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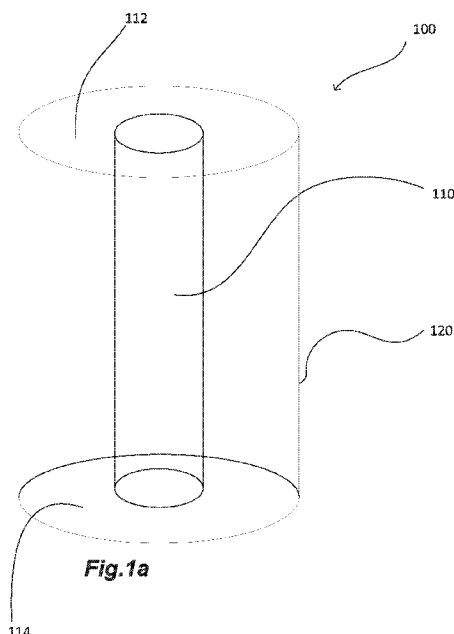
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(54) Title: HAIR STYLING DEVICE



(57) Abstract: A hair styling device comprising a core having a high thermal conductivity, an outer wall spaced from the core, the outer wall comprising an outer surface on which a section of a user's hair is wrappable; and a phase change material disposed between the core and the outer wall, the phase change material for releasing heat to the section of the user's hair via the outer surface in use.



HAIR STYLING DEVICE

Technical Field

5 The present invention relates to a hair styling device and a kit of parts for styling a user's hair.

Background

10 Hair rollers are commonly used for treating or styling hair, for instance to shape or curl the hair. The application of heat to a user's hair alters the hydrogen bonds within the keratin of the hair. The application of heat is therefore commonly used to cause the hair to curl or otherwise wave.

Typically, hot hair rollers are pre-heated before being rolled into the hair, for example on a dock. Once in the user's hair, the heat stored in the thermal mass of the hot hair roller is transferred to the hair as the roller cools thereby styling the hair.

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Summary

According to a first aspect there is provided a hair styling device comprising: a core having a high thermal conductivity; an outer wall spaced from the core, the outer wall comprising an outer surface on which a section of a user's hair is wrappable; and
20 a phase change material disposed between the core and the outer wall, the phase change material for releasing heat to the section of the user's hair via the outer surface in use.

Advantageously, including the phase change material within the hair styling device may provide an improved styling performance in use compared to hair styling devices currently known in the art. As used herein, a phase change material may be any
25 material which releases or absorbs energy at a change of phase (phase transition). The phase change material may therefore store more energy per unit volume compared to conventional hair styling devices. In some examples, the phase change material may also melt and thereby reach an operational temperature quicker than conventional hair styling devices, such that a charging time (time taken for the hair styling device to be
30 ready for use) is reduced. This may reduce the power consumption of a hair styling device or kit, which may be environmentally advantageous.

The latent heat storage of the phase change material may maintain the temperature on the surface of the outer wall for a longer period than conventional hair styling devices, which can allow for an improved energy transfer from the hair styling device to the section of hair. In other words, a large proportion of the energy stored by the phase change material is released while the phase change material maintains its temperature. The phase change material may also allow for a weight reduction in the hair styling device compared to conventional hair styling devices.

In use, the core may surround a heat source such as a heating element on a dock. Of course, embodiments in which the heat source is part of the hair styling device are also envisaged. In those cases, a dock may provide an electrical connection to allow the heat source to heat electrically or the heat source may not require a dock (i.e., switch activated in a contained device). In this way, the heat source may transfer heat to the core.

The core has a high thermal conductivity. That is heat transfer occurs at a higher rate compared to a core having a low thermal conductivity. The core is therefore efficient at transferring heat. The core having a high thermal conductivity may therefore speed the time to heat and melt the phase change material and, in some cases, may reduce the required power to heat the phase change material. In some examples the core of the hair styling device may have a thermal conductivity of at least 100 W/mK at 20 °C. To this end, the core may be a metallic material, for example aluminium, or any other suitably conductive material.

The core may be positioned centrally within the hair styling device. That is, the core may be positioned so it is a uniform distance from the outer wall. In some examples, the core is a tube concentrically arranged with respect to the outer surface. A central placement of the core may allow for more uniform heating of the phase change material. Although in some examples the core may be positioned off-centre, for example to distribute the weight of the hair styling device unevenly, which could allow for more comfortable use by the user.

In some examples, a diameter of the core of the hair styling device may be less than the uniform distance between the core and the outer wall. The phase change material may therefore have a thickness which is more than the diameter of the core.

This may allow the hair styling device to store a maximised amount of energy while balancing the time taken to charge the hair styling device.

In use, the section of the user's hair is heated by the phase change material releasing thermal energy and thereby heating the outer wall, which has the outer surface upon which the section of hair is wrapped. The outer surface may therefore be adapted for receiving a section of the user's hair. For example, the outer surface may comprise a flocking layer.

In some examples the hair styling device further comprises a member for transferring heat from the core to the phase change material, the member being located between the core and the outer wall. The core heats the phase change material through radiation of heat energy into the phase change material, as such because the core is at the centre of the hair styling device, the phase change material closest to the core will melt sooner than the phase change material which is further away (and closer to the outer wall). The member may be located between the core and the outer wall, in other words extending through the phase change material. The member may provide a greater surface area to radiate heat through the phase change material. The member may therefore provide the advantage of improving the heat distribution in the phase change material. There may be faster and or more uniform melting of the phase change material across the hair styling device, which may in turn speed the melting time (time to be completely melted) of the phase change material, which may reduce a charging time (time taken to be ready for use in styling) of the hair styling device. The member may be located completely within the phase change material, so not in contact with the core and or outer wall. In other examples the member may be in contact with the core and or outer wall. In some cases, the member is integral with one or both of the core and outer wall.

In some examples the member extends from the core towards the outer wall. Contact between the member and the core may improve thermal transfer between the core and the member because the transfer is via conduction from the core to the member. This may in turn speed the melting time of the phase change material and thus reduce the charging time of the hair styling device.

In some examples the member extends from the core for more than half a distance from a first point on the core to a second point directly opposed to the first point on the outer wall. For example, the core and outer wall may be concentric tubes. In this case the member may extend radially from the core towards the outer wall, and the distance from the first point to the second point may be a distance in a radial direction. As described above, the member having a greater surface area for contacting the phase change material may improve the speed of melting the phase change material. The member extending at least halfway between the core and the outer wall may speed up the melting time of the phase change material within the hair styling device. In some examples there is less than a millimetre between an end of the member and the outer wall. The hair styling device having at least some space between the end of the member and the outer wall may avoid the member facilitating conduction heating from the core to the outer wall, which may result in uneven heating on the outer surface.

In some examples, the member comprises a first portion and a second portion, wherein the first portion and the second portion diverge from one another. The member comprising two (or more) portions may give a substantially branched configuration which, may provide more exposed surface area of the member to the phase change material when compared to a member with a single, linear, body. So, there may be more phase change material in contact with a portion of the member which may speed up the melting time.

In some examples, the member comprises a plurality of apertures. When at least some of the phase change material is in liquid form it can flow through the member via the plurality of apertures. Flow of the phase change material during the melting process means that the phase change material may also undergo convective heat transfer, for example in areas of the phase change material which are distant from contact with the member. So, the inclusion of apertures through the member may facilitate more flow of the phase change material compared to solid members. Alternatively, or in addition as the phase change material solidifies during cooling it may reduce in volume. As such, the phase change material may contract into the apertures which may result in the advantage that the member is subject to less stress than a solid member when the phase change material solidifies about it. The apertures may be distributed about the member.

The distribution may be even across the member or more concentrated in areas which are subject to higher stresses relative to the remainder of the member (for example a point where the member splits into a first and second portion). The apertures may be differently sized across a member; this may be optimized according to areas of higher relative stress having larger apertures, for example. In some examples the members may be formed of a mesh. In other examples the members may form a porous structure which the phase change material sit about.

In some examples, the hair styling device comprises a plurality of members distributed about the core, the plurality of members for transferring heat from the core to the phase change material. The plurality of members which are distributed about the core may improve the overall heating effect of the hair styling device. For example, by spacing multiple members around the core may advantageously allow for a high surface area capable of heating the phase change material. In some examples, a plurality of members may be easier to manufacture than a single member. That is, a single member which spirals around the core may be more difficult to make on a production line compared with multiple planar discs spaced along the length of the core. The plurality of members may have differing features. For example, every other member may have apertures therethrough. In some examples, all of the plurality of members incorporate the same one or more of the above-described features.

In some examples, the plurality of members each have a length corresponding to a length of the core, the length of the plurality of members extending parallel to a longitudinal axis of the core. The length of the plurality of members extending parallel to a longitudinal axis of the core may allow two adjacent members to at least partially segment the phase change material. The segments of phase change material may of course be linked in examples where the member does not extend all the way to the outer wall. The plurality of members may be arranged about the core in a cog-like configuration, for example. This may have the advantage that heat convection within the liquid phase change material is preserved, as each segment of phase change material can still have convectional heating.

