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

(57) There is provided a HNB device (100), comprising: a heater chamber (120) including a plurality of heater elements (140); a consumable cavity (160) formed between the heater elements, the consumable cavity for receiving a consumable (200) in an insertion direction (105); wherein the consumable cavity includes a first section (162) which converges in the insertion direction.

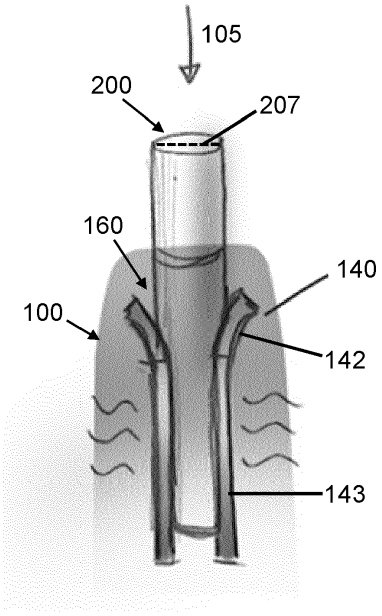

Fig. 6

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Description

Field of the Invention

[0001] The present invention relates to a heat-not-burn smoking substitute device.

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 a convergent section in a consumable cavity of a HNB device.

[0006] According to a first aspect of the present invention, there is provided a HNB device comprising: a heater chamber including a plurality of heater elements; a consumable cavity formed between the heater elements, the consumable cavity for receiving a consumable in an insertion direction; wherein the consumable cavity includes a first section which is convergent in the insertion direction.

[0007] Optionally, the HNB device further comprises a consumable opening in the HNB device through which the consumable is receivable into the consumable cavity.

[0008] Optionally, the first section of the consumable cavity is located towards the consumable opening Optionally, the consumable cavity has a wide end which opens towards the consumable opening.

[0009] Optionally, the wide end of the consumable cavity is approximately as wide or wider than the consumable opening, as measured in a direction perpendicular to the insertion direction.

[0010] Optionally, the consumable cavity includes a second section which, with reference to the insertion direction, follows the first section of the consumable cavity.

[0011] Optionally, the second section is convergent in the insertion direction.

[0012] Optionally, the second section is non-convergent in the insertion direction.

[0013] Optionally, the second section is non-convergent and non-divergent in the insertion direction.

[0014] Optionally, each heater element of the plurality of heater elements comprises a first portion and a second portion, wherein the first portion is provided at a first angle greater than zero relative to the insertion direction, and the first section of the consumable cavity is formed between the first portions.

[0015] Optionally, the first angle is greater than zero and less than 45 degrees, preferably less than 30 degrees, and more preferably less than 20 degrees.

[0016] Optionally, each second portion is provided at a second angle relative to the insertion direction, wherein the second angle is smaller than the first angle.

[0017] Optionally, the second angle is less than 10 degrees and greater than zero degrees.

[0018] Optionally, the second angle is approximately zero degrees.

[0019] Optionally, the heater elements are panel heaters.

[0020] According to a second aspect of the present invention, there is provided a HNB system comprising a HNB device as described above and a consumable receivable into the consumable cavity of the HNB device.

[0021] Optionally, the consumable is receivable into the consumable cavity to cause compression of the consumable between the heater elements.

[0022] Optionally, the consumable is substantially cylindrical when not inserted into the consumable cavity and has a consumable diameter when not inserted into the consumable cavity.

[0023] Optionally, an engagement area is formed where the consumable and each heater element are in engagement.

[0024] Optionally, each engagement area has a width, measured in a direction perpendicular to the insertion direction, which is greater than the consumable diameter.

[0025] Optionally, the consumable cavity is configured to compress a width of the consumable in a direction perpendicular to the insertion direction to 80 percent or less.

[0026] Optionally, the consumable cavity is configured to compress the width of the consumable in the direction perpendicular to the insertion direction to 70 percent or less.

[0027] Optionally, the consumable is substantially cylindrical when not inserted into the consumable cavity.

[0028] Optionally, an engagement area is formed where the consumable and each heater element are in engagement.

[0029] Optionally, each engagement area has a width, measured in a direction perpendicular to the insertion direction, which is greater than a consumable radius of the consumable when not inserted into the consumable cavity.

[0030] Optionally, the consumable cavity of the HNB device includes a second section which, with reference to the insertion direction, follows the first section of the consumable cavity.

[0031] Optionally, the consumable, when inserted into

the consumable cavity, engages at least 80 percent of a heat-generating surface of each heater element in the second section of the consumable cavity.

[0032] 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

[0033] 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 including a HNB device and a consumable, showing the HNB device and the consumable in an engaged state.

Figure 2 is another perspective view of the HNB system of Figure 1, showing the HNB device and the consumable in a disengaged state.

Figure 3 is perspective view of part of the HNB device of Figure 1.

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

Figure 5 is a cross-sectional view of part of the HNB device and the consumable of Figure 1.

Figure 6 is a cross-sectional view of part of the HNB device and the consumable of Figure 1.

