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(54) **HEAT-NOT-BURN DEVICE AND SYSTEM**

(57) There is provided a HNB device (100), comprising: a consumable cavity (120); an IR heater (140) arranged alongside the consumable cavity, the IR heater for heating a consumable (200) received into the consumable cavity; and an IR reflective surface (150) which extends about the consumable cavity and the IR heater.

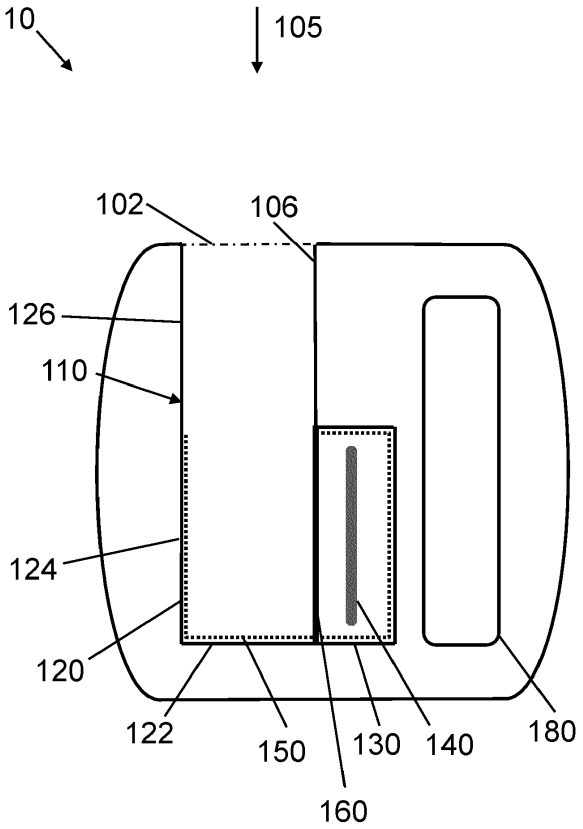

Fig. 3

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Description

Field of the Invention

[0001] The present invention relates to a heat-not-burn device and system.

Background

[0002] A typical aerosol generating apparatus may comprise a power supply, an aerosol generating unit that is driven by the power supply, an aerosol precursor, which in use is aerosolised by the aerosol generating unit to generate an aerosol, and a delivery system for delivery of the aerosol to a user.

[0003] A drawback with known aerosol generating apparatuses relates to residue of heat-not-burn consumables in a heater system of the aerosol generating apparatuses as a result of piercing of the consumable by a heater rod.

[0004] In spite of the effort already invested in the development of aerosol generating apparatuses/systems further improvements are desirable.

Summary of the Invention

[0005] At its most general, the present invention relates to the inclusion of an IR reflective surface extending about an arrangement of a consumable cavity and an IR heater.

[0006] According to a first aspect of the present invention, there is provided a HNB device comprising a consumable cavity; an IR heater arranged alongside the consumable cavity, the IR heater for heating a consumable received into the consumable cavity; and an IR reflective surface which extends about the consumable cavity and the IR heater.

[0007] Optionally, the HNB device comprises a chamber which includes the consumable cavity and a heater compartment alongside the consumable cavity; wherein the IR heater is located in the heater compartment.

[0008] Optionally, an IR transmissive window is arranged between the consumable cavity and the IR heater to provide a physical barrier between the consumable cavity and the IR heater.

[0009] Optionally, the IR transmissive window has an extent along the consumable cavity which is at least as great as an extent of the IR heater along the consumable cavity.

[0010] Optionally, the consumable cavity is bounded by the IR reflective surface and the IR transmissive window.

[0011] Optionally, the consumable cavity has a substantially cylindrical shape and the IR transmissive window is configured to continue the cylindrical shape of the consumable cavity.

[0012] Optionally, wherein the IR transmissive window has an IR transmissivity of at least 0.8, preferably at least 0.9, and more preferably at least 0.95.

[0013] Optionally, the HNB device comprises a plurality of IR heaters, and the IR reflective surface encloses the consumable cavity and the plurality of IR heaters.

[0014] Optionally, the plurality of IR heaters is configured to sequentially heat the chamber.

[0015] Optionally, the plurality of IR heaters is equidistantly spaced about the consumable cavity.

[0016] Optionally, a first IR heater of the plurality of IR heaters and a second IR heater of the plurality of IR heaters are located on opposite sides of the consumable cavity.

[0017] Optionally, the HNB device comprises a chamber which includes the consumable cavity and a plurality of heater compartments alongside the consumable cavity, wherein an IR heater of the plurality of IR heaters is located in each heater compartment.

[0018] Optionally, the IR reflective surface has a reflectance of at least 0.9, preferably of at least 0.95.

[0019] Optionally, the IR heater is arranged substantially parallel to the consumable cavity.

[0020] Optionally, the IR heater is spaced from the consumable cavity. For example, the IR heater may be spaced from the consumable cavity by at least 2 millimetres. In some examples, the IR heater may be spaced from the consumable cavity by at least 3 millimetres, or by at least 4 millimetres.

[0021] Optionally, the IR may be spaced from the consumable by up to 6 millimetres. In some examples, the IR heater may be spaced from the consumable cavity by up to 5 millimetres, or by up to 4 millimetres.

[0022] According to a second aspect of the present invention, there is provided a HNB system comprising the HNB device as described above and a consumable.

[0023] Optionally, the consumable extends parallel to the IR heater when the consumable is received into the consumable cavity.

[0024] The invention includes the combination of the aspects and preferred features described except where such a combination is clearly impermissible or expressly avoided.

Summary of the Figures

[0025] So that the invention may be understood, and so that further aspects and features thereof may be appreciated, embodiments illustrating the principles of the invention will now be discussed in further detail with reference to the accompanying figures, in which:

Figure 1 is a perspective view of a HNB system in an engaged state.

Figure 2 is a perspective view of a HNB system in a disengaged state.

Figure 3 is a cross-sectional view of a HNB device of the HNB system of Figure 1.

Figure 4 is another cross-sectional view of a HNB device of the HNB system of Figure 1.

Figure 5 illustrates a first consumable temperature distribution.

Figure 6 illustrates a second consumable temperature distribution.

Figure 7 illustrates a temperature profile of an IR heater of the HNB system of Figure 1.

Detailed Description of the Invention

[0026] Before describing several examples implementing the present disclosure, it is to be understood that the present disclosure is not limited by specific construction details or process steps set forth in the following description and accompanying drawings. Rather, it will be apparent to those skilled in the art having the benefit of the present disclosure that the systems, apparatuses and/or methods described herein could be embodied differently and/or be practiced or carried out in various alternative ways.

[0027] Unless otherwise defined herein, scientific and technical terms used in connection with the presently disclosed inventive concept(s) shall have the meanings that are commonly understood by those of ordinary skill in the art, and known techniques and procedures may be performed according to conventional methods well known in the art and as described in various general and more specific references that may be cited and discussed in the present specification.