In some examples, each of the plurality of members comprises a disc, each disc spaced apart from an adjacent disc along a length of the core. Two adjacent discs may

define a series of layers of phase change material along the length of the core. These layers may of course be linked in examples where the member does not extend all the way to the outer wall. Separating the phase change material into layers and advantageously small layers may help reduce separation of the phase change material (e.g., the separation of additives contained within the phase change material etc) over the lifetime of the hair styling device, and as such, may extend the lifetime of the hair styling device.

In some examples, the plurality of members are evenly distributed about the core. The even distribution of the plurality of members may increase the distribution of heat within the hair styling device relative to the core. In some examples, the plurality of members can be arranged symmetrically about the core.

In some examples at least one of the plurality of members extends from the core to the outer wall. The members may conductively heat the outer wall in addition to the phase change material. In some cases, this may be advantageous to reduce the charging time of the hair styling device.

In some examples, each of the plurality of members are identical. Having identical members means each member has a substantially uniform heating profile of the phase change material with respect to the other members. This may help to maintain uniform heating across the phase change material.

In some examples, the phase change material has melting temperature of at least 50 °C. Having a melting temperature of at least 50 °C may result in the achievable temperature of the outer surface being optimal for styling a user's hair. That is, the temperature of the outer surface may be hot enough to change the shape of the hair (e.g., curl). The melting temperature may be at least 70 °C.

In some examples the phase change material has a latent heat of at least 150 kJ/kg. The latent heat of the phase change material in this range may give the advantage of an optimized heat storage to weight ratio for hair styling devices.

In some examples, the phase change material is an organic material. Organic phase change materials may be more robust and cheaper than inorganic materials. Some example organic phase change materials could be CT74, RT111 HC or Erythritol, or a combination thereof. CT74 has a melting temperature of 75 °C and a latent heat of 226

kJ/kg. RT111 HC has a melting temperature of 111 °C and a latent heat of 210 kJ/kg. Erythritol has a melting temperature of 118 °C and a latent heat of 340 kJ/kg.

In other examples, the phase change material is an inorganic material. Some inorganic materials may have a higher latent heat than organic phase change materials.

5 In some examples, the phase change material may be a mix of organic and inorganic materials. The members may divide the phase change material into layers (or wedges) and each layer (or wedge) may contain a different phase change material. These different phase change materials may be only organic or only inorganic or a combination thereof.

10 In some examples, the outer wall has a lower thermal conductivity than the core. The outer wall having a lower thermal conductivity than the core may provide a degree of protection to the user, for example by reducing the risk of burning on the outer surface. For example, the outer surface may have a coating with a lower thermal conductivity than the core.

15 In some examples, the hair styling device further comprises a heat source thermally coupled to the core. For example, a heat source may be disposed at least partially within the core. That is, the heat source may extend through the core such that the core encloses at least part or all of the heat source. The core may be in contact with the heat source such that heat from the heat source is transferred to the core through
20 conduction. The heat source may be heating element such as a resistive heater for example.

According to a second aspect of the invention, there is provided a hair styling device comprising: a core having a high thermal conductivity; an outer wall spaced apart from the core, the outer wall comprising an outer surface on which a section of a
25 user's hair is wrappable; and a plurality of members disposed around the core, each of the plurality of members extends towards the outer wall, wherein the hair styling device comprises a phase change material disposed between the core and the outer wall, the phase change material for releasing heat to the section of the user's hair via the outer surface in use, wherein the plurality of members extend through at least some of the
30 phase change material. The heat released to the user's hair may be at a constant

temperature (defined by the phase change temperature of the phase change material used) for a period of time.

According to a third aspect of the invention there is provided a hair styling kit comprising: a hair styling device as described above; and a dock, the hair styling device
5 configured to be removably coupled to the dock, wherein the dock is configured to heat the core of the hair styling device via a heat source when the hair styling device is coupled to the dock. The heat source may be a part of the hair styling device or part of the dock. The heat source may be heating element such as a resistive heater.

In some examples, the dock comprises at least one cavity configured to receive
10 the at least one hair styling device therein. The dock having a cavity may allow for the kit to be compact when charging or storing the hair styling device. The cavity may partially enclose the hair styling device, that is a portion of the hair styling device may be exposed during charging. The hair styling device may have a gripping portion, or the like exposed from the cavity, such that the outer surface is within the cavity. In some
15 examples, the dock may include a mechanism to lift at least a portion of the hair styling device out of the cavity such that the cavity can be fully enclosed by the cavity during charging whilst being easily removable.

In some examples the cavity comprises an insulated wall, such that the cavity insulates the hair styling device when the hair styling device is coupled to the dock.
20 Insulating the wall of the cavity, may help retain heat within the cavity, and so help maintain the temperature of the outer surface of the outer wall. In other words, insulating the cavity may reduce heat loss to the surroundings while the hair styling device is charging.

In some examples, the dock is configured to receive the at least one hair styling
25 device in an upright position relative to the dock. Heating the core of the hair styling device while the hair styling device is in an upright position (where the longitudinal axis of the core is substantially perpendicular to a base of the cavity) may reduce the charging time compared to a horizontal configuration. In particular, the time taken for the phase change material to completely melt may be reduced, for example the upright
30 position may allow for improved convection heating within the partially melted phase change material relative to a horizontal configuration. Receiving the hair styling device

in an upright position may also reduce the footprint of the dock, requiring less materials and so lowering the cost.

In some examples the dock comprises a controller configured to maintain the heat source at an optimal temperature for melting the phase change material. The controller may maintain the temperature of the core e.g., by actuating the heat source on and off, and or maintain the temperature of the heat source at a constant temperature e.g., by controlling the current running through a resistive element. To this end, the controller may comprise a temperature sensor and or a feedback loop. The controller may for example be a PID-controller.

The optimal temperature may be phase change material specific, as different phase change materials may have different melting temperatures. The optimal temperature may be at least 20° over the phase change material melt temperature. In some examples the controller may maintain the temperature in the range of at least 20° over the phase change material melt temperature and at least 10° below a flash point of the phase change material.

In some examples, the hair styling kit comprises a plurality of the hair styling devices. By providing a plurality hair styling devices, the user may be able to style all of their hair in one go, as such this may improve the ease of use of the kit for the user. For example, the kit may include between 4 and 16 hair styling devices.

In some examples, wherein the dock comprises a plurality of the cavities corresponding to the plurality of the hair styling devices. The hair styling devices within the kit may be of varying diameter and or shape such that in use they can style different sections of hair. For example, the hair styling kit may comprise 3 to 7 devices of a smaller diameter than the remaining devices within the kit which are for use on a front portion of the user's hair.

Further features and advantages of the invention will become apparent from the following description of preferred embodiments of the invention, given by way of example only, which is made with reference to the accompanying drawings. Unless otherwise stated the above features shall be considered as combinable with one another.

Brief Description of the Drawings

Figure 1a shows a perspective view of an example hair styling device according to the present invention;

Figure 1b shows a plan view of Figure 1a;

5 Figure 2 shows a perspective view of an example hair styling device according to the present invention including a member;

Figure 3a shows a perspective view of an example of a hair styling device according to the present invention, including a plurality of members;

Figure 3b shows a plan view of the hair styling device of Figure 3a;

10 Figure 3c shows a perspective view of a further example of a hair styling device according to the present invention, including a plurality of members;

Figure 3d shows a perspective view of a yet further example of a hair styling device according to the present invention, including a plurality of members;

15 Figure 4a to 4d show the melting of a phase change material with the member arrangement of Figure 3d;

Figure 5a shows an example dock for charging a plurality of styling devices according to the present invention; and

Figure 5b shows the dock of Figure 5a with a plurality of styling devices according to the present invention.

20 Throughout the description and accompanying drawings like numerals refer to like parts.

Detailed Description

25 Examples of a hair styling device and the associated docking station will now be discussed. The hair styling device in the below description is a hair roller, although it should be understood other hair styling devices are envisaged. The hair styling device has two different phases in use; a charging phase and a styling phase. As used herein the charging phase refers to inputting heat energy to the hair styling device and so causing the temperature of the device to rise up to, and beyond the melting point of the
30 phase change material in order to store energy latently. The styling phase refers to the phase in which the user uses the hair styling device to style a section of hair.

Referring now to Figure 1a and 1b, an example hair styling device 100 is illustrated. The hair styling device 100 includes a core 110 and an outer wall 120. The core 110 and outer wall 120 have an upper wall 112 and a lower wall 114 extending therebetween. Between the core 110 and the outer wall 120, and upper 112 and lower wall 114, is a phase change material 130.

