out of the device at a selected area.

[0018] As shown in Fig. 2c, the air flow A can have the opposite direction of the directions shown in Fig. 2b. Blowing air A out of the system at the treatment area will guide "hot" air, heated by the heat sinks of the control electronics and the light engine LE, along the hairs H, and room temperature air A along the electronics. The latter is most probably more efficient in transporting damp M. Advantageously, moist M is not sucked into to the system, which is better for the electronics of the light engine and its control unit.

[0019] Different embodiments of this first aspect of the invention thus provide one or more of the following features: One or both clamping members S1, S2 of a hair styling clamp S allow vapor M to pass. Active moist transportation, for instance by air flow A, is applied within these clamping members S1, S2 to transport atomized water M away. One-sided heat treatment. The treatment area is divided into parts LE with air channels in-between. The direction of the air flow A can be both ways. However outwards is preferred, as in this way the light engine and the control electronics can be cooled in addition to the (warm) air transport of atomized water.

[0020] In accordance with a second aspect, non-conformal clamping members S1, S2 may be used, which may have cross-sections as shown in the examples of Figs. 3a - 3d. Again, one of both clamping members S1, S2 of the hair straightener S may be provided with a light engine LE.

[0021] For a good hair styling result, pressure and ten-

sion on the hair H are needed. Pressure is applied by clamping the hair just before and/or during treatment. During experiments it has been found out that pressure can be applied in several ways: uniform, nonuniform, misaligned or conform. The best styling result were obtained when the top and bottom part of the clamp were not conforming to each other. When both clamping members S1, S2 are non-conform there is more room for moist M to escape. If the moist M cannot escape, a re-moisturizing effect of the hair will occur, which is not beneficial for reshaping.

[0022] This invention is about getting rid of vapor M originating from the hairs during heating. It is not about steam guidance as disclosed in US2015327650A1, US2009159093A1. The vapor M dealt with by this invention is not provided by the hair styling device S.

[0023] Different embodiments of this second aspect of the invention thus provide one or more of the following features: The clamping members S1, S2 are not conforming to each other, i.e. they do not have matching shapes, while usual hair straighteners have two heating plates of the same shape. By having a smaller pressure field between the clamping members S1, S2, compared to the treatment area, the moist M is passively guided away from the hairs H and light source LE.

[0024] While non-conformal clamping members S1, S2 are advantageously used in combination with active air suction as per the first aspect, they can be used without active air transportation as this non-conformal option allows for a passive system that is not in need of any active moisture transportation.

[0025] Figs. 4a - 4b show 2 possible embodiments of hair curling devices in accordance with the invention. In Fig. 4a, hair H is guided though a hair treatment area comprising 2 light units L1, L2 each having a respective light engine LE, the light units L1, L2 being spaced apart by a gap G that is sufficiently large to allow moist M to escape from the gap G. As the hair H may have a thickness of about 0.2 mm, the gap should be at least 0.3 mm to allow both hair H and moist M to pass. The gap G should not be too big because otherwise the light intensity will be attenuated too much, so preferably not more than e.g. 5 mm. In view thereof, a gap G between 0.5 and 3 mm would be preferred, such as of about 1 - 2 mm. After the hair H has been heated as a result of the optical radiation by the light units L1, L2, the hair is wound around a cylinder C so as to apply a curly shape to the hair H.

[0026] In the embodiment of Fig. 4b, hair H is radiated by a light engine LE in a light unit L while it is being wound around the cylinder C. The light unit L is spaced from the cylinder C by a gap G that is sufficiently wide to allow moist M to escape. Here the hair treatment area is formed by the light unit L and the cylinder C.

[0027] In yet another embodiment, a light engine is positioned inside a transparent cylinder C.

[0028] Embodiments of the invention thus provide a hair styling device S that uses a light emitting treatment area LE to heat the hair H with active and/or passive transportation of moist M. The light output wavelength is preferably in the range of 400-900 nm, and more preferably in the range of 450-550 nm. To prevent the hair from being damaged, the output energy fluence on the hair surface is preferably in the range between 1 J/cm^2 and 10 J/cm^2, more preferably between 3 J/cm^2 and 7 J/cm^2, and most preferably between 4 and 6 J/cm^2.