[0028] All examples implementing the present disclosure can be made and executed without undue experimentation in light of the present disclosure. While particular examples have been described, it will be apparent to those of skill in the art that variations may be applied to the systems, apparatus, and/or methods and in the steps or in the sequence of steps of the methods described herein without departing from the concept, spirit, and scope of the inventive concept(s). All such similar substitutions and modifications apparent to those skilled in the art are deemed to be within the spirit, scope, and concept of the inventive concept(s) as defined by the appended claims.

[0029] The use of the term "a" or "an" in the claims and/or the specification may mean "one," as well as "one or more," "at least one," and "one or more than one." As such, the terms "a," "an," and "the," as well as all singular terms, include plural referents unless the context clearly indicates otherwise. Likewise, plural terms shall include the singular unless otherwise required by context.

[0030] The use of the term "or" in the present disclosure (including the claims) is used to mean an inclusive "and/or" unless explicitly indicated to refer to alternatives only or unless the alternatives are mutually exclusive. For example, a condition "A or B" is satisfied by any of the following: A is true (or present) and B is false (or not present), A is false (or not present) and B is true (or present), and both A and B are true (or present).

[0031] As used in this specification and claim(s), the words "comprising, "having," "including," or "containing" (and any forms thereof, such as "comprise" and "comprises," "have" and "has," "includes" and "include," or "contains" and "contain," respectively) are inclusive or open-ended and do not exclude additional, unrecited elements or method steps.

[0032] Unless otherwise explicitly stated as incompatible, or the physics or otherwise of the embodiments, examples, or claims prevent such a combination, the features of examples disclosed herein, and of the claims, may be integrated together in any suitable arrangement, especially ones where there is a beneficial effect in doing so. This is not limited to only any specified benefit, and instead may arise from an "ex post facto" benefit. This is to say that the combination of features is not limited by the described forms, particularly the form (e.g. numbering) of example(s), embodiment(s), or dependency of claim(s). Moreover, this also applies to the phrase "in one embodiment," "according to an embodiment," and the like, which are merely a stylistic form of wording and are not to be construed as limiting the following features to a separate embodiment to all other instances of the same or similar wording. This is to say, a reference to 'an,' 'one,' or 'some' embodiment(s) may be a reference to any one or more, and/or all embodiments, or combination(s) thereof, disclosed. Also, similarly, the reference to "the" embodiment may not be limited to the immediately preceding embodiment. Further, all references to one or more embodiments or examples are to be construed as non-limiting to the claims.

[0033] The present disclosure may be better understood in view of the following explanations, wherein the terms used that are separated by "or" may be used interchangeably:

As used herein, an **"aerosol generating apparatus"** (or **"electronic(e)-cigarette"**) may be an apparatus configured to deliver an aerosol to a user for inhalation by the user. The apparatus may additionally/alternatively be referred to as a "smoking substitute apparatus", if it is intended to be used instead of a conventional combustible smoking article. As used herein a combustible "smoking article" may refer to a cigarette, cigar, pipe or other article, that produces smoke (an aerosol comprising solid particulates and gas) via heating above the thermal decomposition temperature (typically by combustion and/or pyrolysis). An aerosol generated by the apparatus may comprise an aerosol with particle sizes of 0.2 - 7 microns, or less than 10 microns, or less than 7 microns. This particle size may be achieved by control of one or more of: heater temperature; cooling rate as the vapour condenses to an aerosol; flow properties including turbulence and velocity. The generation of aerosol by the aerosol generating apparatus may be controlled by an input device. The input device may be configured to be

user-activated, and may for example include or take the form of an actuator (e.g. actuation button) and/or an airflow sensor.

[0034] Each occurrence of the aerosol generating apparatus being caused to generate aerosol for a period of time (which may be variable) may be referred to as an **"activation"** of the aerosol generating apparatus. The aerosol generating apparatus may be arranged to allow an amount of aerosol delivered to a user to be varied per activation (as opposed to delivering a fixed dose of aerosol), e.g. by activating an aerosol generating unit of the apparatus for a variable amount of time, e.g. based on the strength/duration of a draw of a user through a flow path of the apparatus (to replicate an effect of smoking a conventional combustible smoking article).

[0035] The aerosol generating apparatus may be portable. As used herein, the term **"portable"** may refer to the apparatus being for use when held by a user.

[0036] As used herein, an **"aerosol generating system"** may be a system that includes an aerosol generating apparatus and optionally other circuitry/components associated with the function of the apparatus, e.g. one or more external devices and/or one or more external components (here "external" is intended to mean external to the aerosol generating apparatus). As used herein, an "external device" and "external component" may include one or more of a: a charging device, a mobile device (which may be connected to the aerosol generating apparatus, e.g. via a wireless or wired connection); a networked-based computer (e.g. a remote server); a cloud-based computer; any other server system.

[0037] An example aerosol generating system may be a system for managing an aerosol generating apparatus. Such a system may include, for example, a mobile device, a network server, as well as the aerosol generating apparatus.

[0038] As used herein, an **"aerosol"** may include a suspension of precursor, including as one or more of: solid particles; liquid droplets; gas. Said suspension may be in a gas including air. An aerosol herein may generally refer to/include a vapour. An aerosol may include one or more components of the precursor.

[0039] As used herein, a **"precursor"** may include one or more of a: liquid; solid; gel; loose leaf material; other substance. The precursor may be processed by an aerosol generating unit of an aerosol generating apparatus to generate an aerosol. The precursor may include one or more of: an active component; a carrier; a flavouring. The active component may include one or more of nicotine; caffeine; a cannabidiol oil; a non-pharmaceutical formulation, e.g. a formulation which is not for treatment of a disease or physiological malfunction of the human body. The active component may be carried by the carrier, which may be a liquid, including propylene glycol and/or glycerine. The term "flavouring" may refer to a component that provides a taste and/or a smell to the user. The flavouring may include one or more of: Ethylvanillin (vanilla); menthol, Isoamyl acetate (banana oil); or other. The precursor may include a substrate, e.g. reconstituted tobacco to carry one or more of the active component; a carrier; a flavouring.

[0040] As used herein, a **"flow path"** may refer to a path or enclosed passageway through an aerosol generating apparatus, e.g. for delivery of an aerosol to a user. The flow path may be arranged to receive aerosol from an aerosol generating unit. When referring to the flow path, upstream and downstream may be defined in respect of a direction of flow in the flow path, e.g. with an outlet being downstream of an inlet.

[0041] As used herein, a **"delivery system"** may be a system operative to deliver an aerosol to a user. The delivery system may include a mouthpiece and a flow path.

[0042] As used herein, a **"flow"** may refer to a flow in a flow path. A flow may include aerosol generated from the precursor. The flow may include air, which may be induced into the flow path via a puff by a user.

[0043] As used herein, an **"aerosol generating unit"** may refer to a device configured to generate an aerosol from a precursor. The aerosol generating unit may include a unit to generate a vapour directly from the precursor (e.g. a heating system or other system) or an aerosol directly from the precursor (e.g. an atomiser including an ultrasonic system, a flow expansion system operative to carry droplets of the precursor in the flow without using electrical energy or other system). A plurality of aerosol generating units to generate a plurality of aerosols (for example, from a plurality of different aerosol precursors) may be present in an aerosol generating apparatus.