Figure 7 is a perspective view of the consumable of Figure 1 in the engaged state.

Figure 8 is a perspective view of a conventional consumable.

Detailed Description of the Invention

[0034] 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.

[0035] 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.

[0036] 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.

[0037] 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.

[0038] 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).

[0039] 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.

[0040] 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.

[0041] 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.

[0042] 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).

[0043] 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.

[0044] 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.

[0045] 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.

[0046] 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.

[0047] 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.

[0048] 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.

[0049] 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.

[0050] 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.

[0051] 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.

[0052] 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.

[0053] 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.

[0054] 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).

[0055] 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).

[0056] 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.

[0057] 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.

[0058] 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. 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. The consumable 200 is insertable into the HNB device 100 through the consumable opening 102 in an insertion direction 105. In some examples, the insertion direction 105 is perpendicular to the consumable opening 102.

[0059] 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.

[0060] The consumable 200 comprises an aerosol-former 202. 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). Suitably, the HNB device 100 comprises a heating system comprising a heater chamber 120 including a plurality of heater elements 140.

[0061] The consumable 200 has 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 for inhalation. The device end 204 and the mouth end 206 may be structurally different, for example the mouth end 206 may include a filter.

[0062] Figures 3 and 4 illustrate parts of the HNB device 100. The HNB device 100 is shown partially transparent in Figure 3 such that components otherwise concealed can be seen. Figure 4 is a cross-sectional view showing the heater elements 140 and the consumable cavity 160 as intersected by a plane including the insertion direction 105.

[0063] The heater elements 140 are arranged in the heater chamber 120 and form a consumable cavity 160 between the heater elements 140. The consumable cavity 160 is for receiving the consumable 200 in the insertion direction 105. More particularly, the consumable cavity 160 is configured to receive the consumable 200 through the consumable opening 102 of the HNB device 100.

[0064] The consumable cavity 160, which is formed between the heater elements 140, has a first end 161, a first section 162, a second section 163, and a second end 164. In some examples, the consumable cavity 160 may also be referred to as a consumable slot.

[0065] The first end 161 and the second end 164 are opposite ends of the consumable cavity 160. In Figure 4, the first end 161 and the second end 164 are indicated by dashed-dotted lines. The first section 162 and the second section 163 of the consumable cavity 160 are located between the first end 161 and the second end 164. More particularly, the first section 162 is located towards the

first end 161 while the second section 163 is located towards the second end 164. Thus, the first section 162 is between the first end 161 and the second section 163, and the second section 163 is between the first section 162 and the second end 164.

[0066] The first end 161 of the consumable cavity 160 opens towards the consumable opening 102. In use, the consumable 200 is received into the consumable cavity 160 through the first end 161 of the consumable cavity 160. In this example, the first end 161 of the consumable cavity 160 is wider than consumable opening 102, which may be convenient for insertion of the consumable 200 into the consumable cavity 160. The width of first end 161 of the consumable cavity 160 and the width of the consumable opening 102 are measured in a direction perpendicular to the insertion direction 105.

[0067] The first section 162 of the consumable cavity 160 is located towards the consumable opening 102. With reference to the insertion direction 105, the first section 162 of the consumable cavity 160 follows the first end 161 of the consumable cavity 160.

[0068] The first section 162 of the consumable cavity 160 converges in the insertion direction 105. That is to say, a width 165 of the consumable cavity 160, as measured perpendicular to the insertion direction 105, decreases in the insertion direction 105 along the first section 162. More particularly, the width 165 of the consumable cavity 160 changes over the first section 162 from a larger width corresponding to the first end 161 to a narrower width corresponding to the width of the second section 163 which, in this example, has the same width as the second end 164. In Figure 4, the width 165 of the consumable cavity 160 is indicated by a double-headed arrow.

[0069] The second section 163 is located away from the consumable opening 102. Conversely, the second section 163 is located towards the second end 164 of the consumable cavity 160. The second section 163 follows the first section 162 of the consumable cavity 160, with reference to the insertion direction 105.

[0070] In Figures 3 and 4, the second section 163 is neither convergent nor divergent, i.e. is non-convergent and non-divergent. As such, the second section 163 has a width which is substantially constant along the insertion direction 105.

[0071] In Figures 3 and 4, the second section 163 is a comparatively long section of the consumable cavity 160. In some examples, the second section 163 is longer than the first section 164, as measured along the insertion direction 105. In some examples, the second section 163 is longer than it is wide, where the length of the second section 163 is measured along the insertion direction 105 and the width of the second section 163 is measured in a direction perpendicular to the insertion direction 105.

[0072] As shown in Figure 3, two heater elements 140 are provided on opposite sides of the heater chamber 120 and, accordingly, bound the consumable cavity 160 in a direction perpendicular to the insertion direction 105. More particularly, the heater elements 140 include heat-generating surfaces 141 which are arranged to face each other, and the consumable cavity 160 is bounded by the heat-generating surfaces 141. In use, heat from the heat-generating surfaces 141 is transferred to the consumable 200 when the consumable 200 is located in the consumable cavity 160.

