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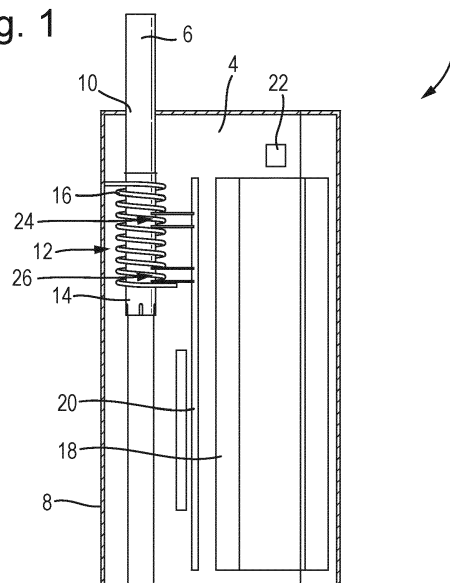
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(54) AEROSOL PROVISION DEVICE

(57) An aerosol provision device (4) comprising a heating arrangement (12) configured to heat an article (6) comprising an aerosol generating material when the article (6) is inserted into the device (4). The device further comprises a first temperature sensor (24) arranged to detect the temperature of a first region of the heating arrangement (12) and a second temperature sensor (26) arranged to detect the temperature of a

second region of the heating arrangement (12). A controller (20) is configured to control operation of the heating arrangement (12). During operation of the device (4), during a first period of time, the controller (20) is configured to control operation of the heating arrangement (12) based on the temperature detected by the first temperature sensor (24) and not the temperature detected by the second temperature sensor (26).

Fig. 1**EP 4 563 023 A1**

Description

Technical Field

[0001] The present invention relates to an aerosol provision device, an aerosol provision system and a method of operating an aerosol provision system.

Background

[0002] Smoking articles such as cigarettes, cigars and the like burn tobacco during use to create tobacco smoke. Attempts have been made to provide alternatives to these articles that burn tobacco by creating products that release compounds without burning. Examples of such products are heating devices which release compounds by heating, but not burning, the material. The material may be for example tobacco or other non-tobacco products, which may or may not contain nicotine.

Summary

[0003] According to a first aspect of the present invention there is provided an aerosol provision device comprising:

- a heating arrangement configured to heat an article comprising an aerosol generating material when the article is inserted into the device;
 - a first temperature sensor arranged to detect the temperature of a first region of the heating arrangement;
 - a second temperature sensor arranged to detect the temperature of a second region of the heating arrangement; and
 - a controller configured to control operation of the heating arrangement, wherein during operation of the device;
- during a first period of time, the controller is configured to control operation of the heating arrangement based on the temperature detected by the first temperature sensor and not the temperature detected by the second temperature sensor.

[0004] Optionally, during a second period of time, the controller is configured to control operation of the heating arrangement based on the temperature detected by the second temperature sensor and not the temperature detected by the first temperature sensor.

[0005] Optionally, the controller is configured to control operation of the heating arrangement by controlling a magnitude of a current supplied to the heating arrangement. Optionally, the controller is configured to control operation of the heating arrangement by controlling a magnitude of a voltage supplied to the heating arrangement.

[0006] Optionally, the first region and second region are different regions of the heating arrangement.

[0007] Optionally, the first region and second region are different regions around the heating arrangement.

[0008] Optionally, the first region and second region are displaced along a length of the heating arrangement.

[0009] Optionally, the first period of time and second period of time occur during a single inhalation from the aerosol provision device.

[0010] Optionally, the heating arrangement comprises a resistive heating arrangement.

[0011] Optionally, the heating arrangement comprises an inductive heating arrangement.

[0012] Optionally, the inductive heating arrangement comprises a (e.g. tubular) susceptor, shaped to receive the article during use, and at least one inductor coil surrounding the susceptor.

[0013] Optionally, the first and second temperature sensors are arranged to detect the temperature of the susceptor. The first and second temperature sensors may be arranged to detect the temperature of an outside surface of the susceptor. The first region may correspond to a first point of the susceptor at which the first temperature sensor is arranged to be in thermal communication with, e.g. by attachment thereto. The second region may correspond to a second point of the susceptor at which the second temperature sensor is arranged to be in thermal communication with, e.g. by attachment thereto.

[0014] Optionally, the at least one inductor coil comprises a first inductor coil and a second inductor coil, and wherein the first region corresponds to region of the susceptor adjacent the first inductor coil and the second region corresponds to a region of the susceptor adjacent the second inductor coil.

[0015] Optionally, the first temperature sensor and/or the second temperature sensor comprises a thermistor or a thermocouple.

[0016] Optionally, during at least a period (e.g. a plurality of periods) of time subsequent to the first and second periods of time, the heating arrangement is controlled based on:

- a temperature detected by the first temperature sensor and not a temperature detected by the second temperature sensor; or
- a temperature detected by the second temperature sensor and not a temperature detected by the first temperature sensor.

