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(71) Applicant: **Imperial Tobacco Limited**
Bristol, BS3 2LL (GB)

(72) Inventor: **The designation of the inventor has not yet been filed**

(74) Representative: **Mewburn Ellis LLP**
Aurora Building
Counterslip
Bristol BS1 6BX (GB)

(54) A METHOD OF MANUFACTURE OF AN AEROSOL GENERATING APPARATUS

(57) A method of manufacture of an aerosol generating apparatus is described. The aerosol generating apparatus includes an electric heater. The method includes performing a first measurement of an electrical property of the heater in a first physical configuration to obtain a first measured value. Mechanically manipulating the heater into a second physical configuration. Performing a second measurement of the electrical property of the heater after mechanically manipulating the heater to obtain a second measured value. Based on a comparison of the first measured value and the second measured value, a determination of the heater having been damaged during the mechanical manipulation is made. Heaters damaged during manufacture can thus be rejected during the manufacture process.

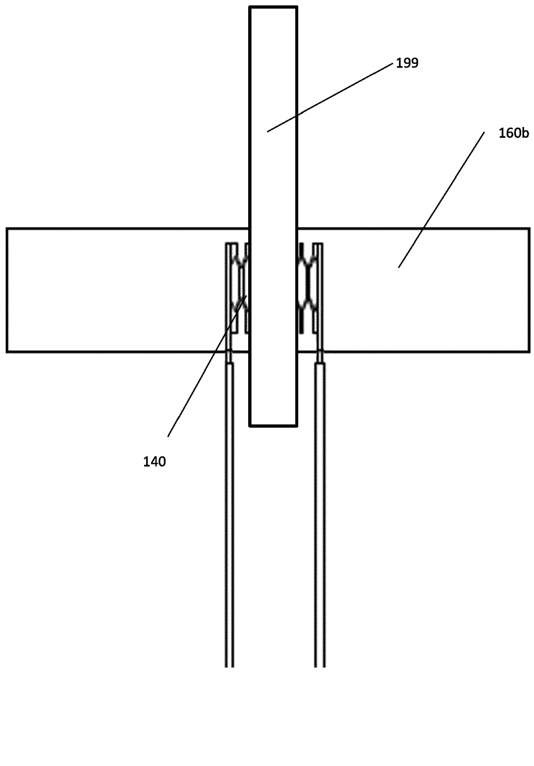

Fig. 8

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Description

FIELD

[0001] The present disclosure relates to a method of manufacture of an aerosol generating apparatus.

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. The aerosol generating unit often includes an electrical heater to generate the aerosol.

[0003] A drawback with known aerosol generating apparatuses is that during manufacture the electrical heater can be damaged during manufacture. Such heaters may not perform as intended.

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

SUMMARY

[0005] In a first aspect the present disclosure provides a method of manufacture of an aerosol generating apparatus, the aerosol generating apparatus including an electric heater. In some embodiments, the aerosol generating device is configured to deliver an aerosol to a user for inhalation by the user, in use.

[0006] In some examples, the method includes: performing a first measurement of an electrical property of the heater in a first physical configuration to obtain a first measured value; mechanically manipulating the heater into a second physical configuration; performing a second measurement of the electrical property of the heater after mechanically manipulating the heater to obtain a second measured value; based on the a comparison of the first measured value and the second measured value, making a determination of the heater having been damaged during the mechanical manipulation.

[0007] In this way, damage to the heater during mechanical manipulation of the heater caused during manufacture can be identified. Damaged heaters can then be rejected from the manufacturing process. End users can thereby avoid encountering a damaged or ineffective heater in the aerosol generating apparatus.

[0008] In some examples, the first physical configuration is planar. In this way, the heater can easily be produced from, for example, a flat precursor heater substrate, and therefore easily handled and stored. In some examples the heater is formed from a planar metal sheet. In some examples, the heater is flat stamped from a planar metal sheet.

[0009] In some examples, the second physical configuration is tubular. In this way, tubular heater, which has been mechanically manipulated to form the tubular configuration, can be detected as damaged. Tubular heaters, having a 3-dimensional form, may be particularly susceptible to damage during formation of the tubular form and or during handling during the manufacture process. Tubular heaters may be particularly useful in aerosol generating system since the tubular form can provide a cavity into which a wicking element can be located. In other examples tubular form can provide an airflow path which naturally passes over or close to the heater (the location of precursor vapourisation).

[0010] In some examples, the mechanical manipulation includes wrapping the heater around a mandrel to impart the tubular second physical configuration. In this way, the wrapping of the heater around a mandrel is a particular manipulation during which damage to the heater may occur. Detecting such damage is thus particularly beneficial. The mandrel provides a stable and well defined surafce against which to form the tubular heater. This gives consistent shape and size to the tubular heater.

[0011] In some examples, the mechanical manipulation includes withdrawing the mandrel from the heater in second physical configuration. The withdrawing of the mandrel from the heater is a mechanical manipulation during which damage to the heater may be occur since the heater is in physical contact with the heater prior to and during withdrawal. Checking for and detecting heater damage may thus particularly beneficial in such examples.

[0012] In some examples, the mechanical manipulation includes engaging the heater with an aerosol precursor wicking element. The wicking element may have a porous structure. The engagement of the heating element with the wicking element is a mechanical manipulation during which damage to the heater may occur. For example parts of the heater element may become snagged on or bent by the material of the wicking element. Checking for and detecting heater damage may thus particularly beneficial in such examples.

[0013] In some examples, the wicking element at least partially surrounds the heater in the second physical configuration. A wicking element that at least partially surrounds the heater may be particularly susceptible to damaging the heater element during manufacture. Checking for and detecting heater damage may thus particularly beneficial in such examples.

[0014] In some examples, the mechanical manipulation includes installing the heater in an aerosol generating apparatus, for example installing within a housing of the aerosol generating apparatus. Installing the heater element in the aerosol generating apparatus is a mechanical manipulation during which damage to the heater may occur. For example, the heating element may need to be squeezed to achieve installation. Damage may occur. Checking for and detecting heater damage at this point may thus particularly beneficial. The heater element may be installed into a body of the aerosol generating apparatus. The heater may be installed into a heater assembly of the aerosol generating apparatus.

[0015] In some examples, the second measurement is performed after installing the heater in the aerosol generating appparatus. In this way, the heater may be checked for damage in it's final location in the aeorosl generating apparatus. No further mechanical manipulations may occur after installation in the aerosol generating apparatus. Checking for and detecting heater damage at this point may thus particularly beneficial.

[0016] In some examples, the installation includes electrically connecting the heater to a pair of electrodes of the aerosol generating apparatus. In this way, the electrical connections to the heater are made prior to performing the second measurement. The making of the electrical connections may be an opportunity for damage to the heater to occur. Checking for and detecting heater damage at this point may thus particularly beneficial.

[0017] In some examples, the second measurement is performed via the pair of electrodes. In this way, the aerosol generating apparatus may perform the second measurement of the electrical parameter of the heater. This may avoid the need to access heater electrodes to perform the second measurement. Accessing the heater electrodes may be an opportunity for damage to the heater, which should be avoided.

[0018] In some examples the heater has a lattice structure. Such heaters may be particularly fragile and or liable to bending. They may therefore be particularly susceptible to damage during manufacture. Checking for and detecting heater damage for such heaters may thus be particularly beneficial.