[0073] Each heater element 140 has a first portion 142 and a second portion 143. The first section 162 of the consumable cavity 160 is formed between the first portions 142 of the heater elements 140. Suitably, the first portion 142 of at least one heater element 140 is arranged at a first angle relative to the insertion direction 105, where the first angle is greater than zero degrees and is less than 45 degrees. For example, the first angle may be approximately 15 degrees.

[0074] The second section 163 of the consumable cavity 160 is formed between the second portions 143 of the heater elements 140. In this example, the second section 163 of the consumable cavity 160 has a constant width and, as such, the second portions 143 of the heater elements 140 are parallel to the insertion direction 105. More generally, the second portion 143 of at least one heater element 140 is arranged at a second angle relative to the insertion direction 105, where the second angle may be approximately zero degrees or may be greater than zero degrees. For example, the second angle may be less than 10 degrees; preferably less than 6 degrees, and more preferably less than 4 degrees. In some examples, the second angle may be 2 or 3 degrees. As noted, in the present example the second angle is zero degrees for each second portion 143 of the heater elements 140.

[0075] Figure 5 is a cross-sectional view of the consumable 200 located between the heater elements 140, where the cross-section has been taken through a plane perpendicular to the insertion direction 105. In particular, the consumable 200 is shown between the second portions 143 of the heater elements 140.

[0076] As shown in Figure 5, the consumable 200 is compressed between the heater elements 140 when the consumable 200 is received into the consumable cavity 160. That is to say, the consumable 200 is brought from an uncompressed configuration (shown in Figure 2) into a compressed configuration shown in Figure 5. In some examples, the consumable 200 is deformed from a circular cross-section to a flattened cross-section, e.g. an obround cross-section.

[0077] In some examples, the consumable cavity 160 is configured to compress an (uncompressed) width of the consumable 200 in a direction perpendicular to the insertion direction 105 to 80 percent or less of the (uncompressed) width; or to 70 percent or less of the (uncompressed) width.

[0078] In some examples, the consumable 200 engages the majority of the heat-generating surface 141 of the second portion 143 of the heater elements 140. For example, the consumable 200 may engage at least 80

percent of the heat generating surface 141 of the second portion 143; or may engage at least 90 percent of the heat generating surface 141 of the second portion 143; or may engage approximately 100 percent of the heat generating surface 141 of the second portion 143.

[0079] In some examples, the consumable 200 is substantially cylindrical when in the uncompressed configuration, and has a consumable diameter 207 (indicated in Figure 6 by a dashed line) when in the uncompressed configuration. The consumable diameter 207 may be, for example, 7 mm. Upon insertion into the consumable cavity 160, the consumable 200 and the heater elements 140 are brought into in engagement to form an engagement area 208 where each heater element 140 engages the consumable 200 (shown as dashed lines in Figure 5).

[0080] Each engagement area 208 has a width, which is measured in a direction perpendicular to the insertion direction 105, which in some examples is greater than half of the (uncompressed) consumable diameter 207, i.e. greater than the consumable radius. For example, the engagement area 208 may have a width exceeding 3.5 mm.

[0081] Figures 6 and 7 illustrate the HNB system 10 in the engaged state and in operation. Figure 6 shows a cross-section of the HNB system 10 intersected by a plane including the insertion direction 105. Figure 7 illustrates a temperature distribution of a portion of the consumable 200 which is in the compressed configuration.

[0082] 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 160 formed between the heater elements 140.

[0083] 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 heater elements 140 as part of a session. Suitably the heating elements 140 are configured to heat the consumable 200 to a suitable temperature, which may be between 200 degrees Celsius and 300 degrees Celsius. Conveniently, the heater elements 140 are electrically connectable to a power source 180, for example when the consumable 200 is engaged with the HNB device 100.

[0084] 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 heater chamber 120 and, in particular, the consumable cavity 160 formed between the heater elements 140.

[0085] The first section 162 of the consumable cavity 160 guides the consumable 200 into the consumable cavity 160, and compresses the consumable 200 as the consumable 200 is pushed by the user towards the second section 163 of the consumable cavity 160. Thus, the consumable 200 is compressed from the initial uncompressed configuration to the compressed configuration wherein at least part of the consumable 200 is compressed.

[0086] When the consumable 200 is received into the consumable cavity 160 and compressed, the consumable 200 is heated by the heater elements 140. Thus, the HNB device 100 may be said to provide a "waffle iron" configuration wherein physical compression and heat are applied by the HNB device 100 to the consumable 200. As a result of the compression, contact area between the consumable 200 and the heater elements 140 may be increased and heat transfer to the consumable 200 may be improved such that an improved temperature distribution may be achieved. In particular, a more uniform heat distribution throughout the consumable 200 and a higher average temperature of the consumable 200 may be achieved when compared to a conventional pin heater arrangement.