[0017] Optionally, the device further comprises a third temperature sensor arranged to detect the temperature of a third region of the heating arrangement, and wherein during a third period of time, the controller is configured to control operation of the heating arrangement based on the temperature detected by the third temperature sensor and not the temperature detected by the first or second temperature sensor.

[0018] Optionally, during the first period of time, the heating arrangement is controlled such that the temperature detected by the first temperature sensor is at a first

temperature for a first sub-period of time before changing to a second temperature for a second sub-period of time.

[0019] Optionally, during the second period of time, the heating arrangement is controlled such that the temperature detected by the second temperature sensor rises from a third temperature to a fourth temperature during a third sub-period of time.

[0020] Optionally, the second temperature is less than the first temperature, the third temperature is less than the second temperature, and the fourth temperature is less than, equal to or greater than the second temperature, and/or wherein the fourth temperature is greater than the first temperature.

[0021] According to a second aspect of the present invention there is provided an aerosol provision system comprising:

an aerosol provision device according to any of the embodiments set out above; and

an article, comprising an aerosol generating material, for insertion into the aerosol provision device.

[0022] According to a third aspect of the present invention there is provided a method of operating an aerosol provision device comprising a heating arrangement for heating an article comprising an aerosol generating material, the method comprising:

controlling operation of the heating arrangement during a first period of time based on a temperature of a first region of the heating arrangement and not the temperature of any other region of the heating arrangement.

[0023] Optionally, the method further comprises controlling operation of the heating arrangement during a second period of time based on a temperature of a second region of the heating arrangement and not the temperature of any other region of the heating arrangement.

[0024] Optionally, the first region corresponds to a first point (e.g. measured using a single temperature sensor) of the heating arrangement.

[0025] Any of the features of the aerosol provision device set out above may equally be implemented in the method set out above.

Brief Description of the Drawings

[0026] Embodiments will now be described, by way of example only, and with reference to the accompanying drawings in which:

Fig. 1 shows a side schematic view of an aerosol provision system in accordance with an embodiment of the present invention;

Fig. 2 shows a view focussing on the heating arrangement of the aerosol provision device shown in Fig. 1;

Fig. 3 shows a plot of a target temperature profile for a given point on a heating arrangement in accordance with an embodiment;

Fig. 4 shows a plot of current over time according to a first control scheme for the heating arrangement shown in Figures 1 and 2;

Fig. 5 shows a plot of temperature over time corresponding to the control scheme shown in Fig. 4;

Fig. 6 shows a plot of current over time according to a second control scheme for the heating arrangement shown in Figures 1 and 2;

Fig. 7 shows a plot of temperature over time corresponding to the control scheme shown in Fig. 6;

Fig. 8 shows a plot of current over time according to a third control scheme for the heating arrangement shown in Figures 1 and 2;

Fig. 9 shows a plot of temperature over time corresponding to the control scheme shown in Fig. 8;

Fig. 10 shows a focussed view of a heating arrangement according to another embodiment of the present invention;

Fig. 11 shows a plot of current over time according to a control scheme for the heating arrangement shown in Fig. 10;

Fig. 12 shows a plot of temperature over time corresponding to the control scheme shown in Fig. 11;

Fig. 13 shows a schematic side view of an aerosol provision device comprising a resistive heating arrangement, in accordance with another embodiment of the present invention;

Fig. 14 shows a focussed view of a heating arrangement comprising two inductor coils in accordance with a further embodiment of the present invention;

Fig. 15 shows a plot of temperature over time according to a first control scheme implemented for the heating arrangement shown in Fig. 14;

Fig. 16 shows a plot of temperature over time according to a second control scheme implemented for the heating arrangement shown in Fig. 15; and

Fig. 17 shows a flow chart of a method in accordance with an embodiment of the present invention.

Detailed Description

[0027] As used herein, the term "aerosol-generating material" is a material that is capable of generating aerosol, for example when heated, irradiated or energized in any other way. Aerosol-generating material may, for example, be in the form of a solid, liquid or gel which may or may not contain an active substance and/or flavourants. Aerosol-generating material may include any plant based material, such as tobacco-containing material and may, for example, include one or more of tobacco, tobacco derivatives, expanded tobacco, reconstituted tobacco or tobacco substitutes. Aerosol-generating material also may include other, non-tobacco, products, which, depending on the product, may or may not contain nicotine. Aerosol-generating material may for example be in the form of a solid, a liquid, a gel, a wax or the like. Aerosol-generating material may for example also be a combination or a blend of materials. Aerosol-generating material may also be known as "smokable material".

[0028] The aerosol-generating material may comprise a binder and an aerosol former. Optionally, an active and/or filler may also be present. Optionally, a solvent, such as water, is also present and one or more other components of the aerosol-generating material may or may not be soluble in the solvent. In some embodiments, the aerosol-generating material is substantially free from botanical material. In some embodiments, the aerosol-generating material is substantially tobacco free.