[0029] As set out in more detail in a co-pending application entitled to the same priority date as the present application (attorney's ref.: 2017PF02405), incorporated by reference herein, embodiments of the present invention are related to a hair styling device comprising a heat source for heating hair, and an optical radiation source for - in combination with heat from the heat source - heating the hair to a temperature sufficiently high for hair styling, in which the heat source obtains its heat from energy provided by the optical radiation source, and in a preferred embodiment, only from the optical radiation source. Advantageously, the heat source may include a heat sink of the optical radiation source. The optical radiation source may advantageously be covered by a cover that is not fully transparent, whereby optical radiation energy is transformed into thermal energy, the heat source including the cover. The cover may advantageously be largely transparent for wavelengths effective for hair styling, while the cover is largely not transparent for wavelengths less effective for hair styling. Advantageously, the optical radiation source may be covered by a cover that is heated by the heat source.

[0030] As set out in more detail in a co-pending application entitled to the same priority date as the present application (attorney's ref.: 2017PF02407), incorporated by reference herein, embodiments of the present invention are related to a hair styling device that comprises an optical radiation source for radiating hair, a sensor unit for measuring effects from radiating hair, and a feedforward control device for controlling the optical radiation source in dependence on a signal from the sensor unit. The optical radiation source may produce a first flash having a first energy density that may be lower than required for photo-thermal hair reshaping, the optical radiation source being controlled to produce a subsequent flash in dependence on a sensor signal obtained in response to the first flash, which subsequent flash may have at least the first energy density. The sensor unit may include a sensor arranged before the optical radiation source in a hair flow direction. The hair styling device may comprise, along a direction in which the hair is guided, a first sensor, a first LED unit being controlled in dependence on a signal from the first sensor, a second sensor, and a second LED unit being controlled in dependence on a signal from the second sensor. The direction in which hair is guided through the hair styling device may determine which part of the optical radiation source will act as the first LED unit. The hair styling device may comprise a drive mechanism to move the hair along the optical radiation source at a speed controlled by the feedforward control device in dependence on the signal

from the sensor unit.

[0031] As set out in more detail in a co-pending application entitled to the same priority date as the present application (attorney's ref.: 2017PF02408), incorporated by reference herein, embodiments of the present invention are related to a hair styling device having a two-dimensional array of elements to bring hair at a styling temperature, in which the elements produce optical radiation energy. The elements may include one or more LEDs, and preferably a plurality of LEDs, in which case the LEDS are driven in clusters that may be of mutually different shapes and sizes. The hair styling device may comprise sensors to obtain an areal light absorption measurement opposed to the two-dimensional array of elements, and a control unit for individually controlling the elements in dependence of the measurement. The hair styling device may radiate hair from two sides, both of which includes an areal light absorption measurement. The sensors may include LEDs that momentarily do not produce light.

[0032] It should be noted that the above-mentioned embodiments illustrate rather than limit the invention, and that those skilled in the art will be able to design many alternative embodiments without departing from the scope of the appended claims. The notion "ventilator" covers any device that creates a pressure difference and/or an air flow into or from the device. The notion processor includes any form of control electronics for controlling the light engine. The control electronics may be implemented by means of hardware comprising several distinct elements, and/or by means of a suitably programmed processor. In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim. The word "comprising" does not exclude the presence of elements or steps other than those listed in a claim. The word "a" or "an" preceding an element does not exclude the presence of a plurality of such elements. In the device claim enumerating several means, several of these means may be embodied by one and the same item of hardware. The mere fact that certain measures are recited in mutually different dependent claims that do not refer to one another does not indicate that a combination of these measures cannot be used to advantage.

Claims

1. Hair styling device (S) comprising:

a light engine (LE) to deliver optical energy to hair;
wherein the hair styling device (S) is arranged to allow moist (M) escaping from the hair in response to the optical energy being applied to the hair, to escape from the hair styling device (S).

2. Hair styling device (S) as claimed in claim 1, wherein the hair styling device (S) comprises a ventilator for moving the moist (M) away from the light engine (LE).

3. Hair styling device (S) as claimed in claim 2, wherein the hair styling device (S) comprises control electronics to control the light engine (LE), and the ventilator also serves to cool the control electronics and/or the light engine (LE).

4. Hair styling device (S) as claimed in any of the preceding claims, wherein the hair styling device (S) comprises clamping members (S1, S2) arranged for allowing hair to be guided between and styled by the clamping members, at least one of the clamping members (S1, S2) being provided with the light engine (LE).