[0087] In Figure 7, the consumable 200 is compressed into an obround shape with a cross-section having flat segments and curved segments (also shown in Figure 5). Regions 210 of highest temperature are found at the flat segments, which is where the heater elements 140 (not shown in Figure 7) engage the consumable 200. Regions 220 of lowest temperature are at the outermost tips of the curved segments.

[0088] Figure 8 illustrates a temperature distribution of a consumable 300 heated by a pin heater 400 located centrally within the consumable 300. A region of highest temperature 310 surrounds the pin heater 400 at the axial centre of the consumable 300, and temperature drops rapidly with increasing distance to the centre of the consumable 300 to the minimum value at the surface of the consumable.

[0089] It is noted that pin heater-based devices may be limited in their performance due to comparatively small heating surface area, and may have problems with consumable debris in their heating chambers due to piercing of the consumable.

[0090] As such, the consumable 200 compressed between the heater elements 140 may be heated with improved heat distribution to a higher average temperature than the consumable 300 heated by the pin heater 400. For example, the consumable 200 may be heated to an average temperature of 202 degrees Celsius while the consumable 300 may be heated to an average temperature of 165 degrees Celsius.

[0091] In the case of the consumable 200, maximum temperature was approximately 320 degrees Celsius and minimum temperature was approximately 112 degrees Celsius. In the case of the consumable 300, maximum temperature was approximately 302 degrees Celsius and minimum temperature was approximately 108 degrees Celsius.

[0092] By achieving improved heat distribution throughout the consumable, energy consumption may be improved as exceptionally high heater temperature may not be needed for achieving sufficient consumable temperature. Moreover, a higher average consumable temperature may be achieved as a result of improved heat distribution in the consumable.

[0093] Thus, some or all of the following advantages

may be provided by an HNB device as described above:

- increased heater surface area which may enable faster and more uniform heating;
- improved thermal contact by gently compressing/squeezing a consumable (e.g. a round stick) into a flattened shape which may improves heat transfer and provide faster heating;
- flat heater elements may be utilised, which may be more cost-effective to manufacture or procure than, for example, cylindrical outside-in heaters;
- outside-in heating may be provided, thus allows for a closed consumable (e.g. stick) and little to no cleaning. Even without a closed end consumable, less cleaning may be needed (compared to an internal pin heater for instance) since the heater is not directly contacting the substrate material (e.g. tobacco).

[0094] By forming the consumable cavity between the heater elements and, in particular, the convergent first section of the consumable cavity also being formed between the heater elements, heating of the consumable may be improved and available space in the HNB device and particularly the heater chamber may be utilised more efficiently. Also, construction of the HNB device may be simplified. Moreover, having the first section formed by the heater elements may also reduce or entirely remove alignment issues that may arise where a separate funnel structure is utilised.

[0095] By having the wide end of the consumable cavity at least as wide as the consumable opening, guidance of the consumable insertion of the consumable may be improved.

[0096] Where the second section of the consumable cavity is convergent, haptic feedback to a user may be improved during insertion of the consumable. That is to say, the resistance provided by a convergent second section to insertion of the consumable may be improved, for example such that potential damage to the consumable as a result of excessive insertion may be avoided.

[0097] The HNB device 100 described above has two heater elements 140, but any plurality of heater elements may be provided.

[0098] The heater elements 140 described above and shown in the Figures each have a straight first portion which is inclined relative to a straight second portion. In some examples, the heater elements may include curved portions, for example curved first portions, curved second portions or both curved first and second portions.

[0099] 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.

[0100] 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.

[0101] 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.

[0102] Any section headings used herein are for organizational purposes only and are not to be construed as limiting the subject matter described.

[0103] 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.

[0104] 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%.

[0105] 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 circumstances. 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 heater chamber (120) including a plurality of heater elements (140);

a consumable cavity (160) formed between the heater elements, the consumable cavity for receiving a consumable (200) in an insertion direction (105);
wherein the consumable cavity includes a first section (162) which is convergent in the insertion direction.

2. The HNB device according to claim 1,

further comprising a consumable opening in the HNB device for receiving the consumable into the consumable cavity; and
wherein the first section of the consumable cavity is located towards the consumable opening.

3. The HNB device according to claim 2, wherein

the consumable cavity has a wide end (161) which opens towards the consumable opening, and
the wide end of the consumable cavity is approximately as wide or wider than the consumable opening, as measured in a direction perpendicular to the insertion direction.

4. The HNB device according to any preceding claim, wherein the consumable cavity includes a second section (163) which, with reference to the insertion direction, follows the first section of the consumable cavity.

5. The HNB device according to claim 4,
wherein the second section is convergent in the insertion direction.

6. The HNB device according to claim 4,
wherein the second section is non-convergent and non-divergent in the insertion direction.

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

each heater element of the plurality of heater elements comprises a first portion (142) and a second portion (143) and the first portion of each heater element is provided at a first angle greater than zero relative to the insertion direction, and
the first section of the consumable cavity is formed between the first portions of the heater elements.