[0019] In some examples, the method includes flat stamping a sheet of metal to form the heater in the first configuration. In this way, the heater may be particularly simple to manufacture, and to manufacture in large numbers.

[0020] In some examples, the heater includes a plurality of electrically conductive pathways. In this way, damage to such heaters can be checked and detected. Such heaters may be particularly susceptible to damage, for example partially or full short circuits being inadvertently created during mechanical manipulation. Checking for and detecting heater damage for such heaters may thus be particularly beneficial.

[0021] In some examples, the making of the determination includes comparing a difference between the first measurement and the second measurement to a predetermined difference threshold. In some examples, the percentage difference between first and second measurements is calculated. The percentage difference is then compared to a percentage change threshold.

[0022] In some examples, the electrical property is indicative of electrical resistance. This may be particularly simple to measure with low complexity measurement equipment.

[0023] In some examples the heater is flexible. Such heaters may be particularly susceptible to damage during mechanical manipulation. As such, checking for and detecting heater damage for such heaters may thus be particularly beneficial.

[0024] In some examples, the heater forms an airflow passage through the aerosol generating apparatus. In such examples, it is important that the heater maintains its tubular form for airflow maintenance. Damage to such heaters may detrimentally affect airflow performance as well as electrical / thermal performance. As such, checking for and detecting heater damage for such heaters may thus be particularly beneficial.

[0025] In some examples, the heater has electrically conductive fingers. In some examples these fingers are aligned with an airflow direction. The fingers may be particularly susceptible to being bent during mechanical manipulation. As such, checking for and detecting heater damage for such heaters may be particularly beneficial.

[0026] The preceding summary is provided for purposes of summarizing some examples to provide a basic understanding of aspects of the subject matter described herein. Accordingly, the above-described features should not be construed to narrow the scope or spirit of the subject matter described herein in any way. Moreover, the above and/or proceeding examples may be combined in any suitable combination to provide further examples, except where such a combination is clearly impermissible or expressly avoided. Other features, aspects, and advantages of the subject matter described herein will become apparent from the following text and the accompanying drawings.

BRIEF DESCRIPTION OF THE FIGURES

[0027] Aspects, features and advantages of the present disclosure will become apparent from the following description of examples in reference to the appended drawings in which like numerals denote like elements.

Fig. 1 is a block system diagram showing an example aerosol generating apparatus.

Fig. 2 is a block system diagram showing an example implementation of the apparatus of Fig. 1, where the aerosol generating apparatus is configured to generate aerosol from a liquid precursor.

Figs. 3A and 3B are schematic diagrams showing an example implementation of the apparatus of Fig. 2.

Fig. 4 is a cross section diagram showing an example implementation of aerosol generating apparatus in accordance with the present invention.

Fig. 5 is a cross section diagram showing an example implementation of heater assembly in accordance with the present invention.

Fig. 6 illustrates a heater in accordance with the present invention in a first configuration.

Fig. 7 illustrates a heater in accordance with the present invention in a second configuration.

Fig. 8 illustrates a step of mechanically manipulating

the heater from the first to the second configuration.
Fig. 9 schematically illustrates a method of manufacture of a heater according to the present invention.

DETAILED DESCRIPTION OF EMBODIMENTS

[0028] 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.

[0029] 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.

[0030] Any patents, published patent applications, and non-patent publications mentioned in the specification are hereby incorporated by reference in their entirety.

[0031] 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.

[0032] 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.

[0033] 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).

[0034] 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.

[0035] 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.

[0036] 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.

[0037] 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.

[0038] 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).

[0039] 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.

[0040] 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. 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.

[0041] As used herein, a **"storage portion"** may be a portion of the apparatus adapted to store the precursor. It may be implemented as fluid-holding reservoir or carrier for solid material depending on the implementation of the precursor as defined above.

[0042] 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.

[0043] 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.

[0044] 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. As used herein, a **"puff"** (or **"inhale"** or **"draw")** by a user may refer to expansion of lungs and/or oral cavity of a user to create a pressure reduction that induces flow through the flow path.

[0045] 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.

[0046] 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.

[0047] 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.

[0048] As used herein, **"electrical circuitry"** may refer to one or more electrical components, examples of which may include: an Application Specific Integrated Circuit (ASIC); electronic/electrical componentry (which may include combinations of transistors, resistors, capacitors, inductors etc); one or more processors; a non-transitory memory (e.g. implemented by one or more memory devices), that may store one or more software or firmware programs; a combinational logic circuit; interconnection of the aforesaid. The electrical circuitry may be located entirely at the apparatus, or distributed between the apparatus and/or on one or more external devices in communication with the apparatus, e.g., as part of a system

[0049] Referring to Fig. 1, an example aerosol generating apparatus 1 includes a power supply 2, for supply of electrical energy. The apparatus 1 includes an aerosol generating unit 4 that is driven by the power supply 2. The power supply 2 may include an electric power supply in the form of a battery and/or an electrical connection to an external power source. The apparatus 1 includes a precursor 6, which in use is aerosolised by the aerosol generating unit 4 to generate an aerosol. The apparatus 2 includes a delivery system 8 for delivery of the aerosol to a user.

[0050] Electrical circuitry (not shown in figure 1) may be implemented to control the interoperability of the power supply 4 and aerosol generating unit 6.

[0051] In variant examples, which are not illustrated, the power supply 2 may be omitted since, e.g., an aerosol generating unit implemented as an atomiser with flow expansion may not require a power supply.

[0052] Fig. 2 shows an implementation of the apparatus 1 of Fig. 1, where the aerosol generating apparatus 1 is configured to generate aerosol from a liquid precursor.

[0053] In this example, the apparatus 1 includes a device body 10 and a consumable 30.

[0054] In this example, the body 10 includes the power supply 4. The body may additionally include any one or more of electrical circuitry 12, a memory 14, a wireless interface 16, one or more other components 18.

[0055] The electrical circuitry 12 may include a processing resource for controlling one or more operations of the body 10 and consumable 30, e.g. based on instructions stored in the memory 14.

[0056] The wireless interface 16 may be configured to communicate wirelessly with an external (e.g. mobile) device, e.g. via Bluetooth.

[0057] The other component(s) 18 may include one or more user interface devices configured to convey information to a user and/or a charging port, for example (see e.g. Fig. 3).

[0058] The consumable 30 includes a storage portion implemented here as a tank 32 which stores the liquid precursor 6 (e.g. e-liquid). The tank 32 is a storage portion of the apparatus 100. The consumable 30 also includes a heating system 34, one or more air inlets 36, and a mouthpiece 38. The consumable 30 may include one or more other components 40.

[0059] The body 10 and consumable 30 may each include a respective electrical interface (not shown) to provide an electrical connection between one or more components of the body 10 with one or more components of the consumable 30. In this way, electrical power can be supplied to components (e.g. the heating system 34) of the consumable 30, without the consumable 30 needing to have its own power supply.

[0060] In use, a user may activate the aerosol generating apparatus 1 when inhaling through the mouthpiece 38, i.e. when performing a puff. The puff, performed by the user, may initiate a flow through a flow path in the consumable 30 which extends from the air inlet(s) 34 to the mouthpiece 38 via a region in proximity to the heating system 34.