[0029] The aerosol-generating material may comprise or be an "amorphous solid". The amorphous solid may be a "monolithic solid". In some embodiments, the amorphous solid may be a dried gel. The amorphous solid is a solid material that may retain some fluid, such as liquid, within it. In some embodiments, the aerosol-generating material may, for example, comprise from about 50wt%, 60wt% or 70wt% of amorphous solid, to about 90wt%, 95wt% or 100wt% of amorphous solid.

[0030] The aerosol-generating material may comprise an aerosol-generating film. The aerosol-generating film may comprise or be a sheet, which may optionally be shredded to form a shredded sheet. The aerosol-generating sheet or shredded sheet may be substantially tobacco free.

[0031] According to the present disclosure, a "non-combustible" aerosol provision system is one where a constituent aerosol-generating material of the aerosol provision system (or component thereof) is not combusted or burned in order to facilitate delivery of at least one substance to a user.

[0032] In some embodiments, the delivery system is a non-combustible aerosol provision system, such as a powered non-combustible aerosol provision system.

[0033] In some embodiments, the non-combustible aerosol provision system is an electronic cigarette, also known as a vaping device or electronic nicotine delivery system (END), although it is noted that the presence of nicotine in the aerosol-generating material is not a re-

quirement.

[0034] In some embodiments, the non-combustible aerosol provision system is an aerosol-generating material heating system, also known as a heat-not-burn system. An example of such a system is a tobacco heating system.

[0035] In some embodiments, the non-combustible aerosol provision system is a hybrid system to generate aerosol using a combination of aerosol-generating materials, one or a plurality of which may be heated. Each of the aerosol-generating materials may be, for example, in the form of a solid, liquid or gel and may or may not contain nicotine. In some embodiments, the hybrid system comprises a liquid or gel aerosol-generating material and a solid aerosol-generating material. The solid aerosol-generating material may comprise, for example, tobacco or a non-tobacco product.

[0036] Typically, the non-combustible aerosol provision system may comprise a non-combustible aerosol provision device and a consumable for use with the non-combustible aerosol provision device.

[0037] In some embodiments, the disclosure relates to consumables comprising aerosol-generating material and configured to be used with non-combustible aerosol provision devices. These consumables are sometimes referred to as articles throughout the disclosure.

[0038] In some embodiments, the non-combustible aerosol provision system, such as a non-combustible aerosol provision device thereof, may comprise a power source and a controller. The power source may, for example, be an electric power source or an exothermic power source. In some embodiments, the exothermic power source comprises a carbon substrate which may be energised so as to distribute power in the form of heat to an aerosol-generating material or to a heat transfer material in proximity to the exothermic power source.

[0039] In some embodiments, the non-combustible aerosol provision system may comprise an area for receiving the consumable, an aerosol generator, an aerosol generation area, a housing, a mouthpiece, a filter and/or an aerosol-modifying agent.

[0040] In some embodiments, the consumable for use with the non-combustible aerosol provision device may comprise aerosol-generating material, an aerosol-generating material storage area, an aerosol-generating material transfer component, an aerosol generator, an aerosol generation area, a housing, a wrapper, a filter, a mouthpiece, and/or an aerosol-modifying agent.

[0041] An aerosol provision device can receive an article comprising aerosol generating material for heating. An "article" in this context is a component that includes or contains in use the aerosol generating material, which is heated to volatilise the aerosol generating material, and optionally other components in use. A user may insert the article into the aerosol provision device before it is heated to produce an aerosol, which the user subsequently inhales. The article may be, for example, of

a predetermined or specific size that is configured to be placed within a heating chamber of the device which is sized to receive the article.

[0042] With reference to Figure 1, an aerosol provision system 2 in accordance with an embodiment of the present invention is depicted. The aerosol provision system 2 may be a non-combustible aerosol provision system as set out above. The aerosol provision system 2 comprises an aerosol provision device 4 (hereinafter "device 4") for generating aerosol from an aerosol generating material. The aerosol provision system 2 further comprises an article 6 comprising an aerosol generating material. The article 6 may be removable and/or replaceable. In broad outline, the aerosol provision device 4 may be used to heat the article 6 to generate an aerosol or other inhalable medium, which is inhaled by a user of the system 2.

[0043] The aerosol provision device 4 comprises a body 8. The body 8 is shown as partially transparent in Figure 1 so as to more clearly show the components of the device 4. The body 8 may be considered to be a housing arrangement which surrounds and houses various components of the device 4. The body 8 may be formed of a plurality of parts together forming an assembly. An article aperture 10 is formed at one end of the body 8, through which the article 6 may be inserted for heating by a heating arrangement 12. The article 6 may be inserted into an article receiving portion within the device 4. The heating arrangement may surround and/or define the receiving portion.