8. The HNB device according to claim 7,
wherein the first angle is less than 45 degrees, preferably less than 30 degrees, and more preferably less than 20 degrees.

9. The HNB device according to claim 7 or 8,

wherein each second portion is provided at a second angle relative to the insertion direction, wherein the second angle is smaller than the first angle.

10. The HNB device according to claim 9,
wherein the second angle is greater than zero degrees and less than 10 degrees, preferably less than 6 degrees, and more preferably less than 4 degrees.

11. The HNB device according to claim 9,
wherein the second angle is approximately zero degrees.

12. A HNB system (10), comprising:

a HNB device (100) according to any preceding claim, and
a consumable (200) receivable into a consumable cavity (160) of the HNB device;
wherein the consumable is receivable into the consumable cavity to cause compression of the consumable between heater elements (140) of the HNB device.

13. The HNB system according to claim 12,
wherein the consumable cavity is configured to compress a width of the consumable in a direction perpendicular to an insertion direction (105) to 80 percent or less, and preferably 70 percent or less.

14. The HNB system according to claim 12 or 13, wherein

the consumable is substantially cylindrical when not inserted into the consumable cavity and has a consumable diameter (207) when not inserted into the consumable cavity; and
an engagement area (208) is formed where the consumable and each heater element are in engagement, and
wherein each engagement area has a width, measured in a direction perpendicular to the insertion direction, which is greater than half of the consumable diameter.

15. The HNB system according to any one of claims 12 to 14,

wherein the consumable cavity of the HNB device includes a second section (163) which, with reference to the insertion direction (105), follows the first section of the consumable cavity;
wherein the consumable, when inserted into the consumable cavity, engages at least 80 percent of a heat-generating surface (141) of each hea-

ter element in the second section of the consumable cavity.