[0061] Activation of the aerosol generating apparatus 1 may be initiated, for example, by an airflow sensor in the body 10 which detects airflow in the aerosol generating apparatus 1 (e.g. caused by a user inhaling through the mouthpiece), or by actuation of an actuator included in the body 10. Upon activation, the electrical circuitry 12 (e.g. under control of the processing resource) may supply electrical energy from the power supply 2 to the heating system 34 which may cause the heating system 32 to heat liquid precursor 6 drawn from the tank to produce an aerosol which is carried by the flow out of the mouthpiece 38.

[0062] In some examples, the heating system 34 may include a heating filament and a wick, wherein a first portion of the wick extends into the tank 32 in order to draw liquid precursor 6 out from the tank 32, wherein the heating filament coils around a second portion of the wick located outside the tank 32. The heating filament may be configured to heat up liquid precursor 6 drawn out of the tank 32 by the wick to produce the aerosol.

[0063] In this example, the aerosol generating unit 4 is provided by the above-described heating system 34 and the delivery system 8 is provided by the above-described flow path and mouthpiece 38.

[0064] In variant embodiments (not shown), any one or more of the precursor 6, heating system 34, air inlet(s) 36 and mouthpiece 38, may be included in the body 10. For example, the mouthpiece 36 may be included in the body 10 with the precursor 6 and heating system 32 arranged as a separable cartomizer. Figs. 3A and 3B show an example implementation of the aerosol generating device 1 of Fig. 2. In this example, the consumable 30 is implemented as a capsule/pod, which is shown in Fig. 3A as being physically coupled to the body 10, and is shown in Fig. 3B as being decoupled from the body 10.

[0065] In this example, the body 10 and the consumable 30 are configured to be physically coupled together by pushing the consumable 30 into an aperture in a top end 11 the body 10, with the consumable 30 being retained in the aperture via an interference fit.

[0066] In other examples (not shown), the body 10 and the consumable 30 could be physically coupled together in other ways, e.g., by screwing one onto the other, through a bayonet fitting, or through a snap engagement mechanism, for example.

[0067] In other examples, the body 10 and consumable 30 are effectively formed as a single unit. In such examples, the body 10 and consumable 30 are not separable.

[0068] The body 10 also includes a charging port (not shown) at a bottom end 13 of the body 10.

[0069] The body 10 also includes a user interface device configured to convey information to a user. Here, the user interface device is implemented as a light 15, which may e.g. be configured to illuminate when the apparatus 1 is activated. Other user interface devices are possible, e.g., to convey information haptically or audibly to a user.

[0070] In this example, the consumable 30 has an opaque cap 31, a translucent tank 32 and a translucent window 33. When the consumable 30 is physically coupled to the body 10 as shown in Fig. 3A, only the cap 31 and window 33 can be seen, with the tank 32 being obscured from view by the body 10. The body 10 includes a slot 15 to accommodate the window 33. The window 33 is configured to allow the amount of liquid precursor 6 in the tank 32 to be visually assessed, even when the consumable 30 is physically coupled to the body 10.

[0071] Referring to Fig. 4 an aerosol generating system 100, which may be implemented in any of the preceding examples, is shown. The aerosol generating system 100 includes an aerosol precursor tank 120 for storing a liquid aerosol precursor. The aerosol generating system 100 includes a heater assembly 135. The heater assembly 135 includes an electrically resistive heater 140. The electrically resistive heater 140 is fluidically connected to the liquid aerosol precursor housed in the tank 120 via a fluid transfer element 160. In the embodiment shown the fluid transfer element 160 is formed of an outer wicking element 160a and an inner wicking element 160b. The outer wicking element 160a is in direct fluid communication with the aerosol precursor tank 120. The inner wicking element 160b is in fluid communication with the outer wicking element 160a. In general, in this embodiment, the liquid aerosol precursor flows from the aerosol precursor tank 120, through the outer wicking element 160a, through the inner wicking element 160b, to the heater 140. The inner wicking element 160b is generally tubular. The heater 140 is generally tubular. The heater 140 generally lines an internal surface of the inner wicking element 160b. The path through the tubular heater 140, which lines the inner wicking element 160b, to the opening of a mouthpiece 180, forms an aerosol flow path 170.

[0072] In use the liquid aerosol precursor, ultimately sourced from the liquid aerosol precursor tank 120, is vapourised by the heater 140. The vapour generated is drawn along aerosol flow path 170 from the heater 140 to the mouthpiece 180, via the action of a user drawing on the mouthpiece 180. Some or all of the vapour produced at the heater 140 may condense to an aerosol before exiting the mouthpiece 180.

[0073] The aerosol generating system 100 includes a battery 190, which acts an electrical power source. The battery 190 is operatively connected to the heater 140 such the battery 190 can supply electrical power to the heater 140. In the embodiment, the battery 190 is connected to the heater 140 via a control unit 150. The control unit 150 is an example of electrical circuitry. In particular, the battery 190 is operatively connected to the control unit 150, and the heater 140 is operatively connected to the control unit 150. The heater 140 is connected to the control unit 150 via a pair of heater electrodes 145a, 145b (only one electrode is visible in Fig. 4). The control unit 150 controls the power supplied to the heater 140 from the battery 190. The control unit 150 includes a puff sensor. In the embodiment the control unit 150 supplies electrical power to the heater 140 in response to the detection of a puff by the puff sensor. In embodiments, the puff sensor is a microphone or a pressure sensor, for examples.

[0074] Figure 5 shows a detailed view of a cross section of the heater assembly 135 of Fig. 4. The heater 140 is a lattice heater. The heater 140, in situ, has a tubular form. As above, the tubular heater 140 lines an internal surface of the inner wicking element 160b. The inner wicking element 160b and heater 140 are housed within a heater housing 165. In the embodiment, the heater housing 165 is a steel tube. The heater housing 165 includes a longitudinal slot through which a portion of the inner wicking element 160b protrudes. The protruding portion of the inner wicking element 160b is in fluid contact with the outer wicking element 160a at liquid contact point 163. The heater housing 165 may also include one or more liquid flow apertures (not shown) through the housing heater housing 165 to allow aerosol precursor liquid to access the inner wick element 160b.

[0075] Prior to installation as part of the heater assembly 135, the heater 140 has a generally planar form. This form is shown in Fig. 6. In Figure 6 the lattice structure of the heater 140 is clearly seen. The lattice heater 140 is formed of a series of electrically conductive portions, which are electrically connected. As will be appreciated, the lattice heater 140 provides a plurality of conductive pathways through between the two heater electrodes 145a, 145b. The lattice heater 140 includes electrically conductive loops. The lattice heater 140 includes electrically conductive fingers 142, which extend from a central region of the lattice heater 140 in an upstream and downstream direction with reference to the airflow direction (see Fig. 4). The fingers 142 may provide structural strength to the heater 140.

[0076] In use, all of the electrically conductive elements / pathways of the heater 140 will be heated via Ohmic or resistive heating when electrical current is passed through the heater via the heater electrodes 145a, b. The lattice structure of the heater 140 gives a large surface area of the inner wicking element 160b to be heated by the heater 140. This may prevent significant hotspots forming on the inner wicking element 160b, which may otherwise cause undesirable burning of the inner wick element 160b.