[0044] As used herein, a **"heating system"** may refer to an arrangement of at least one heating element, which is operable to aerosolise a precursor once heated. The at least one heating element may be electrically resistive to produce heat from the flow of electrical current therethrough. The at least one heating element may be arranged as a susceptor to produce heat when penetrated by an alternating magnetic field. The heating system may be configured to heat a precursor to below 300 or 350 degrees C, including without combustion.

[0045] As used herein, a **"consumable"** may refer to a unit that includes a precursor. The consumable may include an aerosol generating unit, e.g. it may be arranged as a cartomizer. The consumable may include a mouthpiece. The consumable may include an information carrying medium. With liquid or gel implementations of the precursor, e.g. an e-liquid, the consumable may be referred to as a "capsule" or a "pod" or an "e-liquid consumable". The capsule/pod may include a storage portion, e.g. a reservoir or tank, for storage of the precursor. With solid material implementations of the precursor, e.g. tobacco or reconstituted tobacco formulation, the consumable may be referred to as a "stick" or "package" or "heat-not-burn consumable". In a heat-not-burn consumable, the mouthpiece may be implemented as a filter and the consumable may be arranged to carry the

precursor. The consumable may be implemented as a dosage or pre-portioned amount of material, including a loose-leaf product.

[0046] As used herein, an **"information carrying medium"** may include one or more arrangements for storage of information on any suitable medium. Examples include: a computer readable medium; a Radio Frequency Identification (RFID) transponder; codes encoding information, such as optical (e.g. a bar code or QR code) or mechanically read codes (e.g. a configuration of the absence or presents of cut-outs to encode a bit, through which pins or a reader may be inserted).

[0047] As used herein **"heat-not-burn"** (or **"HNB"** or **"heated precursor"**) may refer to the heating of a precursor, typically tobacco, without combustion, or without substantial combustion (i.e. localised combustion may be experienced of limited portions of the precursor, including of less than 5% of the total volume).

[0048] Aspects and embodiments of the present invention will now be discussed with reference to the accompanying figures. Further aspects and embodiments will be apparent to those skilled in the art.

[0049] Figures 1 and 2 are perspective views of an aerosol generating system, provided as a heat-not-burn system 10 for providing aerosol/vapour to a user.

[0050] The HNB system 10 comprises an aerosol generating apparatus, provided as a HNB device 100, and an aerosol-forming article in the form of a consumable 200, which comprises a precursor in the form of an aerosol former 202. The HNB device 100 and the consumable 200 are configured such that the consumable 200 can be engaged with the HNB device 100. Figure 1 shows the HNB device 100 and the consumable 200 in an engaged state, whilst Figure 2 shows the HNB device 100 and the consumable 200 in a disengaged state. Suitably, the HNB device 100 has a consumable opening 102 (shown in Figure 3 as a dashed-dotted line). The consumable 200 is insertable into the HNB device 100 through the consumable opening 102 in an insertion direction 105.

[0051] The consumable 200 may also be referred to as a stick consumable or as a stick. In that respect, the consumable 200 has a generally cylindrical form with a diameter of 7 mm and an axial length of 70 mm, where "mm" represents the physical unit of millimetres.

[0052] The HNB device 100 is configured to vaporise the aerosol former 202 by heating the aerosol former 202 (so as to form a vapour/aerosol for inhalation by a user) by means of a heater system.

[0053] The consumable 200 includes a device end 204 and a mouth end 206. In use, the device end 204 is received into the HNB device 100 while the mouth end 206 extends from the HNB device 100 for a user to engage. The device end 204 and the mouth end 206 may be structurally different, for example the mouth end 206 may include a filter.

[0054] The HNB device 100 comprises a chamber 110 which includes a consumable cavity 120 and a heater compartment 130.

[0055] The consumable cavity 120 is a generally elongate recess, which may also be referred to as a consumable slot into which the consumable 200 is insertable. In this example, the consumable cavity 120 is substantially cylindrical. Suitably, the consumable 200 is insertable into the consumable cavity 120 through the consumable opening 102 in the insertion direction 105. In some examples, the insertion direction 105 is perpendicular to the consumable opening 102.

[0056] The consumable cavity 120 terminates at a slot end 122, which in this example is an axial end of the cylindrical slot 120. In use, the consumable 200 is insertable until the consumable 200 engages the slot end 122.

[0057] The heater compartment 130 extends alongside the consumable cavity 120 in the insertion direction 105. In particular, the heater compartment 130 extends along a part but not the whole of the consumable cavity 120. The heater compartment 130 is located closer to the slot end 122 than the consumable opening 102. As shown in Figure 2, the heater compartment 130 extends from the slot end 122 towards, but not all the way to, the consumable opening 102.

[0058] The consumable cavity 120 includes a lower portion 124 (or 'first portion') which is alongside the heater compartment 130, and an upper portion 126 (or 'second portion') which extends between the consumable opening 102 and the lower portion 124.

[0059] An IR heater 140 is arranged alongside the consumable cavity 120 in the heater compartment 130 of the chamber 110. The IR heater 140 extends along a part but not the whole of the consumable cavity 120. More particularly, the IR heater 140 is arranged parallel to the consumable cavity 120 such that, in use, the IR heater 140 extends parallel to the consumable 200 when received into the consumable cavity 120.

[0060] The IR heater 140 is a device to generate IR radiation, i.e. infrared radiation, for heating of the consumable 200 when the consumable 200 is received into the consumable cavity 120. IR radiation may include radiation of wavelengths in a range of 1 millimetre to 700 nanometres. Any suitable choice of IR heater 140 may be used, e.g. an IR pin heater or a flat panel IR heater.

[0061] The IR heater 140 is spaced from the consumable cavity 120. In this example, the IR heater 120 is located substantially centrally in the heater compartment 130. As such, the IR heater 120 is spaced approximately 3 millimetres from the consumable cavity 120. Due to the rounded cross-sectional shapes of the IR heater 140 and the consumable cavity 120, this is a minimum separation between the IR heater 140 and the consumable cavity 120 of 3 millimetres.

[0062] Figures 3 and 4 are cross-sectional views of the HNB device 100. In particular, Figure 3 is a cross-sectional view of the HNB device 100 where a cross-section has been taken through the HNB device 100 in the insertion direction 105. Figure 4 is a cross-section taken

perpendicular to the insertion direction 105.

[0063] An IR reflective surface 150 extends about the consumable cavity 120 and the IR heater 140. The IR reflective surface 150 extends around the consumable cavity 120 and the IR heater 140, thereby bounding the consumable cavity 120 and the heater compartment 130 in a direction perpendicular to the insertion direction 105. The IR reflective surface 150 further bounds the consumable cavity 120 in the insertion direction 105. The IR reflective surface 150 further bounds the heater compartment 130 in the insertion direction 105 and in the opposite direction. In Figure 3, the IR reflective surface 150 is shown as a dotted line.