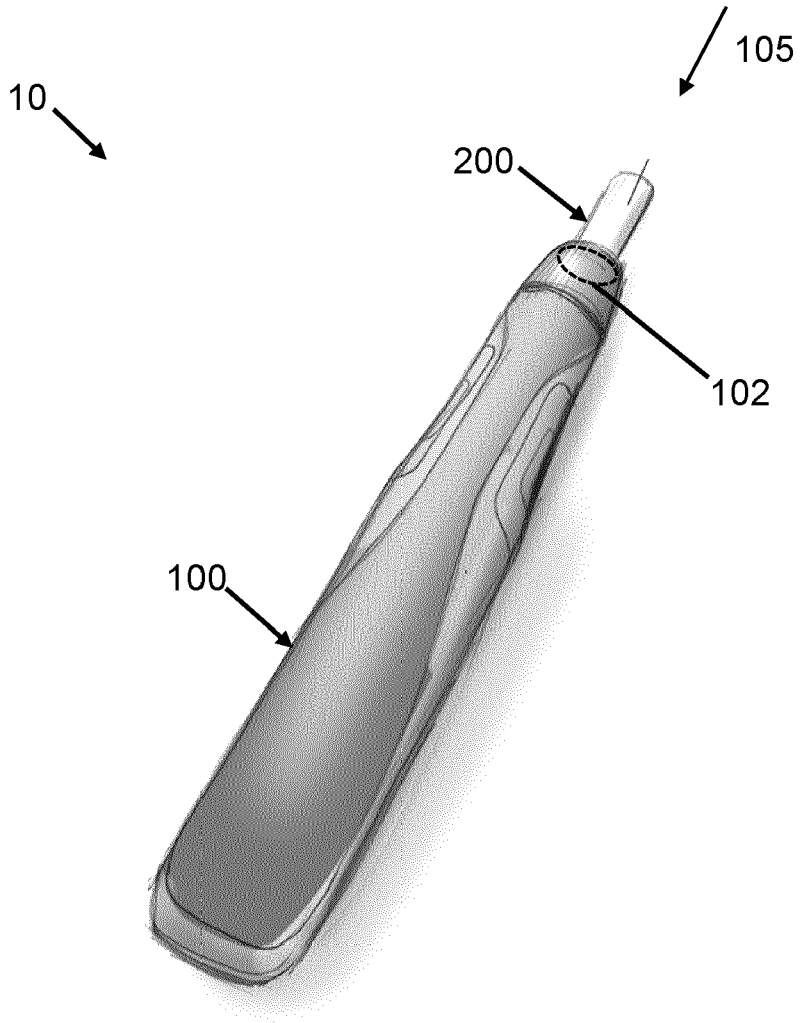

Fig. 1

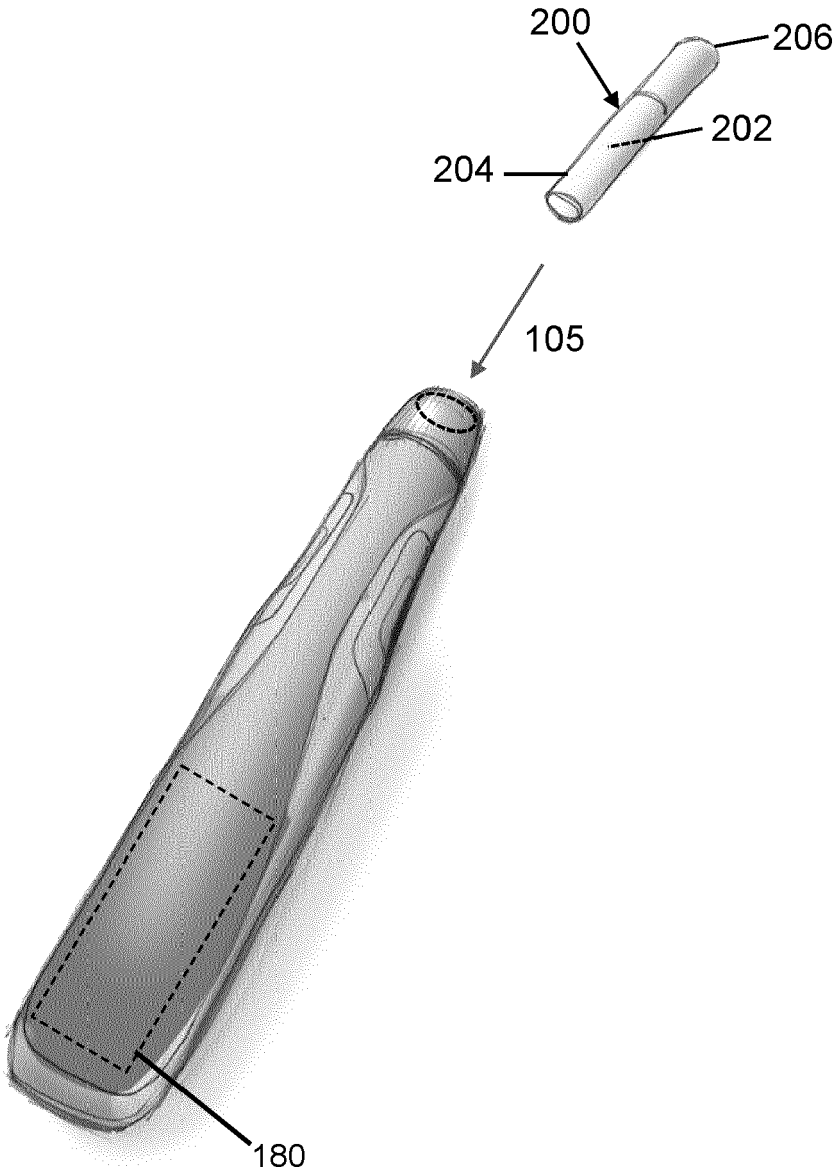

Fig. 2

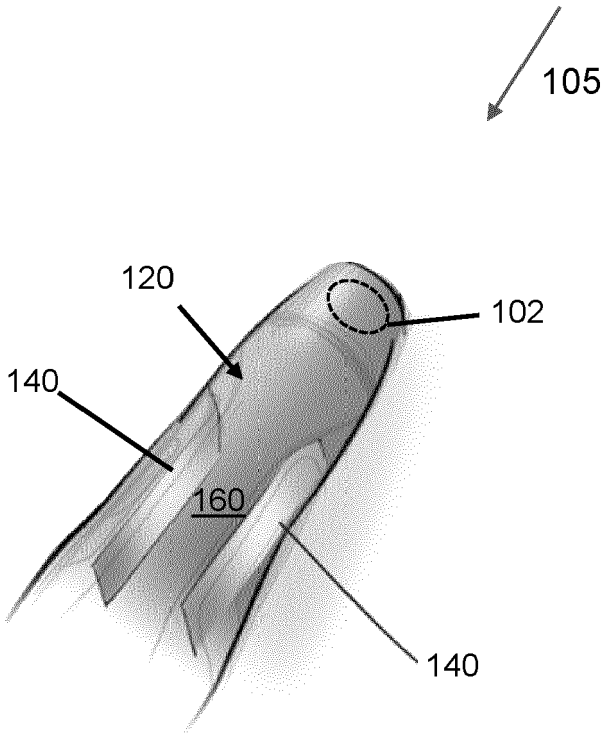

Fig. 3

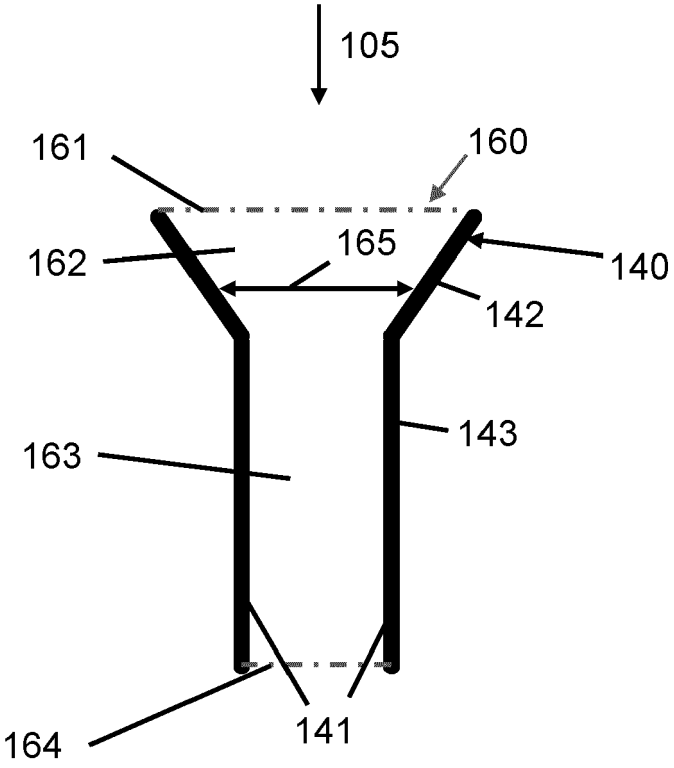

Fig. 4

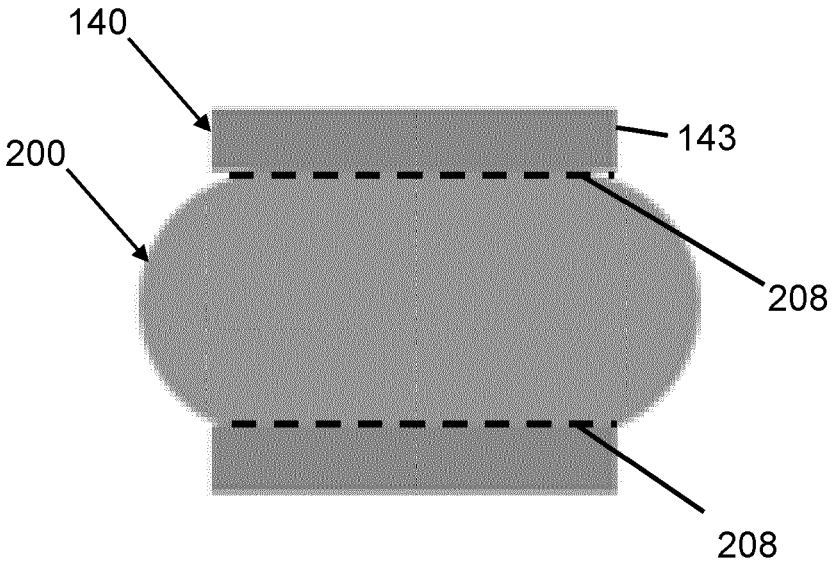