[0077] Fig 7 shows the lattice heater 140 in isolation, after installation in the heater assembly 135. The heater 140 has a generally tubular form. The tubular form is clear in Figure 7.

[0078] The transition from the planar heater configuration of Fig. 6 to the tubular configuration of Fig. 7 is illustrated in Fig. 8. During manufacture of the aerosol generating apparatus, the planar heater 140 (Fig. 6) is mechanically manipulated into the tubular form (Fig. 7). In Fig. 8, the planar heater 140 is shown laid on the inner wick element 160b. In this state, the inner wicking element 160b is a planar elongate sheet of wicking material, for example a porous cotton. A cylindrical mandrel 199 is located on top of the heater 140 and inner wicking element 160b. The inner wicking element 160b and the heater 140 are wrapped around the mandrel 199 (the left and right ends of the inner wicking element 160b and left and right ends of the heater 140 would be lifted in a direction out of the page of Fig. 8). This forms the tubular heater 140, surrounded by the inner wicking element 160b. The mandrel 199 is then withdrawn from the tubular cavity that has been formed within the heater 140.

[0079] The mechanical manipulation from the first configuration of Fig. 6 to the second configuration of Fig. 7 is one example of a mechanical manipulation of the heater 140 that may inadvertently damage the heater 140.

[0080] Fig. 9 schematically illustrates a method of manufacturing the heater 140, including the installation of the heater 140 into the aerosol generating system 100. The method is described below.

[0081] Step 1: Form 205 an initial heater structure. For example, flat stamp a metal sheet to form the lattice heater 140. Immediately after flat stamping, the heater 140 has a flat, planar form or configuration.

[0082] Step 2: measure 210 via the heater electrodes 145a, b an electrical resistance of the heater 140 while the heater 140 is in the flat, planar configuration. Record that measure of resistance as a first resistance value. Measuring the first resistance value is an example of performing a first measurement of an electrical property of the heater in a first physical configuration. In this example, the electrical property is the resistance.

[0083] Step 3: mechanically manipulate 215 the heater 140 to form into a tubular form or configuration. For example, form the flat heater 140 around a cylindrical mandrel 199 to impart to the heater 140 the generally tubular form or configuration. The mandrel 199 is then withdrawn from the heater 140.

[0084] Step 4: mechanically manipulate 220 the heater 140 and inner wick element 160b to wrap the inner wick element 160b around the now tubular heater 140. In some embodiments steps 3 and 4 may be simultaneously. See Fig. 8, for example.

[0085] Step 5: mechanically manipulate 225 the heater 140 and inner wick element 160b to install the inner wicking element 160b and the heater 140 into the heater housing 165.

[0086] Step 6: mechanically manipulate 230 the heater 140 and inner wick element 160b and the heater housing 165 to install the heater housing 165 into the aerosol generating system 100. During this step the heater electrodes 145a, b are electrically connected to the control unit. This step may include installing the outer wicking element 160a.

[0087] Step 7: measure 235 an electrical resistance of the heater 140 after the heater has been mechanically manipulated at least once. For example, after the heater 140 has been installed in the aerosol generating system 100. Record that measure of resistance as a second resistance value. Measuring the second resistance value is an example of performing a second measurement of an electrical property of the heater in a second physical configuration. In this example, the electrical property is the resistance.

[0088] Step 8: compare 240 the first and second resistance values. If a difference between the resistance values exceeds a predetermined threshold resistance difference, then this may be indicative of damage having occurred to the heater 140 during one or more of the mechanical manipulation steps 215, 220, 225, 230.

[0089] Step 9: if the resistance difference exceeds the predetermined resistance threshold, reject 245 the aerosol generating system 100 that contains that heater 140. If the resistance difference does not exceed the predetermined resistance threshold, pass 250 the aerosol generating system 100 that contains that heater 140. The resistance threshold may be a percentage of the electrical resistance in the first configuration. For example, if the resistance changes between first and second configurations by more than, for example, 10%, then the heater 140 may be rejected. In some embodiments, if the measured resistance changes between the first and second configurations by greater than an expected standard deviation of the heater resistance, then the heater may be rejected. For example, if the intended (i.e., non-damaged) heater resistance is 1.2 Ohms $\pm$ 0.1 Ohms, then if the resistance changes by more than 0.1 Ohms (an example standard deviation of heater resistance) between first and second configurations, then the heater may be rejected.

[0090] In this way, aerosol generating systems 100 that include a heater 140 that has been damaged during the production process can be rejected on a production line. Rejected heaters will not therefore be used by a consumer, and the detrimental effects of using a damaged heater 140 may be avoided.

[0091] Examples of damage to the heater 140 that may be detected via this methodology include a change in the intended conductive pathways through the heater 140. For example, if the heater 140 has buckled during manufacture. The intended conductive pathways through the heater 140 are quantified via the first resistance measure. If those conductive pathways are altered during mechanical manipulation step(s), then the electrical resistance may change, which is quantified by the second resistance measurement. Comparing those two resistance measurements can therefore be used as a proxy for a change in the conductive pathways through the heater 140. In turn these changes in conductive pathways can imply damage to the physical / electrical structure of the heater 140.

[0092] For example, if the second resistance measure is much higher than the first resistance measure, there may be an open circuit between heater electrodes 145a, b - in other words the heater 140 has been broken during mechanical manipulation. Such heaters 140 can be rejected.

[0093] For example, if the second resistance measure is much lower than the first resistance measure, there may be a short circuit between heater electrodes 145a, b. The short circuit may be a full short circuit - for example the heater electrodes 145a, b are, in effect, directly electrically connected to one another. The short circuit may be partial - for example, some portions of the heater 140 may be in contact with other portions of the heater 140, effectively shorting out part of the heater 140. Both types of heater damage may be detected according to the present invention, and such heaters rejected.

[0094] In other embodiments, the heater 140 may take a different form from the lattice heater 140 of the embodiment described above. For example, the initial heater form may take the form of a length of electrically conductive wire. The mechanical manipulation of such a wire heater may include wrapping or coiling that heater wire around a wick structure. In such embodiments, the wick structure is located within a cavity formed by the wrapped or coiled wire. This contrasts with the embodiment above in which the lattice heater is located within the wick element(s). However, with a coiled wire heater configuration, the resistance of the heater may still be measured before and after mechanical manipulation, and heater damage be identified in accordance with the above methodology. Such heaters can be rejected.

[0095] In some embodiments, the second measure of resistance may be made after the heater 140 is installed in an aerosol generating apparatus 100. Indeed, in some embodiments, the aerosol generating apparatus 100 may itself perform the second resistance measure. However, in other embodiments, the second resistance measure may be performed after any or all of the mechanical manipulation steps. For example, the second resistance measure may be made after the tubular formation step.

[0096] Electrical resistance is one example of an electrical parameter of the heater 140 that may be measured and compared. It will be appreciated that other electrical parameters would also be suitable. For example, measuring the electrical current through the heater 140. That is, in some embodiments, the electrical parameter is current. In other embodiments, Voltage measured across the heater may be the electrical parameter.