[0044] The heating arrangement 12 may comprise any suitable heating arrangement that is capable of heating the article 6, specifically the aerosol generating material therein, when the article 6 is inserted into the device 4. The heating arrangement 12 may be considered to be, or be part of, an aerosol generator of the device 4.

[0045] In some embodiments, as depicted in Figure 1, the heating arrangement 12 may comprise an inductive heating arrangement. In such embodiments, the heating arrangement 12 may comprise a susceptor 14, e.g. in the form of a tubular susceptor, which is shaped to receive the article 6, e.g. at least part thereof, during use of the system 2. The susceptor 14 may thus form an article receiving portion which receives the article 6. The heating arrangement 12 may further comprise at least one inductor coil (i.e. an inductive coil or an induction coil) 16 surrounding the susceptor 14. In some embodiments, a susceptor may instead be arranged within the article 6, and as such the susceptor 14 may be omitted. The device 4 may nonetheless comprise an arrangement for receiving the article, e.g. in the form of a tube. Whilst in the embodiment of Figure 1 a single susceptor 14 is shown, it will be appreciated that the susceptor 14 may have any suitable form and may instead multiple discrete susceptors.

[0046] The device 4 further comprises a power source 18, e.g. in the form of a battery or any other suitable power source, and a controller 20 (e.g. a control circuit, e.g.

comprising a processor). The power source 18 may comprise a rechargeable battery or a non-rechargeable battery. Examples of suitable batteries include, for example, a lithium battery (such as a lithium-ion battery), a nickel battery (such as a nickel-cadmium battery), and an alkaline battery.

[0047] The device 4 may also include a user-operable control element 22, such as a button or switch, which may be operatively connected to the controller 20 and act to operate the device 4 when pressed. For example, a user may turn on the device 4 by operating the switch 2. The power source 18 may be electrically coupled to the heating arrangement 12 to supply electrical power thereto when required and under the control of the controller 20 so as to heat an aerosol generating material contained within the article 6. The controller 20 may be configured to activate and deactivate the heating arrangement 12 based on a user input, e.g. based on operation of the user-operable control element 22. The user-operable control element 22 may comprise a button and the user input may be via a button press. In some embodiments, the heating arrangement 12 may be configured to activate and/or deactivate automatically, for example on an insertion, or removal of, an article.

[0048] The heating arrangement 12 may define a longitudinal axis, which aligns with an axis of the article 6, and the article 6 may be inserted into the device 4 along said longitudinal axis. In use, the article 6 may be fully or partially inserted into the heating arrangement 12 where it may be heated by one or more components of the heating arrangement 12.

[0049] The heating arrangement 12 shown in Figure 1 is configured to heat the article 6 via induction heating. This induction heating comprises heating the susceptor 14 (i.e. an electrically conducting heating element) using electromagnetic induction. The device 4, e.g. the controller 20 thereof, may be configured to pass a varying electric current, e.g. an alternating electric current, through the inductor coil 16 (i.e. an induction heating assembly or inductive element). The varying electric current in the inductor coil 16 produces a varying magnetic field. The varying magnetic field penetrates the susceptor 14 (i.e. a heating element), which is suitably positioned with respect to the inductor coil 16, and generates eddy currents inside the susceptor 14. The susceptor 14 has electrical resistance to the eddy currents, and hence the flow of the eddy currents against this resistance causes the susceptor 14 to be heated by Joule heating. In cases where the susceptor 14 comprises ferromagnetic material such as iron, nickel or cobalt, heat may also be generated by magnetic hysteresis losses in the susceptor 14, i.e. by the varying orientation of magnetic dipoles in the magnetic material as a result of their alignment with the varying magnetic field. In inductive heating, as compared to heating by conduction for example, heat is generated inside the susceptor 14, allowing for rapid heating. Further, there need not be any physical contact between the inductor coil 16 and the

susceptor 14, allowing for enhanced freedom in construction and application.

[0050] The device 4 further comprises a first temperature sensor 24 arranged to detect the temperature of a first region of the heating arrangement 12 and a second temperature sensor 26 arranged to detect the temperature of a second region of the heating arrangement 12. In embodiments comprising a susceptor 14, as shown in Figure 1, the first and second temperature sensors 24, 26 may be arranged to detect the temperature of the susceptor 14. The first region may correspond to a first point (or portion) on/of the susceptor 14 and the second region may correspond to a second point or portion on/of the susceptor 14. The temperature of the first and second points (or portions) may be indicative of the temperature of the first and second regions of the susceptor, e.g. a first region corresponding to one half of the susceptor 14, and a second region corresponding to a second half of the susceptor 14. One or both of the first and second temperature sensors 24, 26 may be arranged to measure the temperature of an outer surface of the susceptor 14.