[0064] In this example, the IR reflective surface 150 fully encloses the consumable cavity 120 and the IR heater 140 in a direction perpendicular to the insertion direction 105.

[0065] The IR reflective surface 150 is configured to reflect IR radiation incident on the IR reflective surface 150 More particularly, the IR reflective surface 150 has a suitable IR reflectance, which is a numerical value in a range from 0 to 1 and quantifies how much IR radiation is reflected by the IR reflective surface 150. For example, a surface with IR reflectance of 0 would reflect 0 percent of the incident IR radiation, whereas a surface with IR reflectance of 1 would reflect 100 percent of the incident IR radiation. In the present example, an IR reflectance of at least 0.95 is provided such that at least 95 percent of IR radiation is reflected. Notably, the specified value of IR reflectance may not apply to the whole wavelength range of IR radiation, but may instead apply to a particular subset of IR radiation as emitted by the IR heater 140 when the HNB device 100 is in use.

[0066] To achieve the desired IR reflectance, any suitable means may be utilised. For example, a suitable coating may be provided to line the chamber 110, or the chamber 110 may be formed in a body of a suitable choice of metal and provided with a polished surface to achieve the desired IR reflectance. In this example, the IR reflective surface 150 is provided by the internal surface of the chamber 110.

[0067] An IR transmissive window 160 (see Figures 3 and 4; not shown in Figure 2) is arranged between the consumable cavity 120 and the IR heater 140. The IR transmissive window 160 provides a physical barrier between the consumable cavity 120 and the IR heater 140, e.g. to prevent particulates released from the consumable 200 from reaching the IR heater 140, while allowing IR radiation to pass through the IR transmissive window 160. The IR transmissive window 160 has a suitable IR transmissivity, which is a numerical value in a range from 0 to 1 and quantifies how much IR radiation is transmitted through the IR transmissive window 160. For example, IR transmissivity of 0 would mean that 0 percent of the incident IR radiation is transmitted, whereas IR transmissivity of 1 would mean 100 percent of the incident IR radiation is transmitted. In the present example, an IR transmissivity of at least 0.8, preferably at least 0.9, and more preferably at least 0.95 may be suitable. That is to say, at least 80 percent of IR radiation may be transmitted, preferably at least 90%, and more preferably at least 95 percent. As mentioned with reference to the IR reflectance, it is noted also here that the specified value of IR transmissivity may apply to a particular range or ranges of IR wavelengths, as are generated by the IR heater 140, as opposed to the whole spectrum of IR wavelengths.

[0068] As shown in Figure 3, the IR transmissive window 160 is arranged between the consumable cavity 120 and the heater compartment 140, thus separating the consumable cavity 120 and the heater compartment 140.

[0069] The IR transmissive window 160 is arranged to bound the consumable cavity 120 in a direction perpendicular to the insertion direction 105. In combination, the IR reflective surface 150 and the IR transmissive window 160 entirely bound the lower portion 124 of the consumable cavity 120 towards the slot end 122.

[0070] In this example, the upper portion 126 of the consumable cavity 120 has a substantially cylindrical shape and the IR transmissive window 160 is configured to match, and thereby extend, the cylindrical shape of the upper portion 126 also to the lower portion 124 of the consumable cavity 120. That is to say, the IR transmissive window 160 continues the shape of the consumable cavity 120.

[0071] In use, insertion of the consumable 200 into the HNB device 100 through the consumable opening 102 by a user causes the consumable 200 to be received into the consumable cavity 120. Insertion of the consumable 200 causes the consumable 200 to be located alongside the IR heater 140. More particularly, the device end 204 of the consumable 200 is located alongside the IR heater 140 on insertion into the consumable cavity 120.

[0072] The HNB device 100 is configured to generate aerosol/vapour for inhalation by the user through heating of the consumable 200 by means of the IR heater 140 as part of a session. Suitably the IR heater 140 is configured to heat the consumable 200 to a suitable temperature, e.g. of approximately 290 degrees Celsius. Conveniently, the IR heater 140 is electrically connectable to a power source 180, for example when the consumable 200 is engaged with the HNB device 100.

[0073] The IR heater 140 emits IR radiation which may directly or indirectly reach the consumable 200. For example, IR radiation may reach the consumable 200 directly after passing through the IR transmissive window 160. For example, IR radiation may reach the consumable 200 after being reflected by the IR reflective surface 150, e.g. before or after passing through the IR transmissive window 160. For example, IR radiation may be absorbed by the IR transmissive window 160, with the heat generated by the absorption subsequently conducted towards the consumable 200.

[0074] Figures 5, 6 and 7 illustrate operation of the HNB system 10 based on numerical simulation of the HNB system 10. Figures 5 and 6 show a temperature

distribution of the consumable 200 at 30 seconds and 360 seconds, respectively, following initiation of heating by the IR heater 140. Figure 7 shows a temperature profile of the IR heater 140.

[0075] Following initiation of heating, the IR heater 140 is heated to a temperature exceeding 500 degrees Celsius within a pre-heating period. In this example, the pre-heating period may be less than or around 30 seconds.

[0076] At around 30 seconds from initiation of heating, the consumable 200 has a minimum temperature of approximately 27 degrees Celsius and a maximum temperature of approximately 316 degrees Celsius.

[0077] After around 30 seconds from initiation of heating, the temperature of the IR heater 140 is relaxed to a temperature in a range of 300 to 350 degrees Celsius.

[0078] At around 360 seconds from initiation of heating, the consumable 200 has a minimum temperature of approximately 137 degrees Celsius and a maximum temperature of approximately 324 degrees Celsius.

[0079] A HNB device 100 as described above may provide more gradual and progressive heating. For example, the consumable may be heated from one side by using a single-sided heating method, i.e. the IR heater 140 located at one side of the consumable 200. Moreover, the consumable 200 is placed inside the chamber 110 which is provided with the IR reflective surface 150 such that heat may more gradually progress through the consumable 200 during the session.

[0080] The HNB device 100 described above includes a single IR heater 140. In some examples, a plurality of IR heaters 140 may be provided. For example, a second IR heater 140 could be placed on the left side in addition to the IR heater 140 on the right side of the consumable cavity 120, with reference to Figure 4. According to such examples, the IR reflective surface extends about the consumable cavity and the plurality of IR heaters 140.

[0081] Where a plurality of IR heaters 140 is provided, a corresponding plurality of heater compartments 130 may be provided. The IR heaters 140 may be distributed across the heater compartments 130 such that a single IR heater 140 is provided in each heater compartment 130 of the plurality of heater compartments 130.

[0082] Where a plurality of IR heaters 140 is provided, the IR heaters 140 may be operated simultaneously or may be operated sequentially. Sequentially operating the IR heaters 140 is understood to activating a particular heater 140 or subset of the plurality of heaters 140 for a pre-determined period of time. After expiry of said pre-determined period of time, a different heater 140 or different subset of heaters 140 is activated for another pre-determined period of time. Thus, zonal heating may be achieved where the heaters 140 are spaced around the consumable cavity 120 and activated in sequence.