[0097] In some embodiments, the heater has an intended electrical resistance (i.e., undamaged) of between 0.1 Ohms and 3.0 Ohms. In an embodiment, the heater has an intended electrical resistance (i.e., undamaged) of 1.2 Ohms $\pm$ 0.1 Ohms.

[0098] In some embodiments, there may be an additional predetermined upper resistance value against which the second measurement is checked. If the heater is measured in the second configuration to have a resistance above the predetermined upper resistance value, then the heater may be rejected as damaged. The predetermined upper resistance value may be 2.0 Ohms, for example. In some embodiments, there may be an additional predetermined lower resistance value against which the second measurement is checked. If the heater is measured in the second configuration to have a resistance below the predetermined lower resistance value, then the heater may be rejected as damaged. The predetermined lower resistance value may be 0.5 Ohms, for example.

Claims

1. A method of manufacture of an aerosol generating apparatus, the aerosol generating apparatus including an electric heater, the method including:

   performing a first measurement of an electrical property of the heater in a first physical configuration to obtain a first measured value;
   mechanically manipulating the heater into a second physical configuration;
   performing a second measurement of the electrical property of the heater after mechanically manipulating the heater to obtain a second measured value;
   based on a comparison of the first measured value and the second measured value, making a determination of the heater having been damaged during the mechanical manipulation.

2. A method according to claim 1, wherein the first physical configuration is planar.

3. A method according to claim 1 or claim 2, wherein the second physical configuration is tubular.

4. A method according to claim 3 wherein the mechanical manipulation includes wrapping the heater around a mandrel to impart the tubular second physical configuration.

5. A method according to claim 4 wherein the mechanical manipulation includes withdrawing the mandrel from the heater in second physical configuration.

6. A method according to any preceding claim, wherein the mechanical manipulation includes engaging the heater with an aerosol precursor wicking element.

7. A method according to claim 6 wherein the wicking element at least partially surrounds the heater in the second physical configuration.

8. A method according to any preceding claim, wherein the mechanical manipulation includes installing the heater in a housing of the aerosol generating apparatus.

9. A method according to claim 8 wherein the installation includes electrically connecting the heater to a pair of electrodes of the aerosol generating apparatus.

10. A method according to claim 9 wherein the second measurement is performed via the pair of electrodes.

11. A method according to any preceding claim, including flat stamping a sheet of metal to form the heater in the first configuration.

12. A method according to any preceding claim wherein the heater includes a plurality of electrically conductive pathways.

13. A method according to any preceding claim wherein the making of the determination includes comparing a difference between the first measurement and the second measurement to a predetermined difference threshold.

14. A method according to any preceding claim, wherein the electrical property is indicative of electrical resistance.

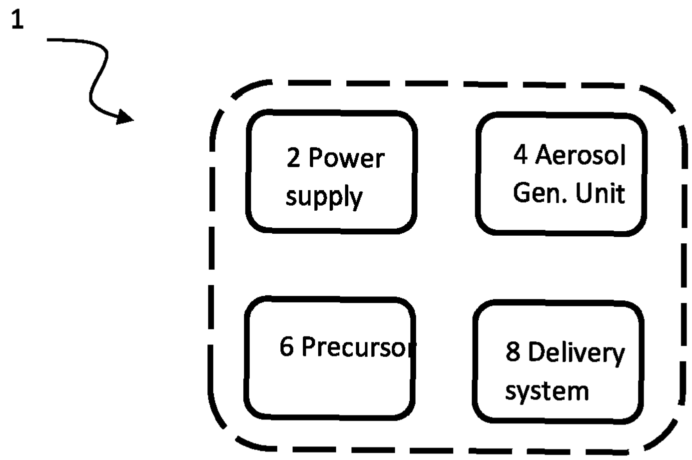
1
2 Power supply
4 Aerosol Gen. Unit
6 Precursor
8 Delivery system