[0051] Figure 2 shows a view focussing on the heating arrangement 12 of the device 4 shown in Figure 1. This Figure more clearly shows the susceptor 14 with the inductor coil 16 wrapped therearound. In some embodiments, as shown in this Figure, the first temperature sensor 24 is in the form of a thermocouple comprising a first wire 24A and a second wire 24B. In a similar manner, the second temperature sensor 26 may be in the form of a thermocouple comprising a first wire 26A and a second wire 26B. Each of the first and second temperature sensors 24, 26, specifically the first and second wires 24A, 24B, 26A, 26B are electrically connected to the controller 20. The first and second temperature sensors 24 may be in thermal contact with the susceptor, e.g. through attachment thereto. The controller 20 may control operation of the device 4, specifically the heating arrangement 12, based on the temperatures measured/detected by the first and second temperature sensors 24, 26.

[0052] Whilst the first and second temperature sensors 24, 26 are in the form of a thermocouple in the embodiment depicted in Figures 1 and 2, the first and second temperature sensors 24, 26 may instead comprise a thermistor, or any other suitable form of temperature sensor. In some embodiments, one of the first or second temperature sensors 24, 26 comprises a thermocouple and the other comprises a thermistor or other suitable temperature sensor. In some embodiments, the first and second temperature sensors may be integrally provided with the heating arrangement.

[0053] As can be seen in Figure 1 and 2, the first region (i.e. the point on the susceptor at which the first temperature sensor 24 is arranged to measure the temperature of) and the second region (at which the second temperature sensor 26 is arranged to measure the temperature of) may be displaced along a length of the heating arrangement 12, e.g. along a length of the susceptor 14

thereof. In addition or alternatively, the first and second regions may be displaced around the heating arrangement 12, e.g. the susceptor 14 thereof.

[0054] Figure 3 shows a target temperature profile for a given point on the susceptor 14. As depicted, this temperature profile may comprise an initial time period 17A whereby the temperature of the susceptor 14 is increased, an intermediate time period 17B whereby the temperature is maintained and then dropped, and a final time period 17C whereby the temperature is caused to rise again and subsequently maintained. This target temperature profile may provide a suitable heating profile for heating an article comprising an aerosol generating material.

[0055] Figure 4 shows a plot of current provided to the inductor coil 16 between times 0 to t5, and Figure 5 shows a plot of temperature measured by the first and second temperature sensors 24, 26 between the same time 0 to t5, for the device 4 shown in Figures 1 and 2. These two Figures demonstrate a control scheme for controlling temperature of the heating arrangement 12 in accordance with a first embodiment of the present invention. This control may be performed by the controller 20.

[0056] When the device 4 is turned on, the current supplied to the inductor coil 16 may be changed from 0 to C1 and remain at C1 for the time period 0 to t1. This causes the temperature to change to a first temperature T1. The current may then be reduced down to C2 during the time period from t1 to t2. This may enable the temperature to be kept at the first temperature T1 from the time period t1 to t2. From time period t2 to t3, the current may be changed to C3, which may cause the temperature to drop down to a second temperature T2. From time t3 to t4, the current may be changed to C4 which may result in the change of the susceptor to from a third temperature T3 to a fourth temperature T4. Then, from time t4 to t5, the current is changed to C5 so as to maintain the temperature of the susceptor at the fourth temperature T4.

[0057] During a first period of time P1 including the period 0 to t3, the temperature is measured by the first temperature sensor 24 and control of the heating arrangement 12 by the controller 20 is performed based on this measurement. As such, during the first period of time P1, the controller 20 controls operation of the heating arrangement 12 based on the temperature detected by the first temperature sensor 24 and not the temperature detected by the second temperature sensor 26. The temperatures in the first time period P1 on Figure 5 thus correspond to the temperatures measured by the first temperature sensor 24.

[0058] In some embodiments, during a second period of time P2, including the time t3 to t5, the temperature is measured by the second temperature sensor 26 and control of the heating arrangement 12 by the controller 20 is performed based on this measurement. In this second period of time P2 the controller 20 may control operation of the heating arrangement 12 based on the temperature detected by the second temperature sensor

26 and not the temperature detected by the first temperature sensor 24. Thus, the temperatures in the second time period P2 on Figure 5 correspond to the temperatures measured by the second temperature sensor 26.

[0059] The controller 20 may be suitably configured to switch between which of the first and second temperature sensor 24, 26 it uses as an input for controlling operation of the heating arrangement 12. It may, for example, comprise a timer configured to cause a switching between which temperature sensor 24, 26 is being used. For example, the controller may switch to operation using the second temperature sensor 26 after a pre-set period of time has elapsed since the start of operation of the device 4, and/or from the start of an inhalation from the device 4.

[0060] In some embodiments, switching between the temperature measured by the first temperature sensor 24 or the temperature measured by the second temperature sensor 26 as an input for controlling operation of the heating arrangement 12 may be triggered by another parameter, e.g. the detection of at least one threshold temperature being reached, or based on an input by a user, e.g. the operation of an input means on the device 4. For example, the controller may be triggered to begin using a temperature measurement from the second temperature sensor 26 when a threshold temperature is detected by the first temperature sensor 24 (e.g. threshold temperature T3). In some embodiments, there may be a combination of elapsed time and the meeting of a threshold before switching to using a different temperature sensor.