[0083] The HNB device 100 as described above may provide some or all of the following advantages:

- more gradual heating than may be achievable for all-round outside-in heating;
- no piercing of the consumable, which may reduce residue in the chamber and be beneficial for device cleaning;
- multiple heaters may be used to heat different sides of the consumable in sequence.

[0084] The features disclosed in the foregoing description, or in the following claims, or in the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for obtaining the disclosed results, as appropriate, may, separately, or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

[0085] While the invention has been described in conjunction with the exemplary embodiments described above, many equivalent modifications and variations will be apparent to those skilled in the art when given this disclosure. Accordingly, the exemplary embodiments of the invention set forth above are considered to be illustrative and not limiting. Various changes to the described embodiments may be made without departing from the spirit and scope of the invention.

[0086] For the avoidance of any doubt, any theoretical explanations provided herein are provided for the purposes of improving the understanding of a reader. The inventors do not wish to be bound by any of these theoretical explanations.

[0087] Any section headings used herein are for organizational purposes only and are not to be construed as limiting the subject matter described.

[0088] Throughout this specification, including the claims which follow, unless the context requires otherwise, the words "have", "comprise", and "include", and variations such as "having", "comprises", "comprising", and "including" will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

[0089] It must be noted that, as used in the specification and the appended claims, the singular forms "a," "an," and "the" include plural referents unless the context clearly dictates otherwise. Ranges may be expressed herein as from "about" one particular value, and/or to "about" another particular value. When such a range is expressed, another embodiment includes from the one particular value and/or to the other particular value. Similarly, when values are expressed as approximations, by the use of the antecedent "about," it will be understood that the particular value forms another embodiment. The term "about" in relation to a numerical value is optional and means, for example, +/- 10%.

[0090] The words "preferred" and "preferably" are used herein refer to embodiments of the invention that may provide certain benefits under some circumstances. It is to be appreciated, however, that other embodiments may also be preferred under the same or different cir-

cumstances. The recitation of one or more preferred embodiments therefore does not mean or imply that other embodiments are not useful, and is not intended to exclude other embodiments from the scope of the disclosure, or from the scope of the claims.

Claims

1. A HNB device (100), comprising:

   a consumable cavity (120);
   an IR heater (140) arranged beside the consumable cavity, the IR heater for heating a consumable (200) received into the consumable cavity; and
   an IR reflective surface (150) which extends about the consumable cavity and the IR heater.

2. The HNB device according to claim 1,

   wherein the HNB device comprises a chamber (110) which includes the consumable cavity and a heater compartment (130) alongside the consumable cavity,
   wherein the IR heater is located in the heater compartment.

3. The HNB device according to claim 1 or 2,
   wherein an IR transmissive window (160) is arranged between the consumable cavity and the IR heater to provide a physical barrier between the consumable cavity and the IR heater.

4. The HNB device according to claim 3,
   wherein the IR transmissive window has an extent along the consumable cavity which is at least as great as an extent of the IR heater along the consumable cavity.

5. The HNB device according to claim 3 or 4,
   the consumable cavity has a substantially cylindrical shape and the IR transmissive window is configured to match the cylindrical shape of the consumable cavity.

6. The HNB device according to any one of claims 3 to 5,
   wherein the IR transmissive window has an IR transmissivity of at least 0.8, preferably at least 0.9, and more preferably at least 0.95.

7. The HNB device according to any preceding claim, wherein

   the HNB device comprises a plurality of IR heaters (140), and
   the IR reflective surface encloses the consumable cavity and the plurality of IR heaters.

8. The HNB device according to claim 7,
   wherein the IR heaters are configured to sequentially heat the chamber.

9. The HNB device according to claim 7 or 8,
   wherein the plurality of IR heaters is equidistantly spaced about the consumable cavity.

10. The HNB device according to any one of claims 7 to 9,
    wherein a first IR heater of the plurality of IR heaters and a second IR heater of the plurality of IR heaters are located on opposite sides of the consumable cavity.

11. The HNB device according to any one of claims 7 to 10,
    wherein the HNB device comprises a chamber (110) which includes the consumable cavity and a plurality of heater compartments (130) alongside the consumable cavity, wherein an IR heater of the plurality of IR heaters is located in each heater compartment.

12. The HNB device according to any preceding claim, wherein the IR reflective surface has a reflectance of at least 0.9, preferably of at least 0.95.

13. The HNB device according to any preceding claim, wherein the IR heater is arranged substantially parallel to the consumable cavity.

14. A HNB system comprising the HNB device according to any preceding claim and a consumable (200).

15. The HNB system according to claim 14, wherein the consumable, when received into the consumable cavity, extends parallel to the IR heater.