Fig. 1

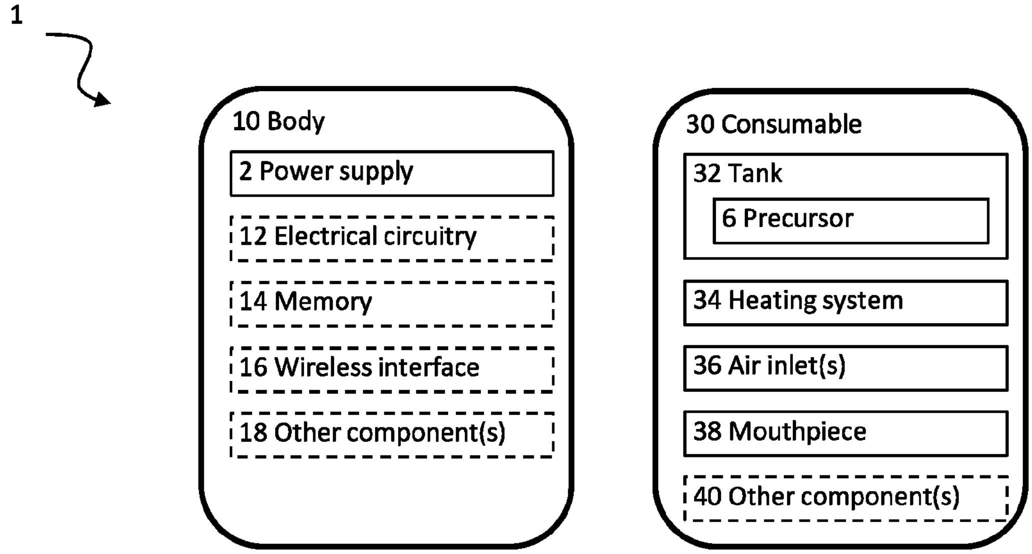

Fig. 2

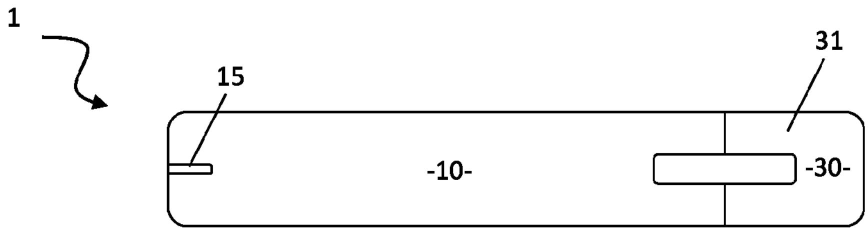

Fig. 3a

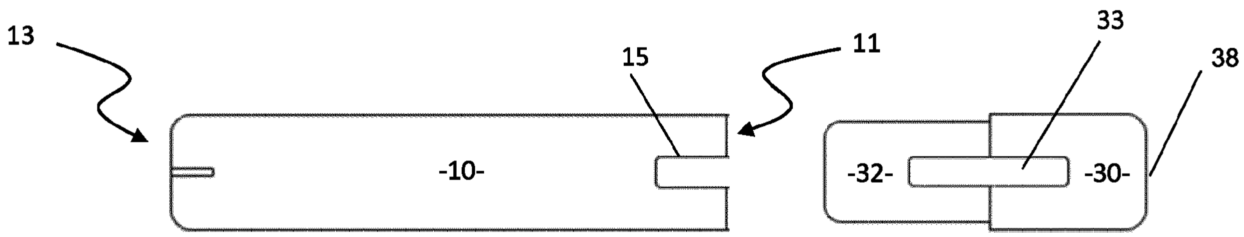

Fig. 3b

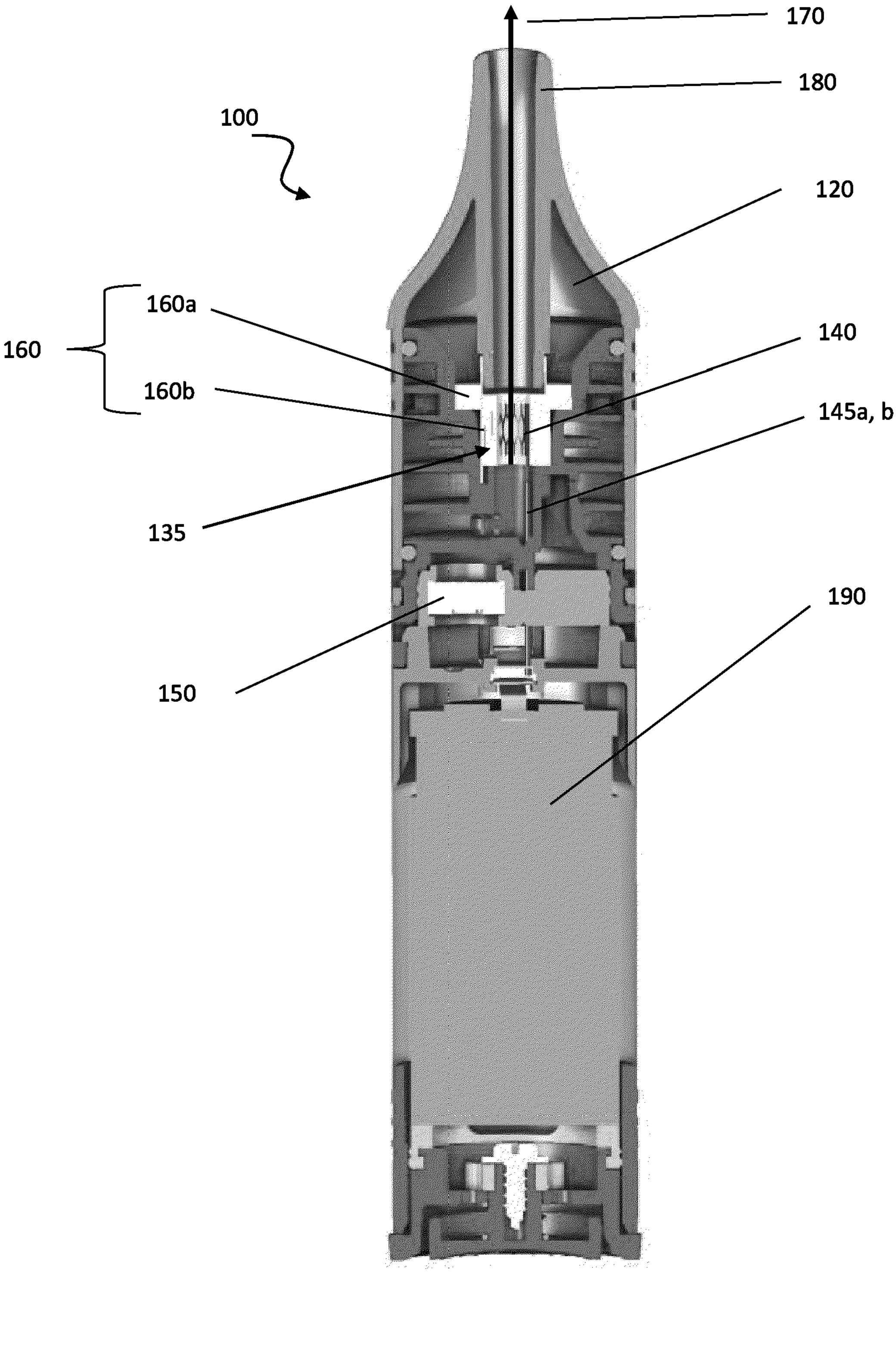

Fig. 4

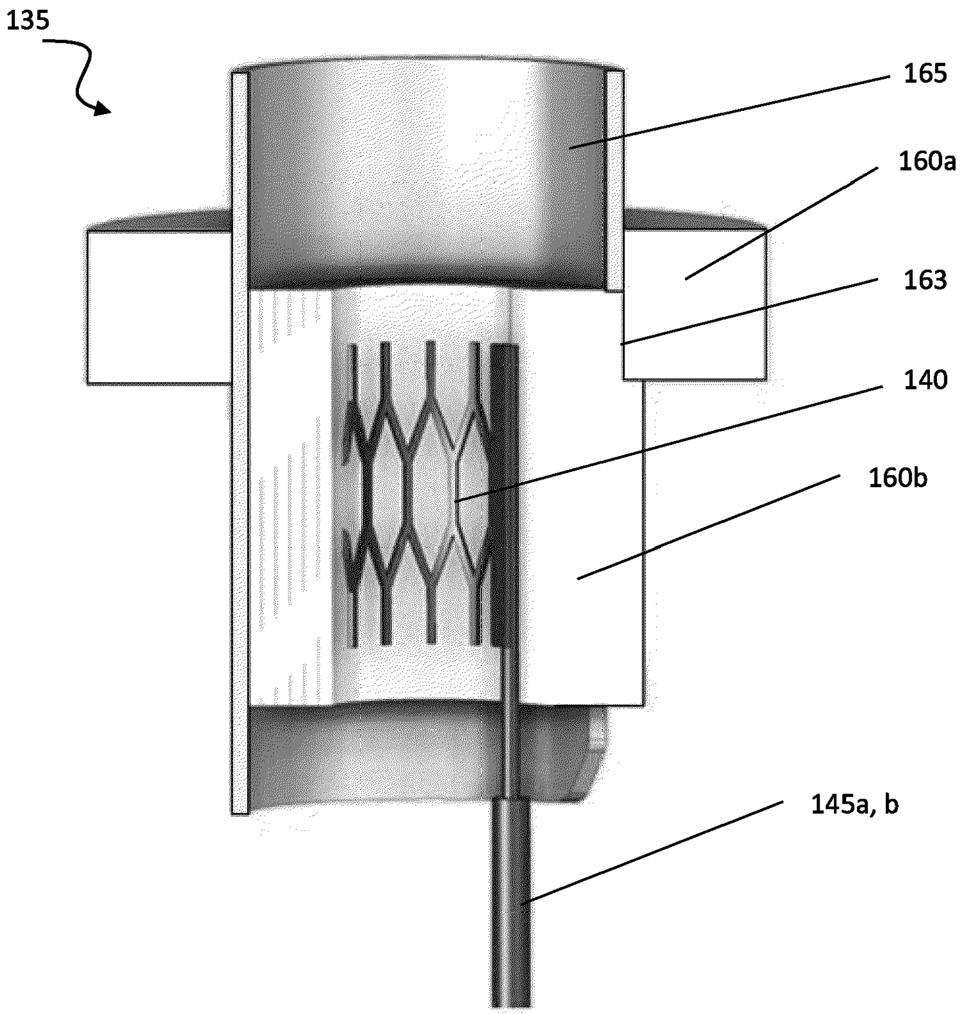

Fig. 5

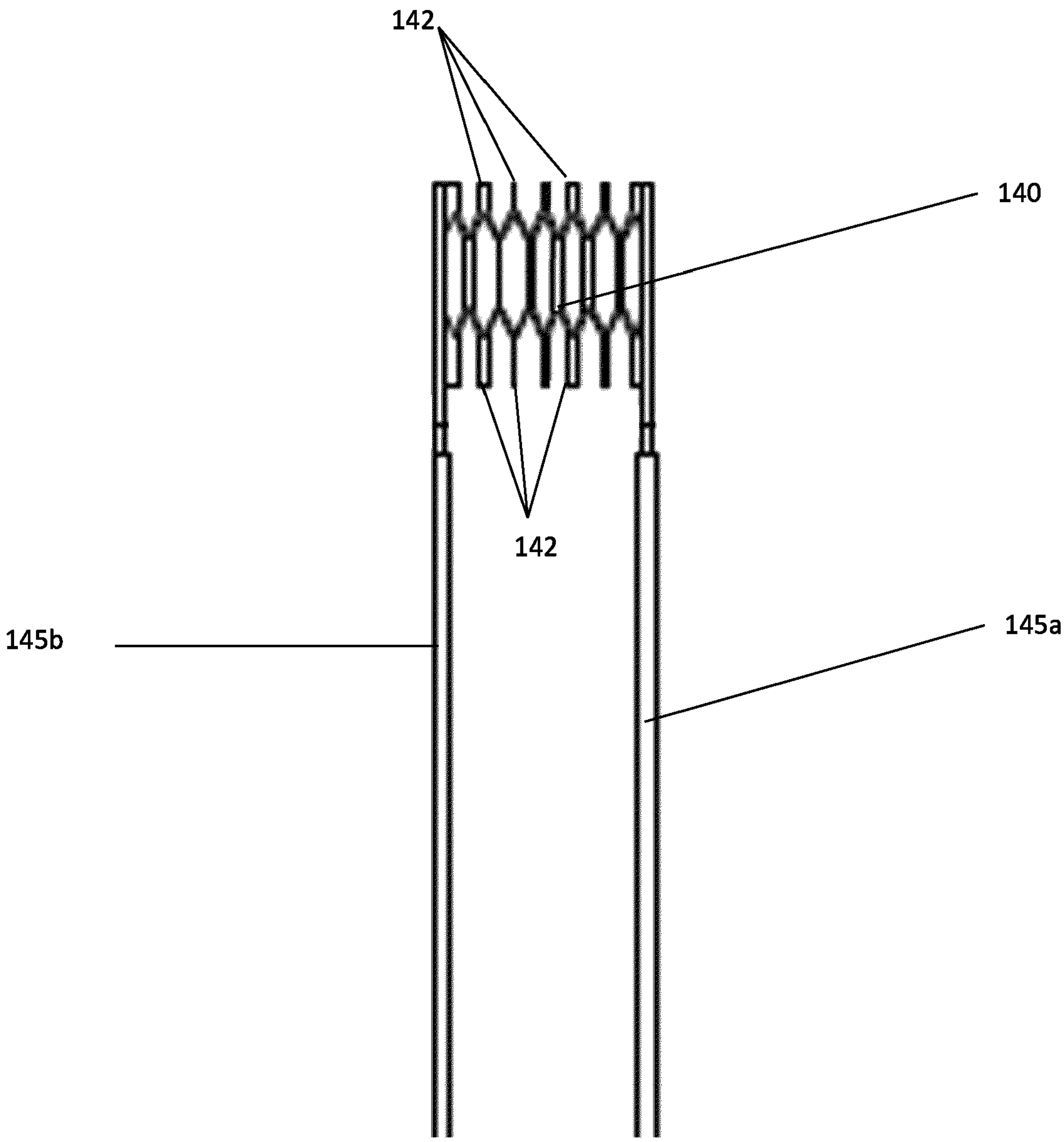

Fig. 6

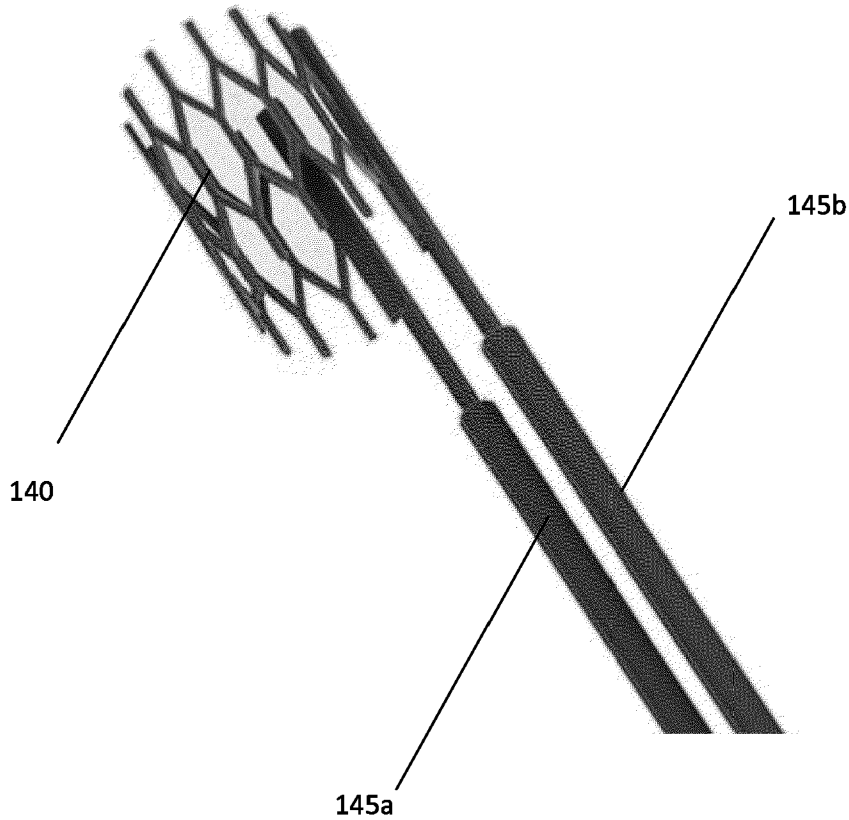