5. Hair styling device (S) as claimed in claim 4, wherein at least one of the clamping members (S1, S2) is provided with openings for allowing moist (M) to escape.

6. Hair styling device (S) as claimed in claim 4, wherein at least one of the clamping members (S1, S2) is provided with openings for allowing air (A) to enter so as to convey the moist (M) out of the hair styling device (S).

7. Hair styling device (S) as claimed in claim 4, 5 or 6, wherein the clamping members (S1, S2) have non-conforming shapes to allow the moist (M) to escape from the hair styling device (S).

8. Hair styling device (S) as claimed in any of the preceding claims 1-3, wherein the hair styling device (S) comprises a hair treatment area comprising the light engine (LE), the hair treatment area having a gap (G) through which the hair (H) can be guided, the gap (G) being sufficiently wide to allow the moist (M) to escape.

9. Hair styling device as claimed in claim 8, wherein a width of the gap (G) is between 0.3 and 5 mm, and preferably between 1 and 2 mm.

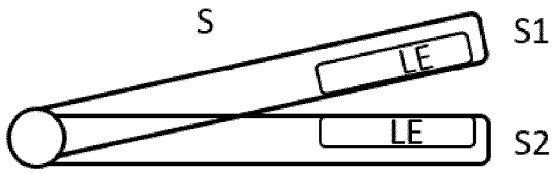

Fig. 1

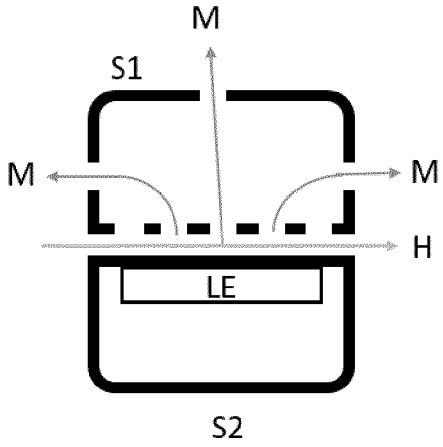

Fig. 2a

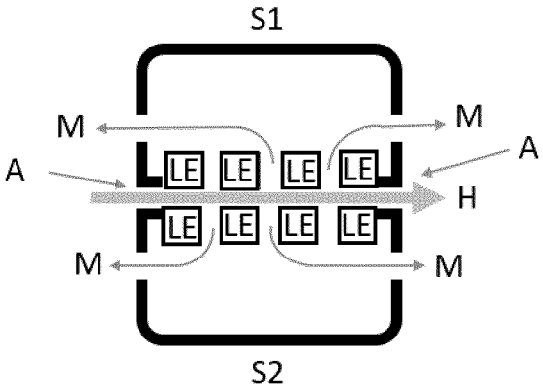

Fig. 2b

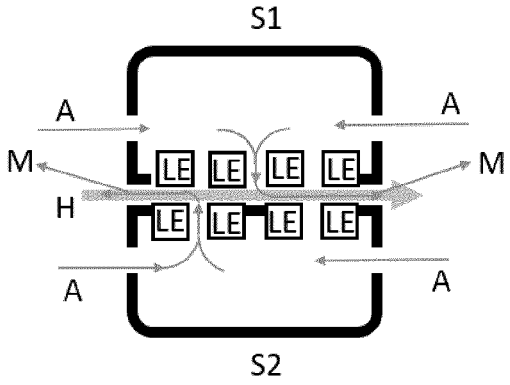

Fig. 2c

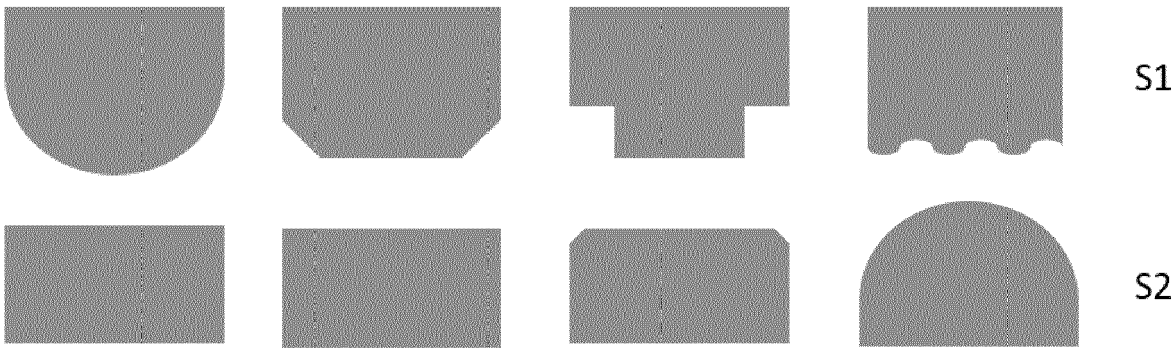

Fig. 3a Fig. 3b Fig. 3c Fig. 3d

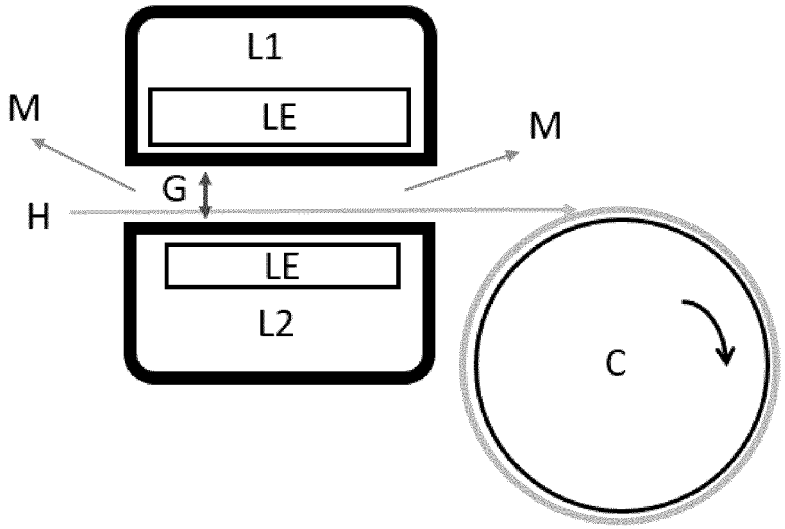

Fig. 4a

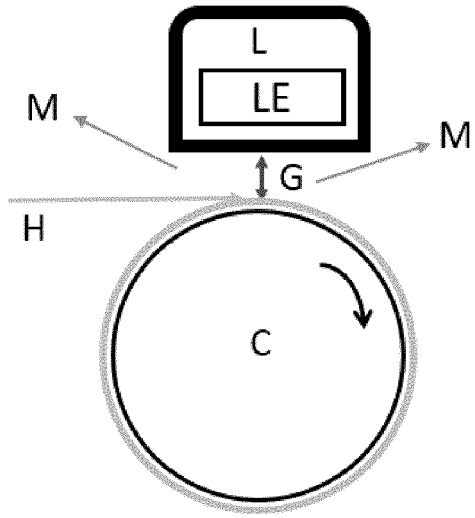