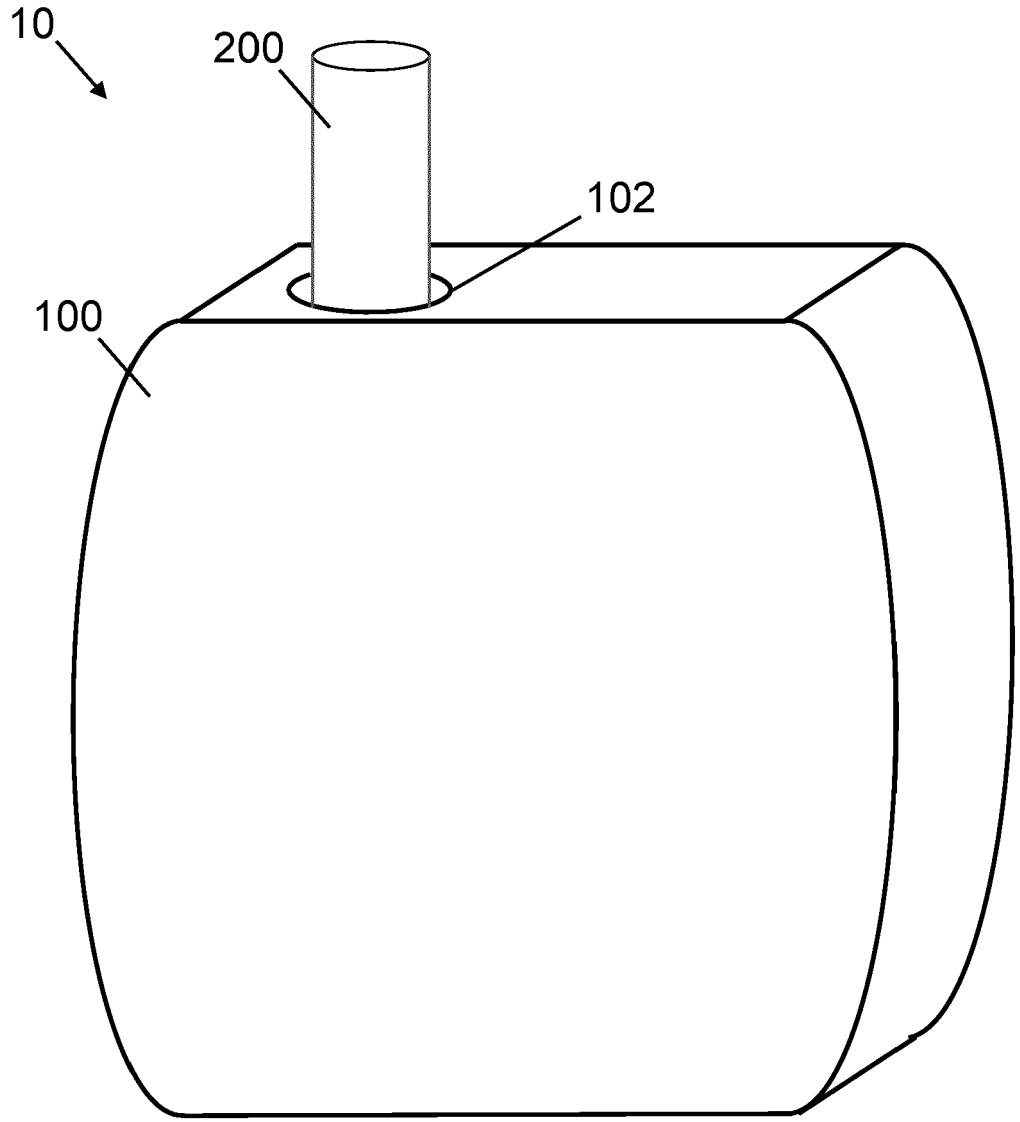

Fig. 1

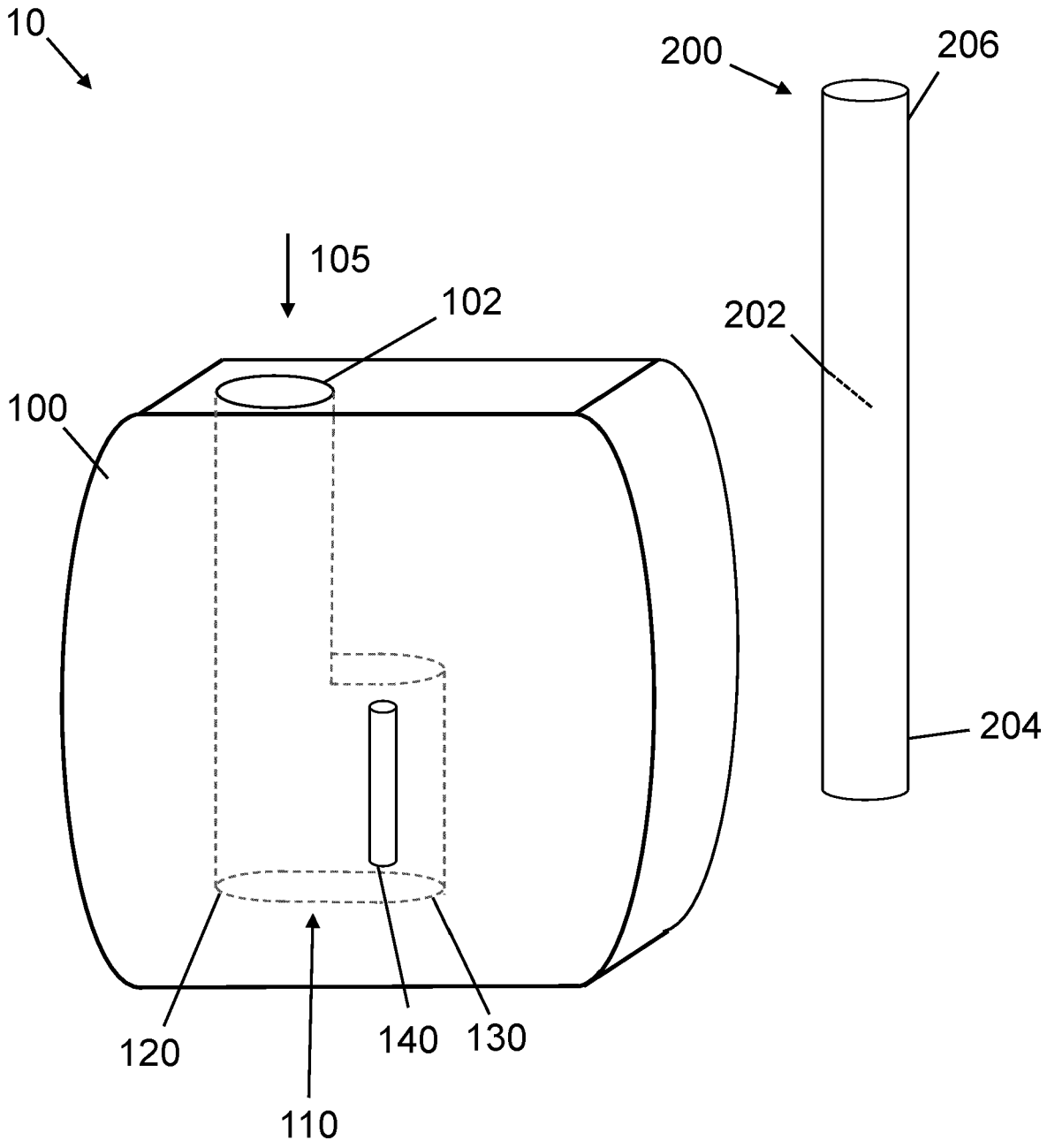

Fig. 2

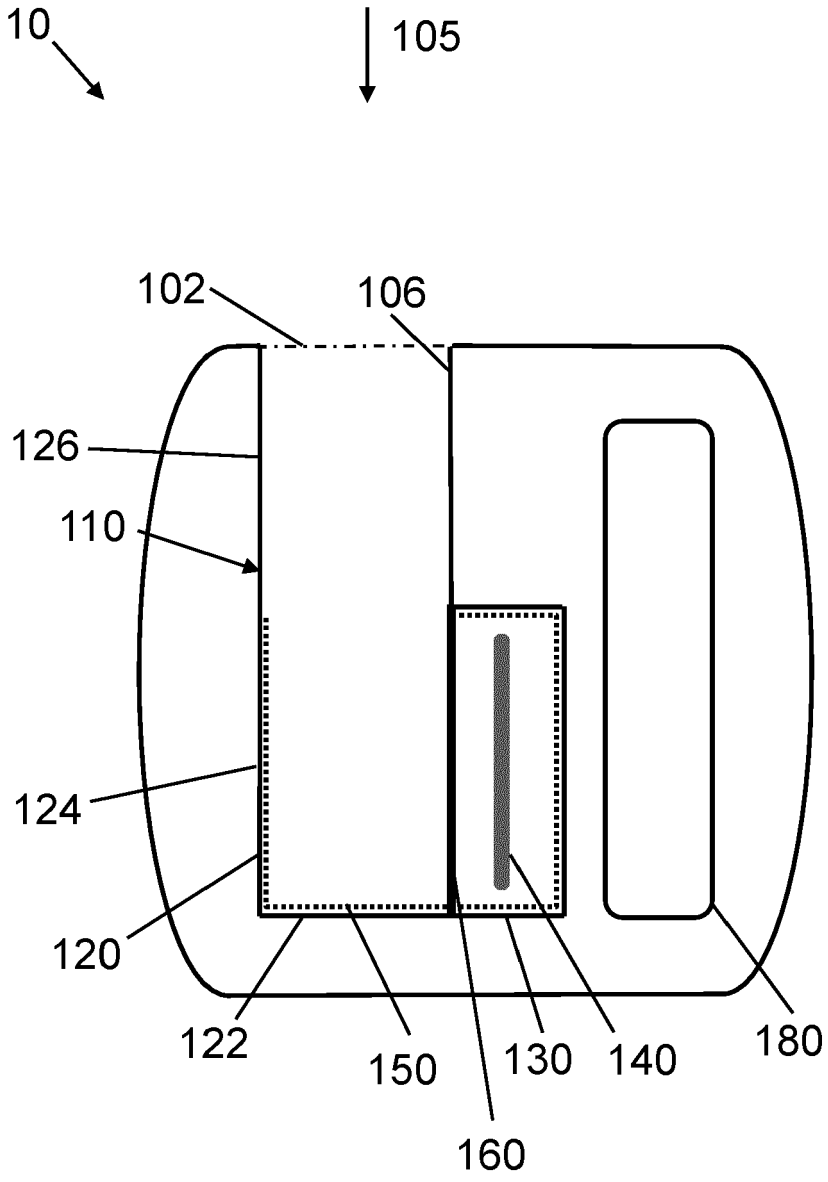

Fig. 3

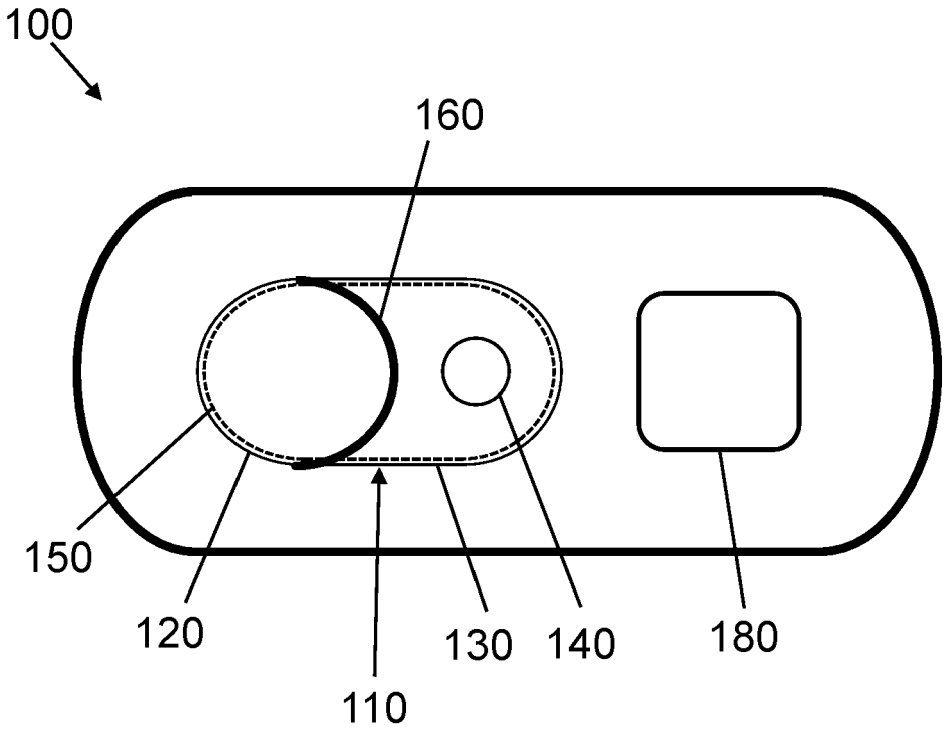

Fig. 4

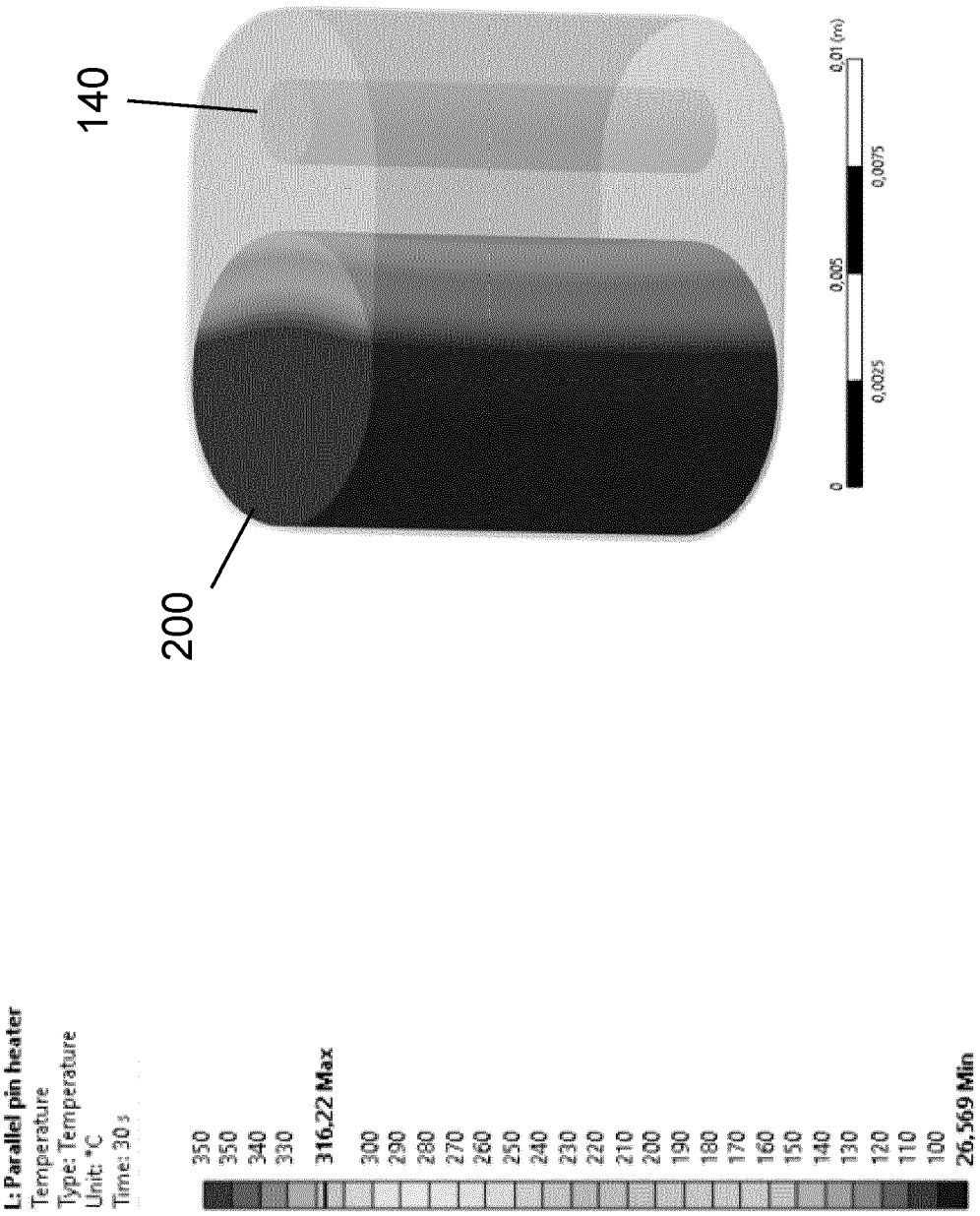
140
200
0,01 (m)
0,0075
0,005
0,0025
0
L: Parallel pin heater
Temperature
Type: Temperature
Unit: °C
Time: 30 s
350
350
340
330
316,22 Max
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
26,569 Min