[0061] In the embodiment shown in Figures 4 and 5, the various changes in the current supplied to the heating arrangement may be triggered by the detection of the various temperatures T1-T4 set out above.

[0062] The first and second time periods P1, or P2, or indeed any other time periods discussed herein, may be pre-set, may vary, e.g. in dependence on the type of article 6 inserted into the device 4, or vary depending on properties of the article 6 as it is heated.

[0063] Controlling operation of the heating arrangement 12 during a first period of time based on the temperature detected by the first temperature sensor 24 and not the second temperature 26 may reduce power consumption. During the first period of time the energy required to perform temperature measurement by the second temperature sensor 26 may not be consumed. In a similar manner, the controller 20 may comprise simpler circuitry and/or programs stored thereon, as there may be less inputs (i.e. less temperature inputs) which need to be processed in order to provide control. In other words, during the first period of time P1, only the temperature detected by the first temperature sensor 24 is used, and thus the control may be simpler than if the controller were having to based control based on temperatures measured by both the first and second temperature sensors 24, 26.

[0064] Whilst during the first period of time the con-

troller 20 operates based on the temperature detected by the first temperature sensor 24 and not the second temperature sensor 26, it is envisaged that controller may operate based on other inputs, e.g. the output of a puff sensor (not shown), the operation of the input means 22 or any other suitable input other than the temperature of the heating arrangement 12.

[0065] As depicted in Figure 4, the controller 20 may be configured to control operation of the heating arrangement 12 by controlling the magnitude of a current supplied to the heating arrangement 12. However, it will be appreciated that any other suitable property may be controlled. For example, the controller 20 may control the voltage supplied to the heating arrangement 12.

[0066] In some embodiments, the first period of time P1 and the second period of time P2 may occur during a single inhalation from the device 4. In such embodiments, the control of the current as depicted in Figure 4 and the temperature profile shown in Figure 5 occur during a single inhalation. The same control scheme depicted in Figures 4 and 5 may thus be repeated for each inhalation from the device 4.

[0067] In some embodiments, during the first time period P1, no temperature measurement is made by the second temperature sensor 26, and similarly during the second time period P2, no temperature measurement is made by the first temperature sensor 24. In other embodiments, the first and second temperature sensors 24, 26 may both provide temperature measurements during the first and second time periods P1, P2, but only the temperature measurement from one of the first and second temperature sensors 24, 26 may be used to control the heating arrangement 12 in each of the first and second time periods P1, P2. The temperature measurement from the temperature sensor 24, 26 which is not being used may effectively be ignored. This may simplify the controller 20 and/or any processing performed by the controller 20. This may reduce power consumption.

[0068] Whilst not shown in Figures 4 and 5, in some embodiments, during periods of time subsequent to the first and second periods of time P1, P2, the heating arrangement 12 may controlled based on a temperature detected by the first temperature sensor 24 and not a temperature detected by the second temperature sensor 26; or a temperature detected by the second temperature sensor 26 and not a temperature detected by the first temperature sensor 24.

[0069] In some embodiments, as shown in Figure 5, during the first period of time P1, the heating arrangement 12 is controlled (e.g. by controlling the current supplied thereto as shown in Figure 4) such that the temperature detected by the first temperature sensor 24 is at a first temperature T1 for a first sub-period of time (the time from 0-t2) before changing to a second temperature T2 for a second sub-period of time (the time from t2-t3).

[0070] In some embodiments, as shown in Figure 5, during the second period of time P2, the heating arrangement 12 is controlled (e.g. by controlling the current

supplied thereto as shown in Figure 4) such that the temperature detected by the second temperature sensor 26 rises from a third temperature T3 to a fourth temperature T4 during a third sub-period of time (the time from t3-t4).

[0071] In some embodiments, as shown in Figure 5, the second temperature T2 is less than the first temperature T1, the third temperature T3 is less than the second temperature T2, and the fourth temperature T4 is less than the second temperature T2.

[0072] The current and temperature profiles shown in Figures 4 and 5 may cause the generation of a suitable aerosol from the article 6 within the device 4. The current and temperature profiles shown in Figures 4 and 5 are just one embodiment of the way in which the heating arrangement may be controlled.

[0073] Figure 6 shows a plot of current provided to the inductor coil 16 between times 0 to t5 and Figure 7 shows a plot of temperature measured by the first and second temperature sensors 24, 26 between the same time 0 to t5, for a different temperature control scheme. Figures 6 and 7 thus depict a second control scheme according to another embodiment of the present invention. In a similar manner to the embodiment described above, in the first time period P1, encompassing time 0-t3, the heating arrangement is controlled based on the temperature measured by the first temperature sensor 24 and not the second temperature sensor 26. During the second time period P2, encompassing time t3-t5, the heating arrangement is controlled based on the temperature measured by the second temperature sensor 26 and not the first temperature sensor 24.