The core 110 is positioned centrally within the hair styling device 100 and the outer wall 120 is arranged concentrically relative to the core 110. The core 110 is tubular in shape. In this way the core 110 can receive a heat source (see 660a in Figure 5a for example) therein. The core 110 is formed of aluminium which has a high thermal conductivity of 236 W/mK at 0 °C, which means it is a good conductor of heat.

The outer wall 120 encloses the core 110, while being spaced apart from the core 110. The outer wall 120 has an outer surface 122 which receives a section of a user's hair in use. In this example, the outer surface 122 has a flocking layer (not shown) which may help to better grip the hair.

The outer wall 120 has a high thermal conductivity such that heat is transmitted across the outer wall 120 and to the outer surface 122 efficiently. However, the thermal conductivity of the outer wall 120 is less than that of the core 110. In this way, the outer wall 120 may provide some insulation to the phase change material 130 to reduce rapid heat loss. The upper wall 112 and lower wall 114 are formed of an insulating material, which may reduce heat loss from any non-styling areas.

The phase change material 130 is between the core 110 and outer wall 120 and has a constant thickness across the hair styling device 100. In this example, areas of the phase change material are in contact with the core 110 or the outer wall 120, so that the overall phase change material (i.e., when viewed as a whole) is in contact with both the core 110 and the outer wall 120. However, intermediary layers of thermally conductive materials are envisaged between the core 110 and outer wall 120, for example two layers of phase change material(s) concentrically arranged and separated by an intermediary wall.

The phase change material 130 is a material which is capable of storing and then releasing energy as heat during a solid to liquid phase transition. Further, the phase change material 130 is a material with a melting point and latent heat suited to the end

use of styling a section of a user's hair. To this end, the phase change material 130 has a high latent heat of at least 150 kJ/kg. The melting temperature of the phase change material 130 is at least 70 °C. In this example, the phase change material 130 is Erythritol which has a melting temperature of 118 °C and a latent heat of 340 kJ/kg.

5 In use, the core 110 is heated by a heat source, for example by being in contact with the heat source. The heat source and its operation is described in more detail below, with reference to Figures 4a to 4d. The core 110 radiates heat to the phase change material 130. The phase change material 130 therefore increases in temperature, storing the heat energy as sensible heat. Once the phase change material 130 has reached a
10 melting temperature the phase change material stops increasing in temperature and melts, storing heat energy as latent heat. Areas of the phase change material 130 which are closest to the core 110 will heat and melt first, because they are closest to the heat source and therefore at a higher temperature. The phase change material 130 therefore has a temperature gradient with hottest areas closest to the core 110 and cooler areas
15 closest to the outer wall 120, such that the phase change material 130 melts in a radiating manner away from the core 110. The melted phase change material 130 also undergoes some convection heating, which may increase the temperature at a boundary between the melted phase change material 130 and the solid phase change material 130 more quickly.

20 Once the phase change material 130 has melted it continues increasing in temperature, storing energy again as sensible energy. The phase change material 130 continues heating until the hair styling device is removed from the heat source (or reaches equilibrium with the heat source).

 During this charging process the outer wall 120 is continuously heated by the
25 phase change material 130, which in turn heats the outer surface 122. The temperature of the outer wall 120 will be dictated by the temperature of the adjacent areas of phase change material 130. So, in use, the outer wall temperature 120 will be at its maximum when most or all of the phase change material 130 is melted.

 Once the outer wall 120 reaches the desired temperature, the hair styling device
30 is charged and so can be removed from the heat source. The hair styling device enters

the styling phase in which section of a user's hair is then wrapped onto the outer surface 122.

The phase change material 130 continues to heat the outer surface 122 of the outer wall 120 through energy transfer during the styling phase, so as to style the section of hair which is wrapped thereupon. As the outer surface 122 radiates this heat energy to the hair, the outer surface 122 and subsequently the phase change material 130 will cool and the phase change material 130 will begin to solidify. During the solidification process the temperature of the phase change material 130 remains constant and releases its latent heat energy, which continues to heat the outer surface 122. Once the phase change material 130 has solidified it will again start cooling, releasing energy as sensible heat. The phase change material 130 will cool until it reaches equilibrium with the ambient temperature surrounding it.

In some examples, a hair styling device 200, 300, 400, 500 includes one or more members 240, 340, 440, 540 to aid with transferring heat to the phase change material. Figures 2 to Figure 3d illustrate various styling devices 200, 300, 400, 500 with differing member arrangements. It should be understood that any suitable member arrangement is envisaged according to the present invention, including but not limited to combinations of the described member arrangements. In other words, any member arrangement capable of distributing heat from a core to a phase change material is envisaged. Any feature described in relation to one of these example devices should be considered as applicable to any other example, unless inherently incompatible therewith. Features of the styling devices described herein which are the same as those described above with reference to Figures 1a and 1b will not be repeated for brevity.

Referring now to Figure 2, an example styling device 200 which incorporates a member 240 is illustrated. The member 240 is between a core 210 and an outer wall 220 such that it extends into the phase change material (not shown). There is a space (filled with phase change material) between an edge 242 of the member 240 and the outer wall 220. The member 240 is formed from a material with a high thermal conductivity, in this example aluminium, and is welded to the core 210, such that it is in contact with the core.

The member 240 is a continuous sheet of aluminium that spirals around the core 210 such that an edge opposed the edge 242, which is adjacent but spaced apart from the outer wall 220, is in contact with the core 210. In this way, the member 240 extends over the length of the device 200. The member 240 effectively adds to the heating surface area of the core 210, so that an increased area of the phase change material is in contact with a surface which has a high thermal conductivity.

Figure 3a illustrates example hair styling device 300 with an example arrangement of a plurality of members 340, and Figure 3b shows a plan view of Figure 3a. The plurality of members 340 protrude from a core 310 and radiate outwardly such that the core 310 and members 340 have a cog-like cross section (illustrated in Figure 3b). The members 340 extend to an outer wall 320. The plurality of members 340 are fixed to the core 310 and outer wall 320, for example through welding. The plurality of members 340 extend parallel to a longitudinal axis 302 of the core 310 and between an upper wall 312 and a lower wall 314, along the length of the hair styling device 300.

In this example the hair styling device 300 has twelve planar members 340 spaced equidistantly around the core 310 (of course any suitable number are envisaged). The length of the plurality of members 340 is 8.5mm, and the length of the hair styling device 300 is 9mm (including the thickness of upper and lower walls 312, 314). The plurality of members 340 have a thickness of 0.5mm

A phase change material 330 is between the core 310 and the outer wall 320. The phase change material 330 is between adjacent members 340 and as such is separated into sections 330a-1 by those members 340. The phase change material 330 is the same material, in this case RT111 HC. In some other cases, one or more of the sections 330a-1 may each have different phase change materials.

Figure 3c shows an example in which a hair styling device 400 again has a plurality of members 440. In this example, each of the plurality of members have a partially curved extension from a core 410 towards an outer wall 420. Each of the members 440 has a first portion 446 which diverges from a second portion 448. at an end 442 of the member 440 which is adjacent to the outer wall 420. Of course, examples in which the divergence is closer to the core 410 are envisaged, as are examples including multiple diverging portions on one member 440.

Figure 3d illustrates a further example of a hair styling device 500 with eleven members 540. In this example the plurality of members 540 are disc shaped members.

A plane of each member 540 is perpendicular to a longitudinal axis 502 of the core 510. The plurality of members 540 protrude around a core 510 towards an outer wall 520. The plurality of members 540 extend approximately 80% of a distance between a point on the core 510 and a directly opposite point on the outer wall 520, and have a length of 28mm. Each of the plurality of members 540 are spaced equidistantly along the length of the core 510

Looking now to Figures 4a to 4d the charging phase of the styling device 500 of Figure 3d is illustrated. During this charging phase, the core 510 is heated using a heat source (not shown). The heat energy from the core 510 transfers along the members 540 and to the phase change material 530. That is, both the core 510 and the members 540 transfer heat to the phase change material 530. The heat energy transfer is predominantly through radiation from the core 510 and members 540 into the phase change material 530. The heat energy is then stored in the phase change material 530 as sensible heat until the phase change material reaches its melting temperature.

Once the melting temperature is reached, the heating via the core 510 and members 540 causes the phase change material 530 to change phase (melting). The melting of the phase change material 530 is over time, with the areas of the phase change material most adjacent to the core 510 and members 540, melting earlier than areas which are more remote from the core 510 and members 540. The phase change material 530 thus has a melted portion 532 of phase change material 530 (adjacent the core 510 and members 540) and a further solid portion 534 of phase change material 530 (adjacent the outer wall 520). The melted portion 532 can be continuous about the core 510 and members 540 as illustrated, or may be in smaller sub-portions. A boundary 536 between the two portions 532, 534 is where the phase change material 530 is undergoing a change of phase. At the boundary 536 the phase change material 530 is a mix of solid and liquid.