Fig. 5

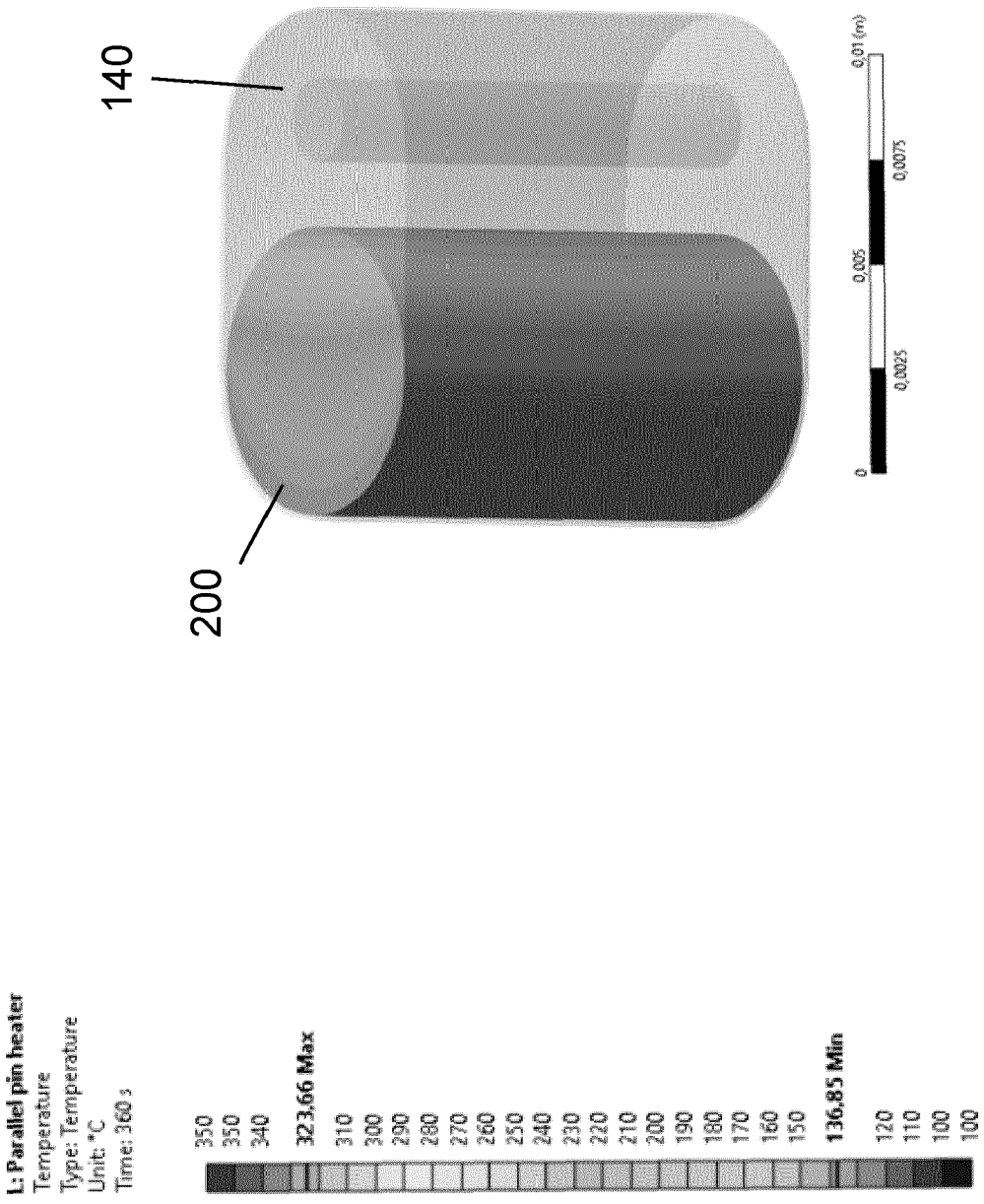
140
200
0,01 (m)
0,0075
0,005
0,0025
0
L: Parallel pin heater
Temperature
Type: Temperature
Unit: °C
Time: 360 s
350
350
340
323,66 Max
310
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
136,85 Min
120
110
100
100

Fig. 6

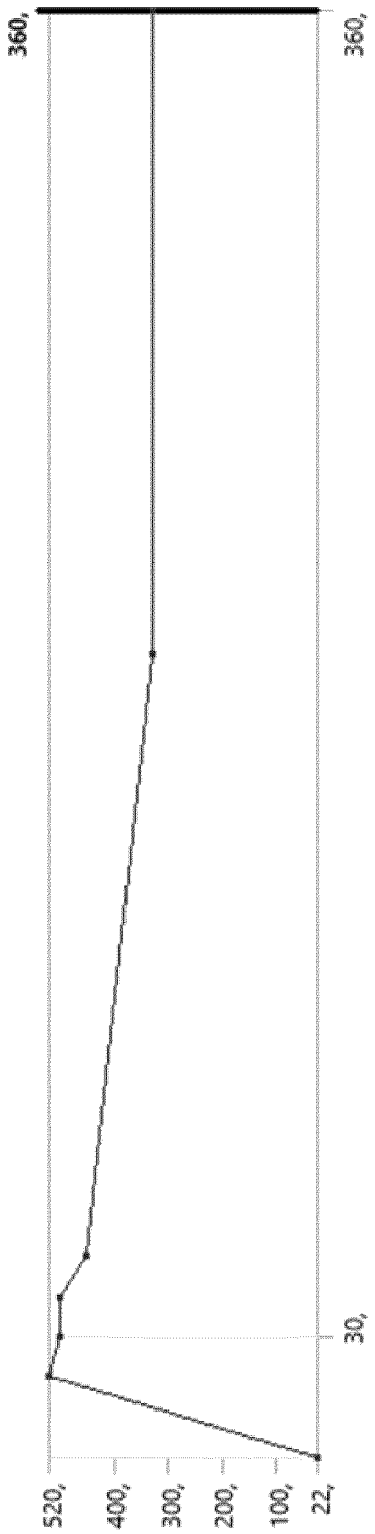

Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 23 19 1164

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A24F
H05B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	2 January 2024	Dobbs, Harvey

CATEGORY OF CITED DOCUMENTS

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