[0074] As depicted, the current supplied to the heating arrangement 12 may be increased from 0 to C1 in the time interval 0-t1, this may result in a temperature change (e.g. from 0°C) to a first temperature T1. The current supplied to the heating arrangement 12 may then be reduced to C2, which may result in the temperature of the susceptor being kept at the first temperature T1 in the time t1-t2. In the time period t2-t3, the current may be changed (e.g. reduced) to C3, and the temperature of the susceptor 14 will be changed to a second temperature T2. At this point, the second period of time P2 begins. From time t3 to t4, the current may be changed to C4, and the temperature of susceptor 14 may change from a third temperature T3 to a fourth temperature which may be equal to the second temperature T2. From time t4 to t5, the current may be changed to C5, and the temperature of the susceptor 14 may be kept at the second temperature T2.

[0075] Figure 8 shows a plot of current provided to the inductor coil 16 between times 0 to t5 and Figure 9 shows a plot of temperature measured by the first and second temperature sensors 24, 26 between the same time 0 to t5, for a different temperature control scheme. Figures 8 and 9 thus depict a third control scheme in accordance with a further embodiment of the present invention. In a similar manner to the embodiment described above, in the first time period P1, encompassing time 0-t3, the

heating arrangement 12 is controlled based on the temperature measured by the first temperature sensor 24 and not the second temperature sensor 26. During the second time period P2, encompassing time t3-t5, the heating arrangement 12 is controlled based on the temperature measured by the second temperature sensor 26 and not the first temperature sensor.

[0076] During the first period of time P1, the current supplied to the heating arrangement 12 is changed from 0 to C1 during the time 0 to t1, and as a result the temperature of susceptor 14 may change (e.g. from 0°C) to a first temperature T1. In the time t1-t2, the current may be reduced to C2, so that the temperature of susceptor 14 can be maintained at the first temperature T1 from t1 to t2. From time t2 to t3, the current may be changed to C3, and the temperature of the susceptor 14 may change to a second temperature T2. From time t3 to t4, the current may be changed to C4, and the temperature of susceptor 14 may change from a third temperature T3 to fourth temperature T4. From time t4 to t5, the current may be changed to C5 and the temperature of the susceptor 14 will be kept at the fourth temperature T4. As shown in Figure 9, the fourth temperature T4 may be greater than the second temperature T2 and/or the first temperature T1.

[0077] Figure 10 shows a view of a heating arrangement 112 of a device according to another embodiment. The device may be substantially the same as the device 4 shown in Figure 1 with the only difference being in relation to the temperature sensors in associated with the heating arrangement 112. The discussion of other features of the device has thus been omitted.

[0078] As shown in Figure 10, the heating arrangement 112 comprises a susceptor 114 with an inductor coil 116 wrapped therearound. In this embodiment, three temperature sensors are provided to measure the temperature of the heating arrangement 112, e.g. the susceptor 114 thereof. Specifically, in some embodiments, the device comprises a first temperature sensor 124 arranged to detect the temperature of a first region of the heating arrangement 112, a second temperature sensor 126 arranged to detect the temperature of a second region of the heating arrangement 112 and a third temperature sensor 128 arranged to detect the temperature of a third region of the heating arrangement 122.

[0079] In some embodiments, as shown Figure 10, the first temperature sensor 124 is in the form of a thermocouple comprising a first wire 124A and a second wire 124B. In a similar manner, the second temperature sensor 126 is in the form of a thermocouple comprising a first wire 126A and a second wire 126B. The third temperature sensor 128 may similarly comprises a first wire 126A and a second wire 126B. Each of the first, second and third temperature sensors 124, 126, 128 specifically the first and second wires 124A, 124B, 126A, 126B, 128A, 128B may be electrically connected to a controller 20. The controller 20 may control operation of the device 4, specifically the heating arrangement 112, based on the

temperatures measured by the first second and third temperature sensors 124, 126, 128. Whilst the first, second and third temperature sensors 124, 126 are in the form of a thermocouple in the embodiment depicted, the first, second and third temperature sensors 124, 126, 128 may instead comprise a thermistor, or any other suitable form of temperature sensor.

[0080] As can be seen in Figure 10, the region corresponding to the first temperature sensor 124, the region corresponding to the second temperature sensor 126 and the region corresponding to the third temperature sensor 126 may be displaced along a length of the heating arrangement 112.