As illustrated by the progression shown in Figures 4a to 4d the melted portion 532 of phase change material 530 increases in area over time such that the boundary 536 moves towards the outer wall 520. The melted portion 532 expands in a radiating

manner from the core 510 and members 540 until most if not all of the phase change material 530 is melted. After the phase change material 530 has changed phase the temperature of the phase change material 530 may again start increasing in temperature, storing energy again as sensible heat. Once the desired temperature of the phase change material 530 and thus outer surface 522 has been reached the heat source no longer heats the core 510. This is when at least 95% of the phase change material 530 has reached a melted state The hair styling device 500 can therefore be used by the user to style the hair, entering the styling phase.

The hair styling device 500 is fully charged (i.e., the desired temperature of the outer surface 522 is reached) in less than 20 minutes, for example 15 minutes.

In both the charging phase and styling phase, the heat energy from the phase change material 530 is continually transferred to the outer surface 522 of the outer wall 520. During the charging process at least some of the heat energy from the phase change material 530 is transferred to an outer surface 522 of the outer wall 520. The temperature of the outer surface 522 therefore also increases during the charging phase. During the styling phase, the phase change material 530 drops in temperature releasing heat energy as sensible energy and the outer surface 522 releases this heat energy to the hair. Once the phase change material 530 reaches a solidifying temperature, the phase change material 530 begins to change phase and remain a substantially constant temperature. This solidification releases heat energy as latent heat and may maintain the outer surface 522 at a constant temperature. Once the phase change material 530 has solidified it continues to cool releasing more heat energy as sensible energy until it reaches room temperature. Throughout the styling process the phase change material 530 is transferring energy to the outer wall 520 and thus outer surface 522 giving the heating effect required to style the hair .

In order to charge a hair styling device a dock 650 is used, as illustrated in Figure 5a and b. The dock 650 has a plurality of cavities 652a-c with a heat source 660a-c protruding therethrough. The heat source(s) 660a-c are coupled to an electrical connection 654.

The cavities 652a-c are each shaped to each receive a respective hair styling device 600a-c (shown in Figure 5b). Each of the cavities 652a-c are a corresponding

shape to that of the respective hair styling device 600a-c. The cavity has a tolerance of 0.5mm to 2mm such that the respective hair styling device 600a-c fits therein with relative snugness, such that there is little to no air gap between an outer surface 622 of the respective hair styling device 600a-c and a wall of the cavity 652a-c. In some cases, the cavity has an insulated wall (not shown).

The cavities 652a-c within the dock 650 may be oriented so that each respective hair styling device 600a-c is charged in an upright position relative to the dock 650. That is an upper lower wall 612, 614, which extend between the core (not shown) and the outer surface 622 of the outer wall (not shown), are parallel with a base 656 of the dock 650. In use, the base of the dock 650 will normally be placed on a surface. In this way gravity may act parallel to a longitudinal axis of the hair styling device 600a-c.

The heat source 600a-c protrudes from a base of the respective cavity 652a-c such that the heat source 600a-c fits inside a core of the respective hair styling device 600a-c placed within the cavity 652a-c. The heat source 600a-c is in contact with the core of said hair styling device 600a-c during charging. The heat source 600a-c is a resistive heater, which is electrically powered.

The dock 650 also includes an electrical connection 654 such as a plug or battery. This electrical connection 654 is electrically coupled to each heat source 660a-c, so as to provide the electrical connection to heat the heat source 660a-c.

The dock 650 includes a controller 658a-c associated with each heat source 660a-c. The controller 658a-c is a PID-controller which may actuate the heat sources 660a-c on and off, for example by controlling the electrical connection. Once the desired temperature of the phase change material or outer surface 622 of one of the hair styling devices 600a is achieved the respective heat source 660a is turned off.. The dock 650 there includes temperature sensing apparatus (not shown) in the cavity 652a and coupled to the controller 658a.

In some examples the controller may be a single controller which turns some or all of the heat sources 660a-c on and off in one action. In other examples, the dock 650 may have a switch and a timer arrangement for controlling the heating the heat sources 660a-c.

As illustrated in Figure 5b, a part 604a-c of the hair styling device 600a-c protrudes from its respective cavity 652a-c. The part 604a-c may allow a user to grip the hair styling device 600a-c to remove it from the dock 650. As such, the part 604a-c may be an additional part atop the device as described with reference to the previous figures. The part being an insulative cap or the like.

The dock and one or more hair styling device together provide a hair styling kit. The kit includes a variety of sizes of hair styling device for styling different sections of a user's hair although illustrated as three hair styling devices, the kit may comprise any suitable number. The kit may also include optional features such as heat protective gloves and or clips to aid with fastening each of the styling devices in place on a user's head.

The above-described examples are to be understood as illustrative examples of the invention. Further embodiments of the invention are envisaged. For example, while the above description refers to the hair styling device (at least core and outer surface) as tubular any suitable shape may be used for example frustoconical. The skilled person will understand that changes in shape to the outer surface and or device in general may have a direct impact on the style of wave or curve within the user's hair. In these examples, the core may be a corresponding shape to the overall device, i.e., so the ratio of phase change material to core remains substantially constant. Further, the cavity on the charging dock may be a complementary shape so as to snugly fit each styling device.

The heat source is described above as forming part of the dock, in some examples however the heat source may be part of the hair styling device, for example a resistive heater disposed inside and thermally coupled to the core. The dock may in these cases provide the electrical connection so as to allow the heat source to provide heat through resistive heating.

It is to be understood that any feature described in relation to any one embodiment may be used alone, or in combination with other features described, and may also be used in combination with one or more features of any other of the embodiments, or any combination of any other of the embodiments. Furthermore, equivalents and modifications not described above may also be employed without departing from the scope of the invention, which is defined in the accompanying claims.

CLAIMS

1. A hair styling device comprising:
 - a core having a high thermal conductivity;
 - 5 an outer wall spaced from the core, the outer wall comprising an outer surface on which a section of a user's hair is wrappable; and
 - a phase change material disposed between the core and the outer wall, the phase change material for releasing heat to the section of the user's hair via the outer surface in use.
- 10 2. The hair styling device of claim 1, wherein the hair styling device further comprises a member for transferring heat from the core to the phase change material, the member located between the core and the outer wall.
- 15 3. The hair styling device of claim 2, wherein the member extends from the core towards the outer wall.
4. The hair styling device of claim 3, wherein the member extends from the core for more than half a distance from a first point on the core to a second point directly opposed to the first point on the outer wall.
- 20 5. The hair styling device of any one of claims 2 to 4, wherein the member comprises a first portion and a second portion, wherein the first portion and the second portion diverge from one another.
- 25 6. The hair styling device of any one of claims 2 to 5, wherein the member comprises a plurality of apertures.
7. The hair styling device as claimed in any preceding claim, wherein the hair styling device comprises a plurality of members distributed about the core, the
- 30

plurality of members for transferring heat from the core to the phase change material.

- 5 8. The hair styling device of claim 7, wherein the plurality of members each have a length corresponding to a length of the core, the length of the plurality of members extending parallel to a longitudinal axis of the core.
- 10 9. The hair styling device of claim 7, wherein each of the plurality of members comprises a disc, each disc spaced apart from an adjacent disc along a length of the core.
- 15 10. The hair styling device of any one of claims 7 to 9, wherein the plurality of members are evenly distributed about the core.
- 20 11. The hair styling devices of any one of claims 7 to 10, wherein at least one of the plurality of members extends from the core to the outer wall.
- 25 12. The hair styling device of any one of claims 7 to 11, wherein each of the plurality of members are identical.
- 30 13. The hair styling device of any one of the preceding claims, wherein the phase change material has melting temperature of at least 50°C.
14. The hair styling device of any one of the preceding claims, wherein the phase change material has a latent heat of at least 150 kJ/kg.
15. The hair styling device of any one of the preceding claims, wherein the phase change material is an organic material.

16. The hair styling device of any one of the preceding claims, wherein the outer wall has a lower thermal conductivity than the core.
17. The hair styling device of any one of the preceding claims, wherein the hair
5 styling device further comprises a heat source thermally coupled to the core.
18. A hair styling kit comprising:
a hair styling device of any one of claims 1 to 18; and
a dock, the hair styling device configured to be removably coupled to
10 the dock,
wherein the dock is configured to heat the core of the hair styling device via a heat source when the hair styling device is coupled to the dock.
19. The hair styling kit of claim 18, wherein the dock comprises at least one cavity
15 configured to receive the at least one hair styling device therein.
20. The hair styling kit of claim 19, wherein the cavity comprises an insulated wall, such that the cavity insulates the hair styling device when the hair styling device is coupled to the dock.
20
21. The hair styling kit of any one of claims 20 to 20, wherein the dock is configured to receive the at least one hair styling device in an upright position relative to the dock.
22. The hair styling kit of any one of claims 18 to 21, wherein the dock comprises
25 a controller configured to maintain the heat source at an optimal temperature for melting the phase change material.
23. The hair styling kit of any one of claims 18 to 22, wherein the hair styling kit
30 comprises a plurality of the hair styling devices.