Fig. 7

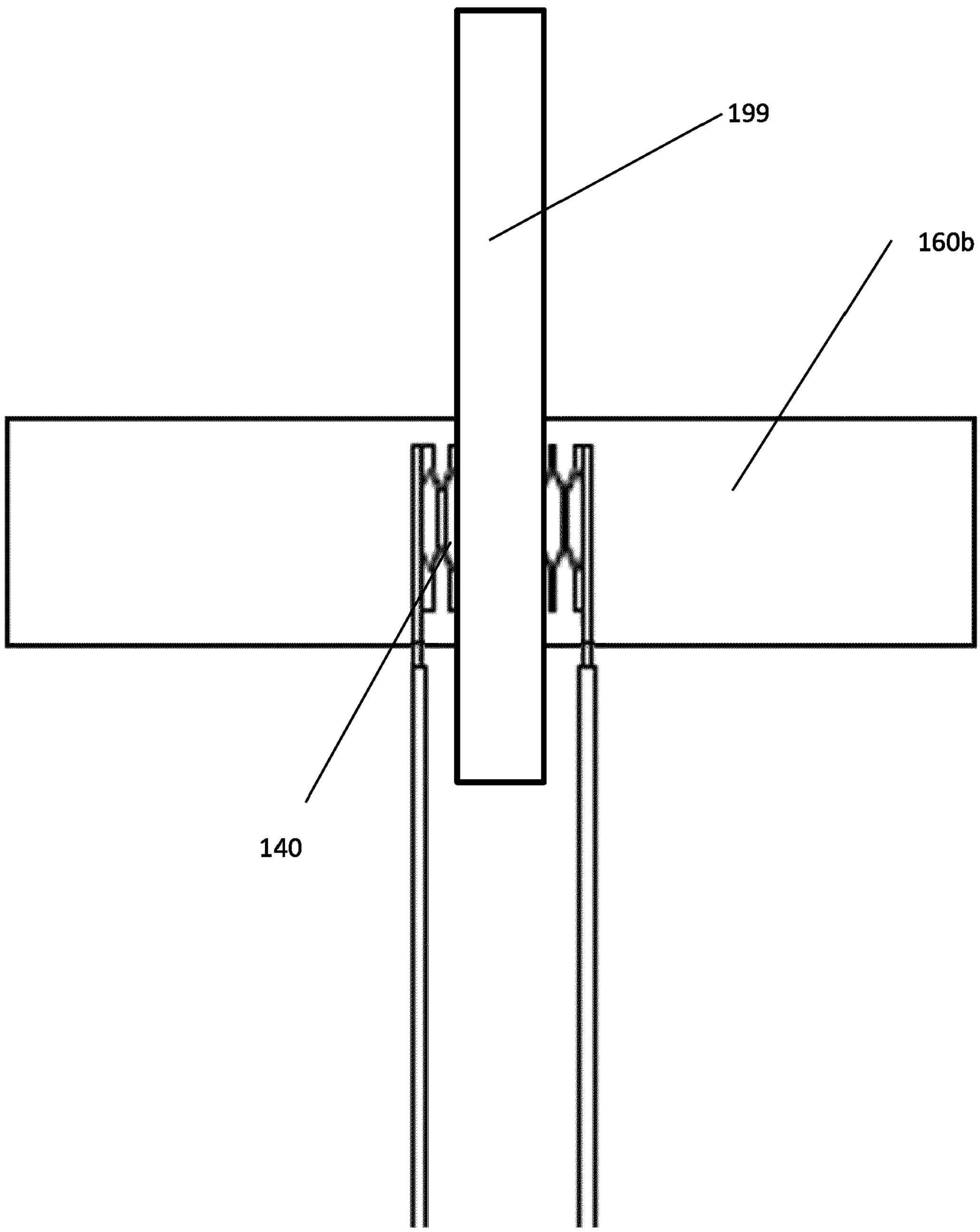

Fig. 8

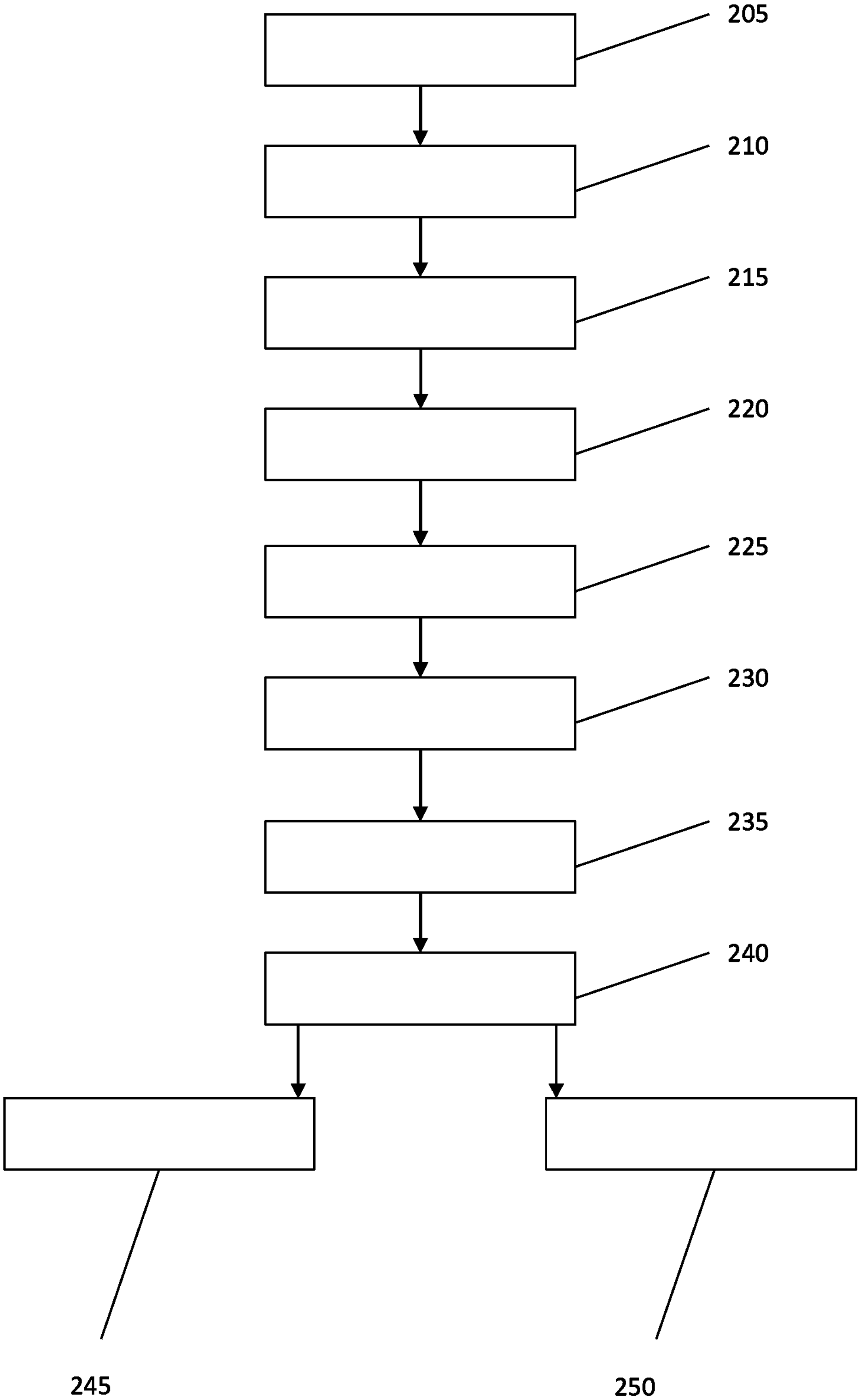

Fig. 9

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EUROPEAN SEARCH REPORT

Application Number
EP 23 21 9746

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A	US 2017/347717 A1 (MATSUMOTO HIROFUMI [JP] ET AL) 7 December 2017 (2017-12-07) * figure 8 * * paragraph [0090] * -----	1-14	INV. A24F40/70 ADD. A24F40/46 A24F40/10
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A24F
H05B
H01C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	29 May 2024	Kirchmayr, Katrin

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29-05-2024

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