Fig. 4b

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 17 19 0266

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X A	FR 2 979 202 A1 (SEB SA [FR]) 1 March 2013 (2013-03-01) * page 3, line 31 - page 11, line 3 * * figures 1-3 *	1,4,7-9 2,3,5,6	INV. A45D2/00 A45D1/04
X	EP 2 110 040 A2 (BLUECERAMIC CO LTD [KR]) 21 October 2009 (2009-10-21) * paragraphs [0013] - [0039] * * figures 2,3 *	1,4-6	
X	WO 2014/108775 A1 (MOYAL DANIEL [IL]) 17 July 2014 (2014-07-17) * page 11, line 28 - page 12, line 10 * * figures 10,11 *	1-6	

TECHNICAL FIELDS SEARCHED (IPC)

A45D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	12 February 2018	Witkowska-Piela, A

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 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 17 19 0266

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

12-02-2018

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR 2979202 A1	01-03-2013	CN 202890915 U	24-04-2013
		FR 2979202 A1	01-03-2013
		IT TO20120145 U1	01-03-2013
EP 2110040 A2	21-10-2009	CN 101558935 A	21-10-2009
		EP 2110040 A2	21-10-2009
		JP 2009254796 A	05-11-2009
		KR 100858028 B1	10-09-2008
		US 2009260650 A1	22-10-2009
WO 2014108775 A1	17-07-2014	US 2015320171 A1	12-11-2015
		WO 2014108775 A1	17-07-2014

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- EP 2861096 A **[0002]**
- EP 3216368 A **[0009]**
- US 2015327650 A1 **[0022]**
- US 2009159093 A1 **[0022]**