24. The hair styling kit of claim 23 when dependent on claim 19, wherein the dock comprises a plurality of the cavities corresponding to the plurality of the hair styling devices.

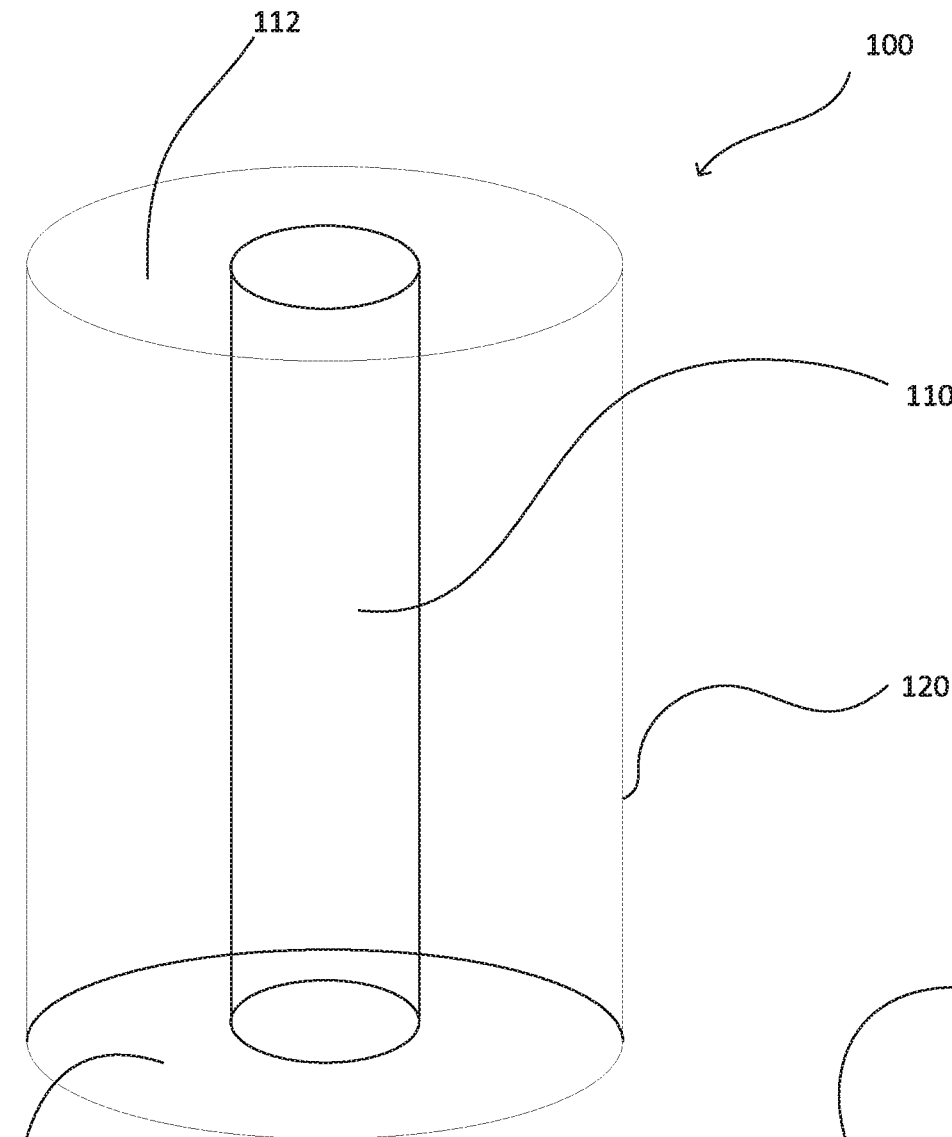


Fig.1a

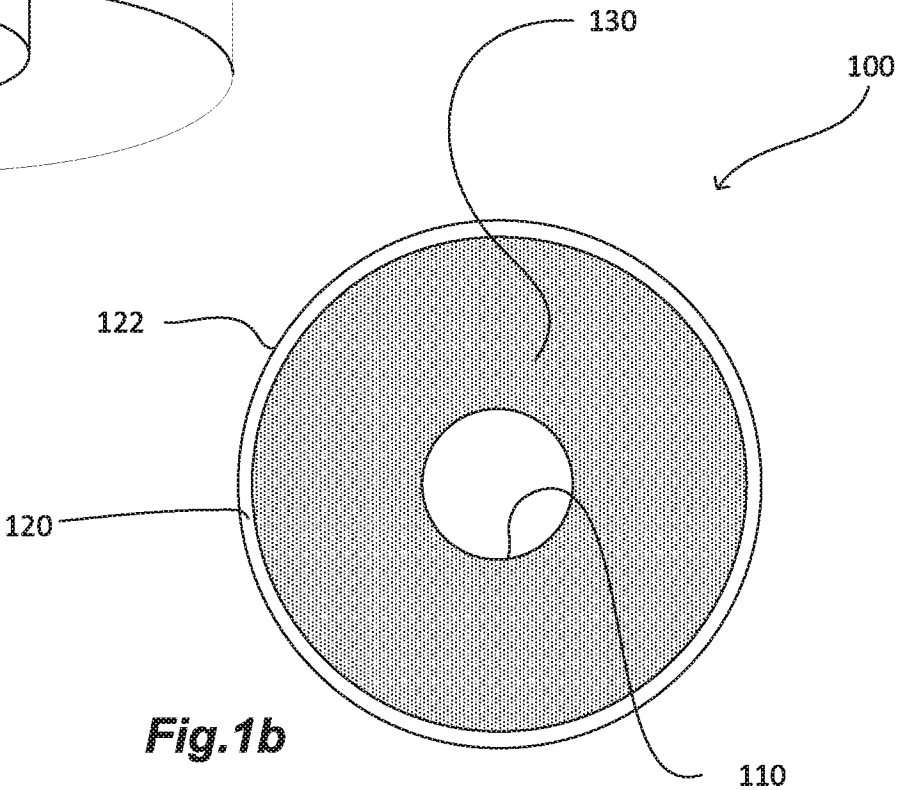