Fig. 5

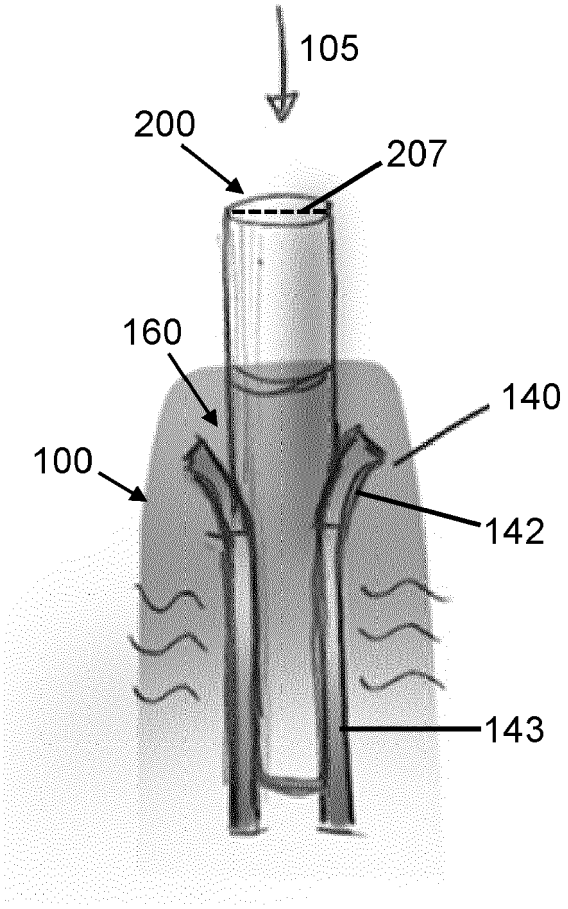

Fig. 6

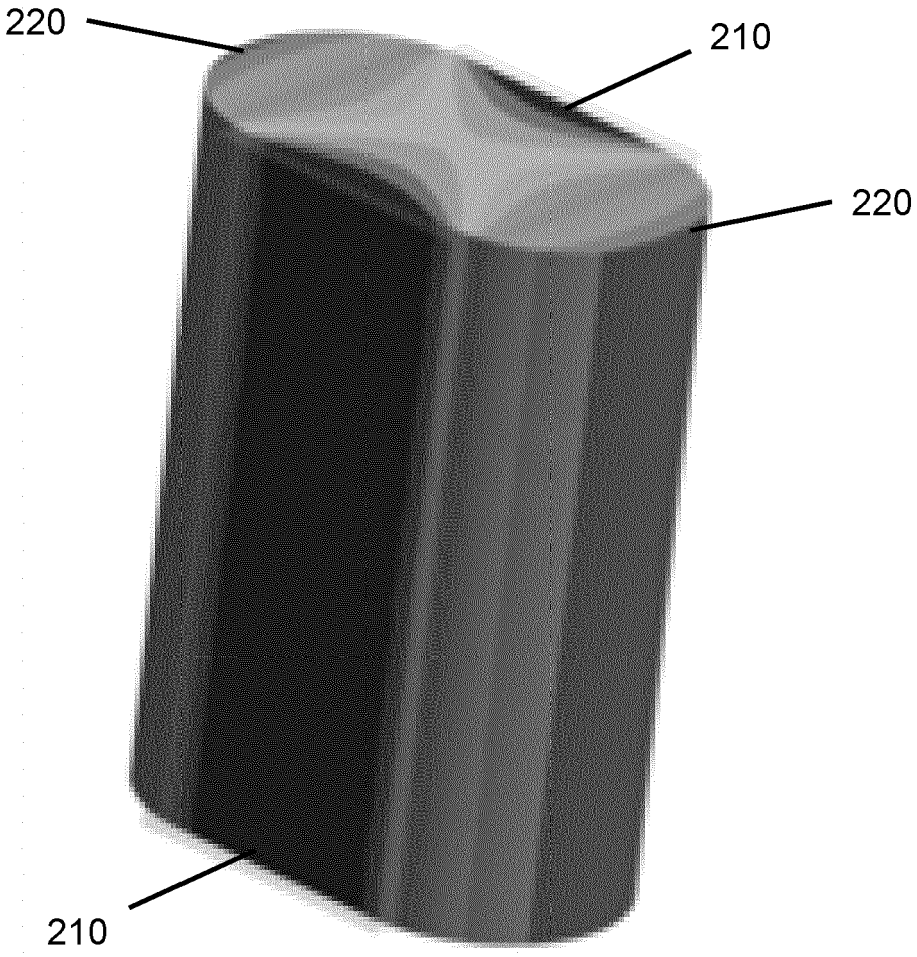

Fig. 7

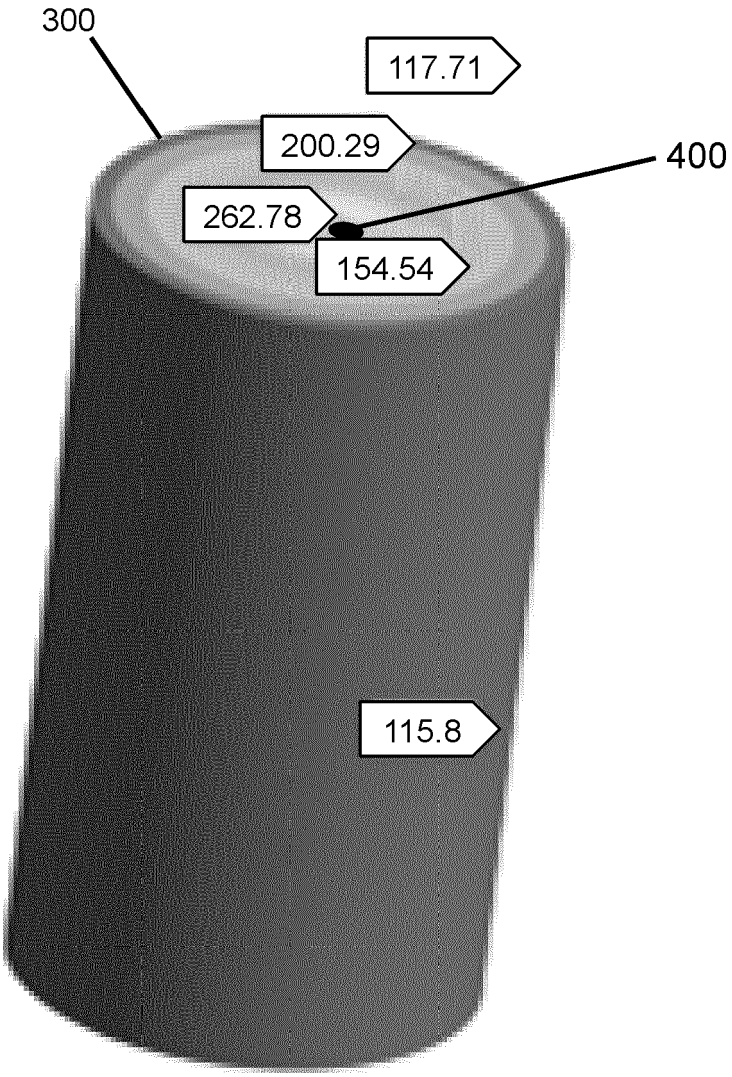

Fig. 8

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Application Number
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A24D
A24F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	24 January 2024	Marzano Monterosso

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