Fig.1b

2/7

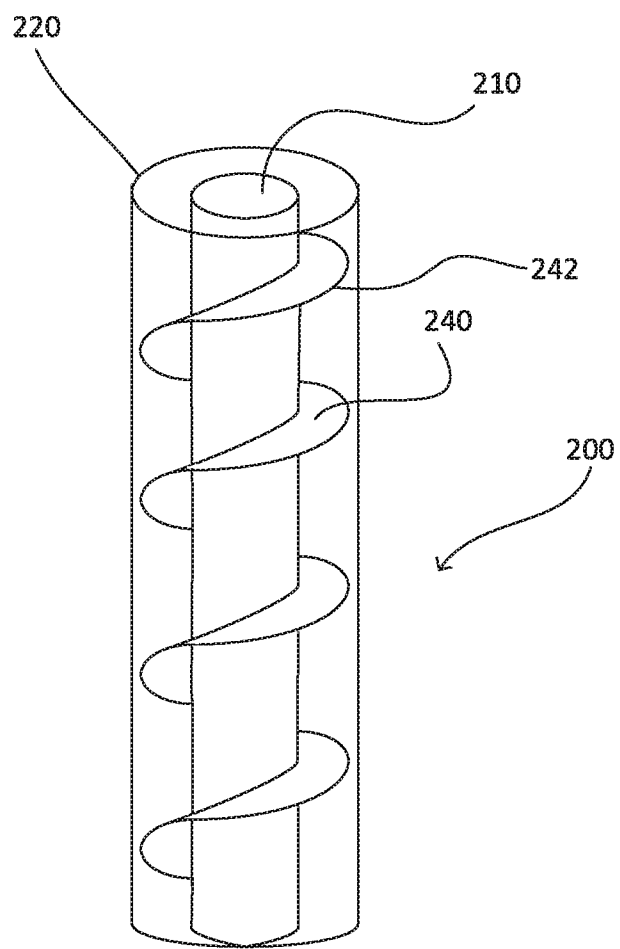
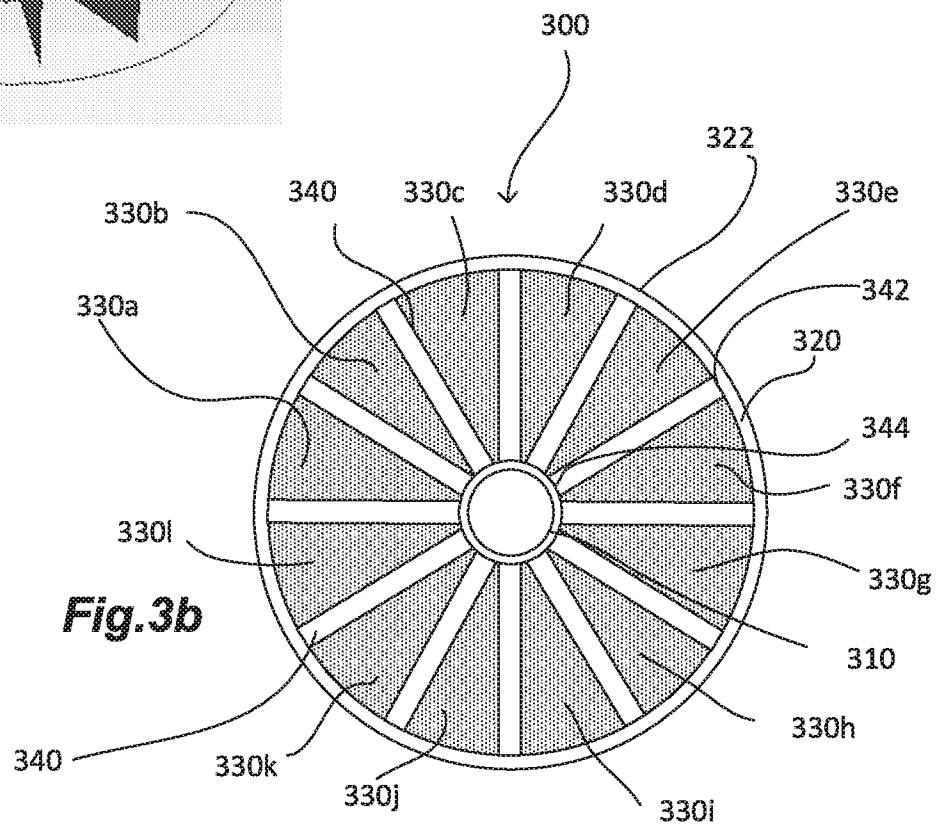
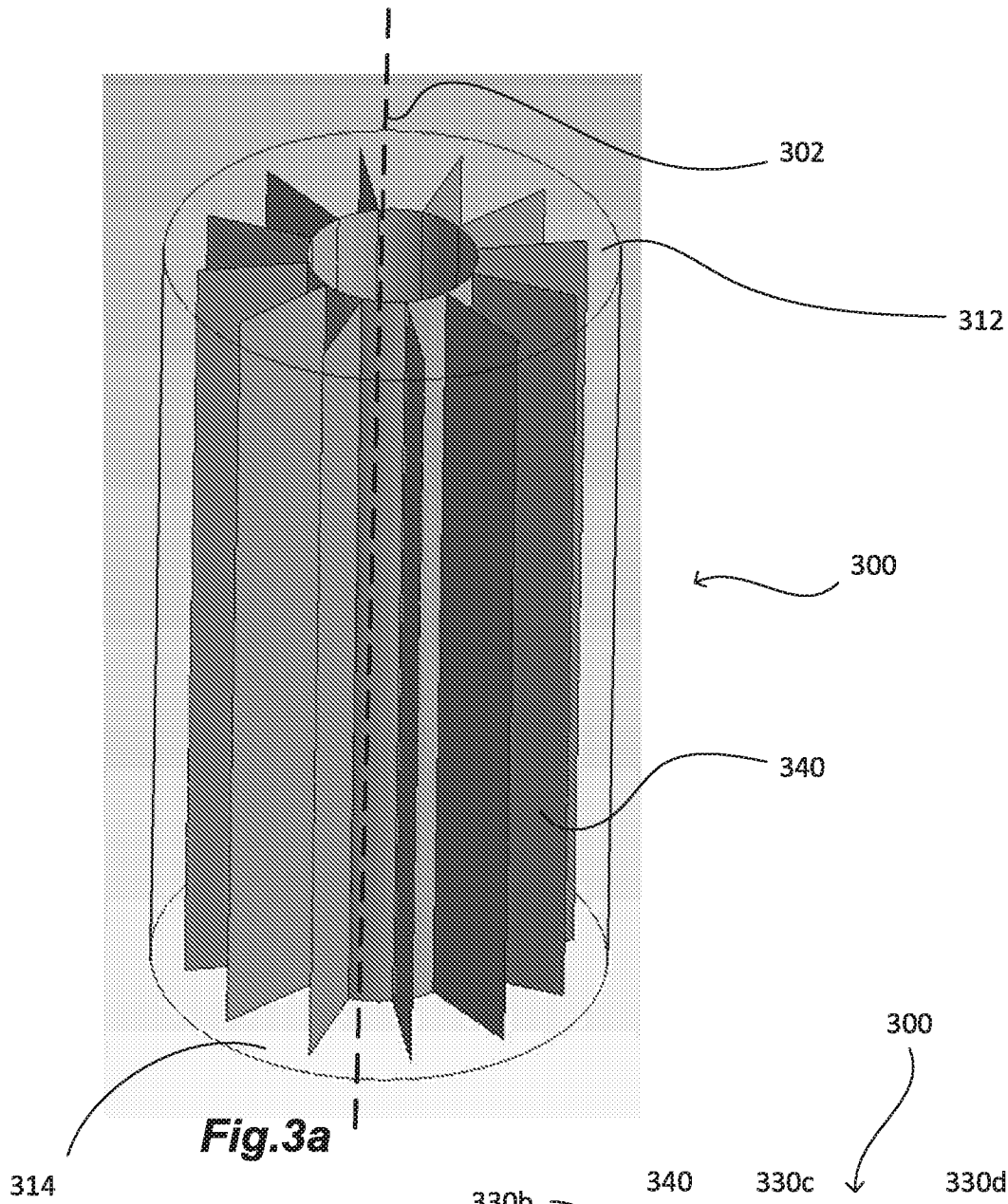


Fig.2

3/7



4/7

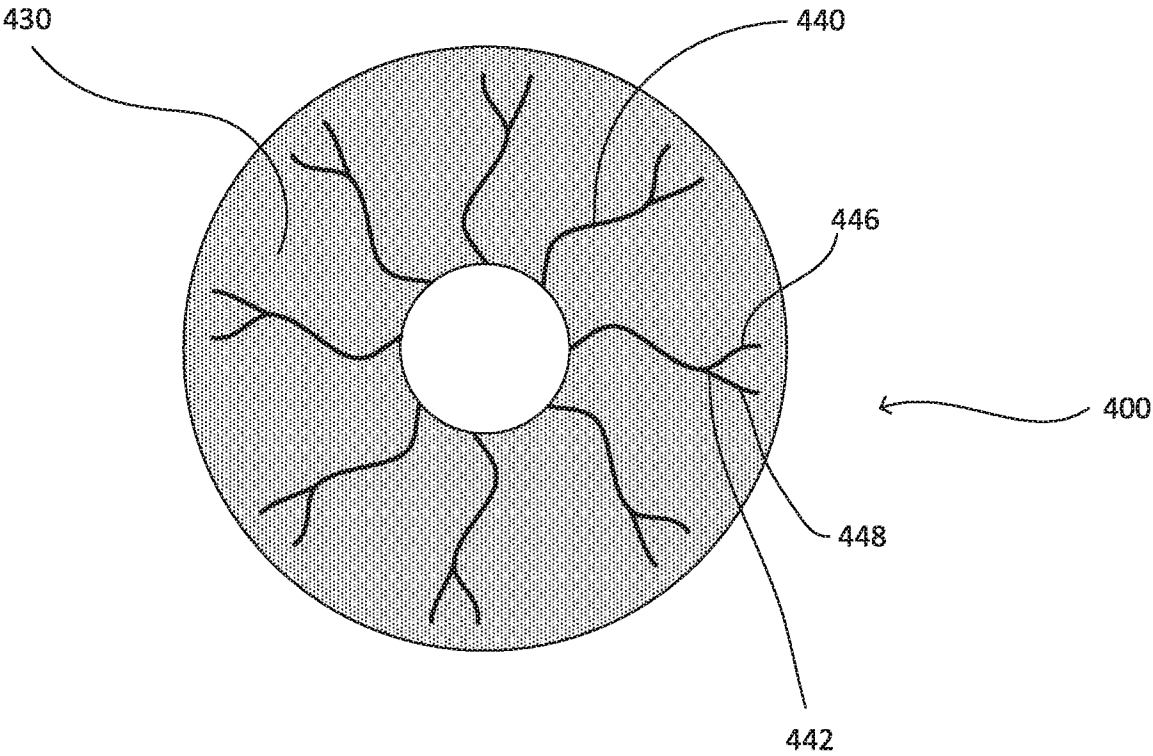
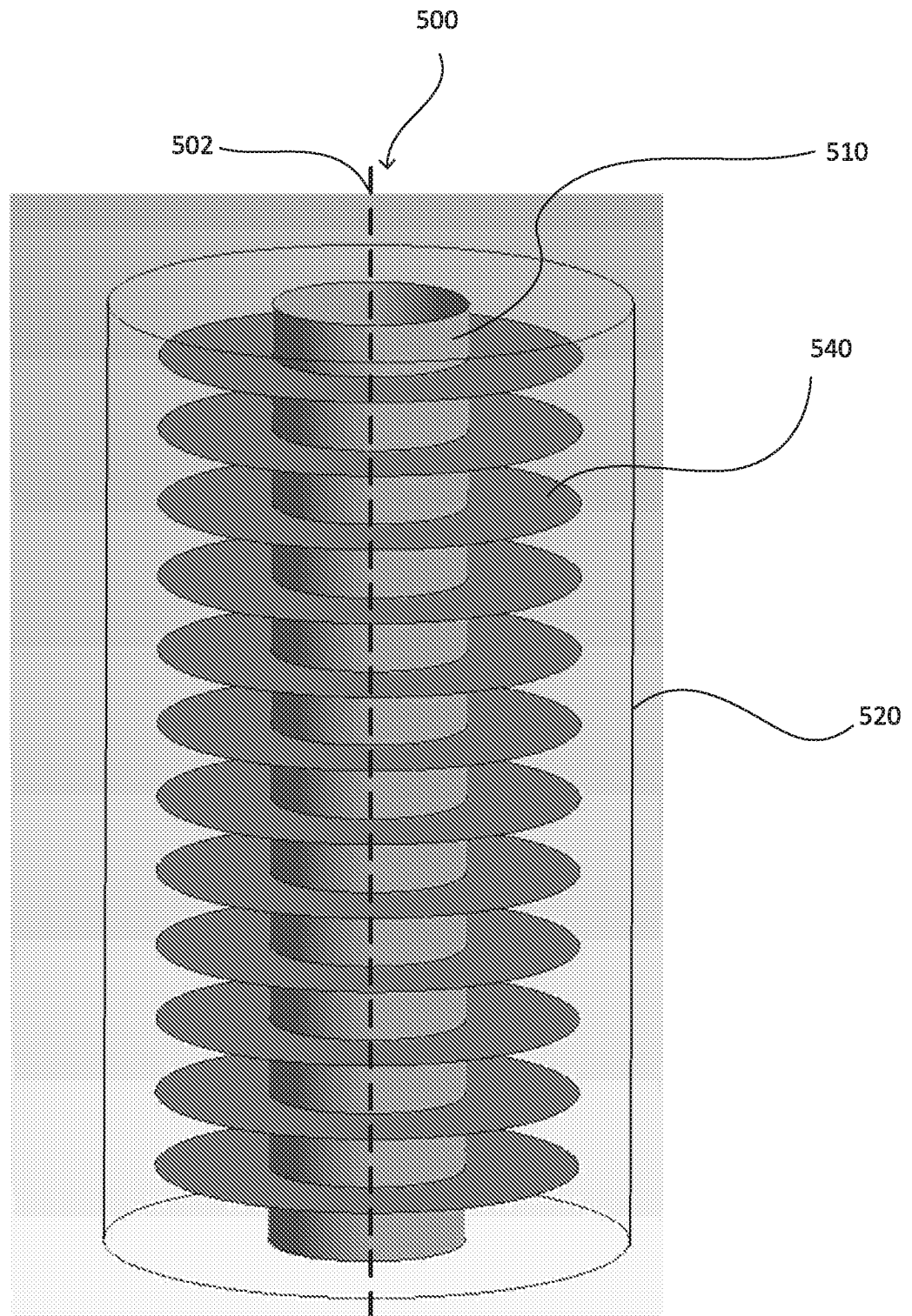


Fig.3c

5/7

**Fig.3d**

6/7

500

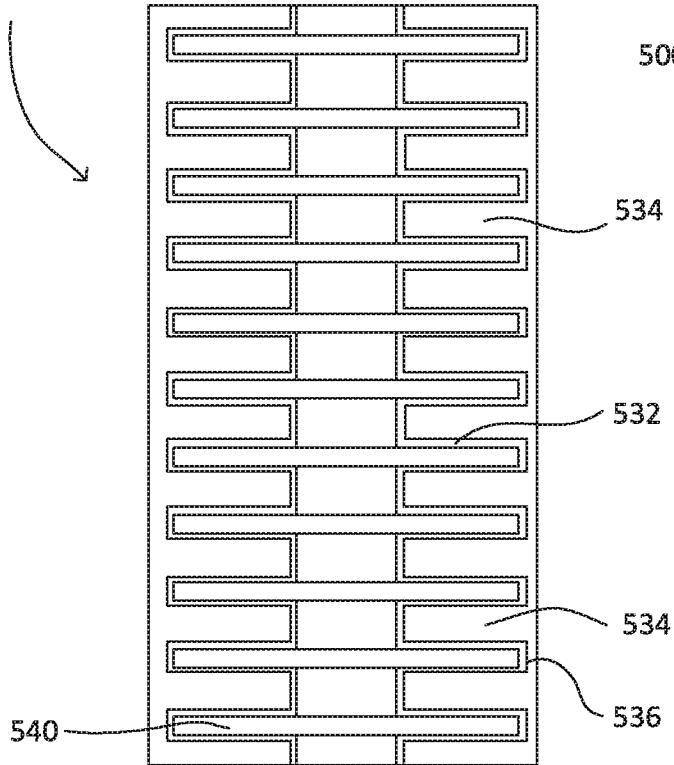


Fig. 4a

500

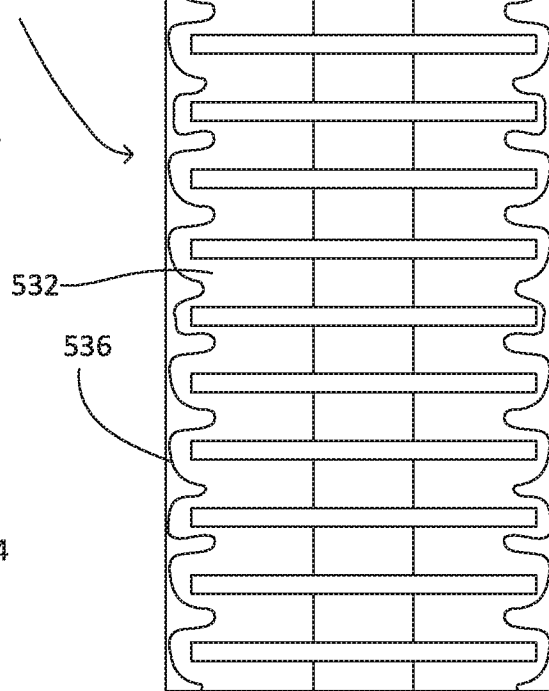


Fig. 4b

540

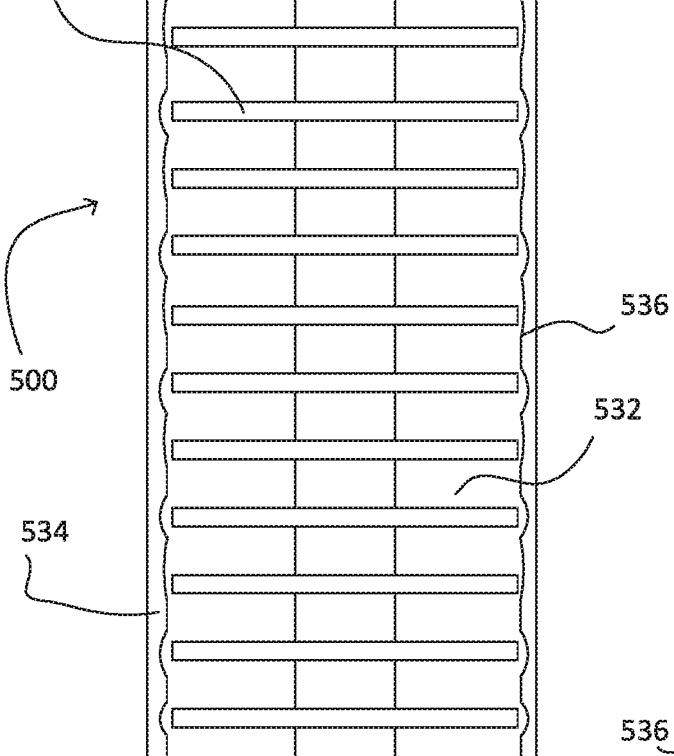


Fig. 4c

532

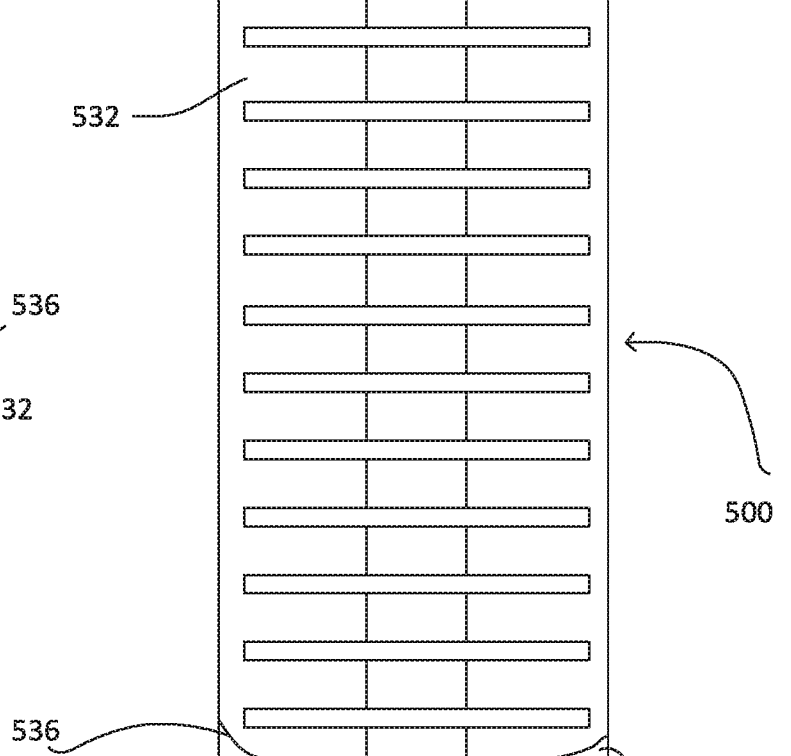


Fig. 4d

534

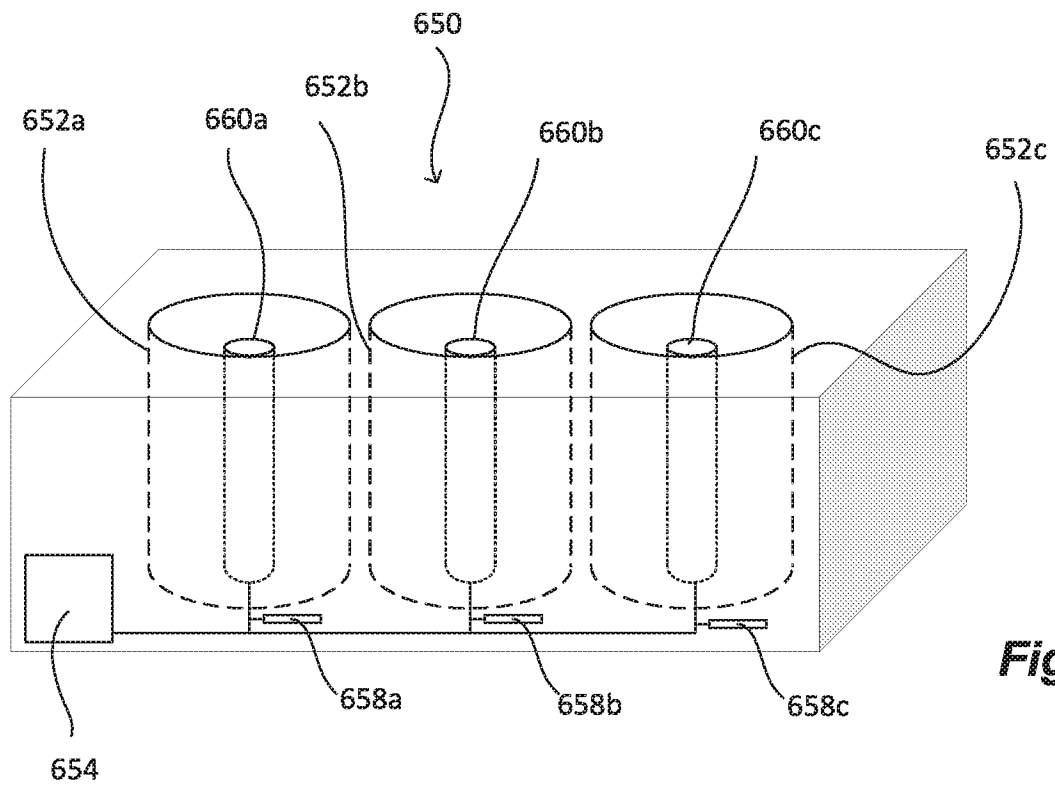


Fig. 5a

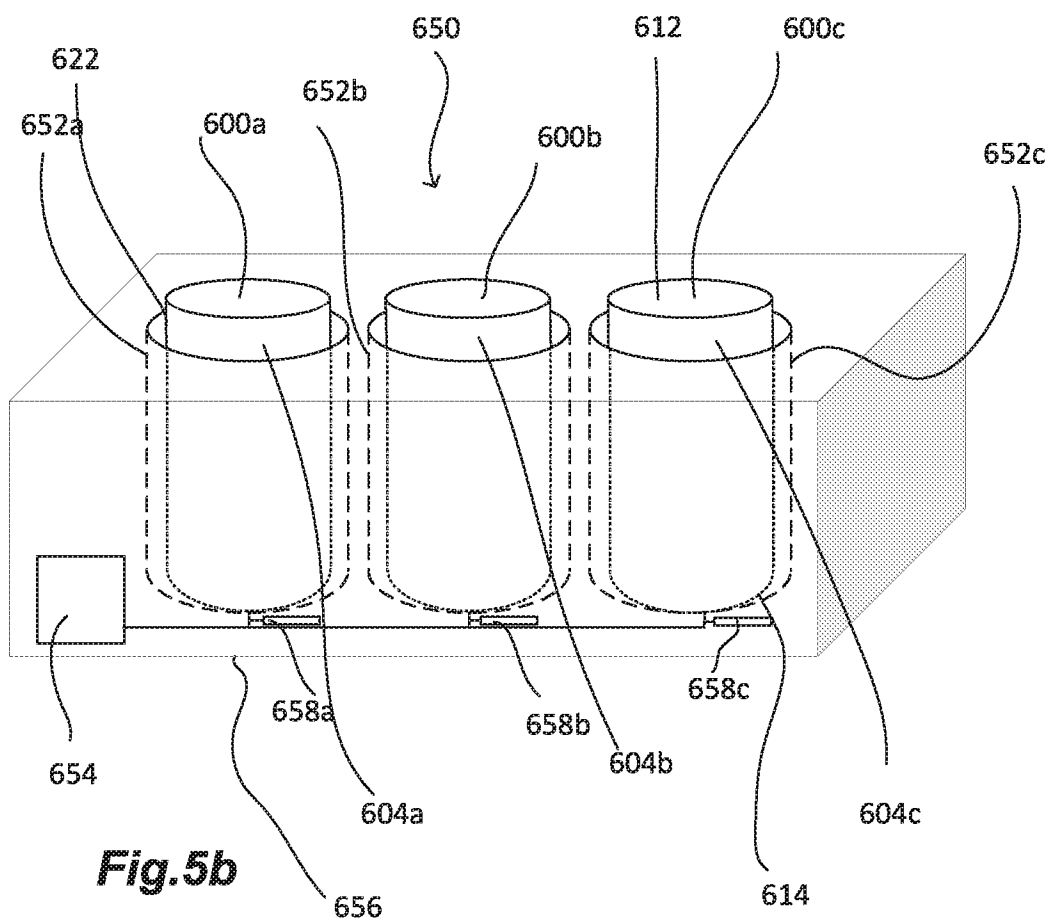


Fig. 5b

INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2023/061271

A. CLASSIFICATION OF SUBJECT MATTER**INV. A45D2/36****ADD.**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A45D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 211 833 225 U (NINGBO FIRSTSTEP ELECTRIC APPLIANCE CO LTD) 3 November 2020 (2020-11-03)	1-8, 10-13, 17
A	figures; examples 1, 2 -----	9
X	US 3 257 541 A (CHRISTIAN JORGENSEN NIELS) 21 June 1966 (1966-06-21)	1, 13-18, 21-23
Y	column 3, line 7 - column 4, line 12; figures -----	24
X	US 3 519 793 A (SOLOMON NATHAN L) 7 July 1970 (1970-07-07)	1-4, 13-23
	column 3, line 19 - column 5, line 15; figures -----	
Y	GB 1 056 099 A (SONCRAND CORP) 25 January 1967 (1967-01-25) figure 2 -----	24



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search

17 January 2024

Date of mailing of the international search report

26/01/2024

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Authorized officer

Zattoni, Federico

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2023/061271

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
CN 211833225	U	03-11-2020	NONE	

US 3257541	A	21-06-1966	AT 290758 B	25-06-1971
			BE 643395 A	29-05-1964
			CH 434597 A	30-04-1967
			CH 443583 A	15-09-1967
			DE 1457443 A1	20-02-1969
			FR 1362367 A	29-05-1964
			GB 1043743 A	28-09-1966
			GB 1043744 A	28-09-1966
			NL 135169 C	17-01-2024
			NL 6401208 A	13-08-1964
			NO 121466 B	01-03-1971
			SE 333797 B	29-03-1971
			US 3257541 A	21-06-1966
			US RE26766 E	13-01-1970

US 3519793	A	07-07-1970	NONE	

GB 1056099	A	25-01-1967	DE 1457463 A1	22-05-1969
			GB 1056099 A	25-01-1967