[0081] In the embodiment shown in Figure 10, during a third period of time, the controller may be configured to control operation of the heating arrangement 112 based on a temperature detected by the third temperature sensor, and not the temperature detected by the first or second temperature sensor. Control during first and second periods of time may be performed in a similar manner to the embodiment set out above. As specific example encompassing all three periods of time is illustrated in Figures 11 and 12

[0082] Figure 11 shows a plot of current provided to the inductor coil 116 between times 0 to t7 and Figure 12 shows a plot of temperature measured by the first, second and third temperature sensors 124, 126, 128 (at different times) between the same time 0 to t7, for a temperature control scheme according to another embodiment of the present invention. With reference to both of these Figures, a first period of time P1 may include the time 0-t3. During time 0-t1, the current supplied to the heating arrangement 112 (e.g. the inductor coil 116 thereof) may be changed from 0 to C1 which may result in the temperature of susceptor 116 changing (e.g. from 0°C) to a first temperature T1. The current can then be reduced to C2, so that the temperature of susceptor 116 can be kept at the first temperature T1 from t1 to t2. From time t2 to t3, the current will be changed to C3, and the temperature of susceptor 116 will change to a second temperature T2. During this first period of time P1, the temperature measured and used for controlling the heating arrangement 112 (and depicted on Fig. 12) may be the temperature measured by the first temperature sensor 124 and not a temperature measured by the second or third temperature sensors 126, 128.

[0083] During a second period of time P2, e.g. from time t3 to t4, the current may be changed to C4, which may cause the temperature of susceptor 14 to change from a third temperature T3 to a fourth temperature T4. During this second period of time P2, the temperature measured and used for controlling the heating arrangement (and depicted on Fig. 12) may be the temperature measured by the second temperature sensor 126 and not a temperature measured by the first or third temperature sensors 124, 128.

[0084] From time t4 to t5 (which may still fall within the second period of time P2), the current may be changed to

C5 causing the temperature of susceptor 116 to be kept at T4.

[0085] During a third period of time P3, including at least time t5 to t6, the current may be changed to C6, and the temperature of susceptor 14 may thus change from a fifth temperature T5 to a sixth temperature T6. From time t6 to t7 (which may also fall within the third period of time P3) the current may be changed to C7 and the temperature of susceptor may be maintained at T6. As depicted, the second, fourth and sixth temperatures T2, T4, T6 may all be equal. During the third period of time P3, the temperature measured and used for controlling the heating arrangement 112 (and thus depicted on Figure 12) may be the temperature measured by the third temperature sensor 128 and not a temperature measured by the first or second temperature sensors 126, 128.

[0086] In some embodiments, in the time period from t6-t7, instead of using the temperature measured by the third temperature sensor 128 as an input (for a controller) for controlling the heating arrangement 112, a temperature measured by the first temperature sensor 124, or indeed the second temperature sensor 126 may be used.

[0087] Whilst three temperature sensors are described in the embodiment above, it will be appreciated that the device may comprise more than three temperature sensors, each temperature sensor being configured to detect the temperature of a different region of the heating arrangement of the device. It will be appreciated that at any given time, the controller may use a temperature detected by one of the temperature sensors, and not a temperature by any of the other temperature sensors, as a means (i.e. an input) for controlling operation of the heating arrangement.

[0088] Figure 13 shows a schematic view of an aerosol provision device 204 in accordance with another embodiment of the present invention. The aerosol provision device 204 is similar to the aerosol provision device 4 shown in Figure 1, except that the heating arrangement 212 of the aerosol provision device 204 shown in Figure 13 comprises a resistive heating arrangement 230, as opposed to an inductive heating arrangement. The resistive heating arrangement 230 may be in the form of a resistive heating tube 231 as shown in Figure 13. The resistive heating arrangement 230 is connected to a controller 220 by electrical connections 232A, 232B which may be in any suitable form, e.g. conductive wires.

[0089] As with the embodiment shown in Figure 1, the aerosol provision device 204 comprises a first temperature sensor 224 arranged to measure the temperature of a first region of the resistive heating arrangement 230 and a second temperature sensor arranged to measure the temperature of a second region of the resistive heating arrangement 230. The first and second temperature sensors 224, 226 may, for example, be arranged to measure the temperature of different points along an outside of the resistive heating tube 231. The aerosol provision device 204 may comprise a third temperature sensor (not shown) arranged to measure a third region of

the resistive heating arrangement 230.

[0090] Other than the differences above, the aerosol provision device 204 may be operated in a similar manner to any of the embodiments of the aerosol provision device 4 set out above. Specifically, the heating arrangement 212 of the aerosol provision device 204 may be operated based on a temperature measured by the first temperature sensor 224, and not a temperature measured by the second temperature sensor 226 during a first period of time. Similarly, during a second period of time, the heating arrangement 212 may be controlled based on a temperature measured by the second temperature sensor 226 and not a temperature measured by the first temperature sensor 224.

[0091] Figure 14 shows a side-on view of a heating arrangement 312 of an aerosol provision device in accordance with another embodiment of the present invention. In the embodiment shown in this Figure, the heating arrangement 312 comprise a first inductor coil 316A and a second inductor coil 316B. The first and second inductor coils 316A, 316B may be identical or differ in some way, e.g. in pitch, material, length, number of turns, etc. The provision of first and second inductor coils 316A, 316B may facilitate zonal heating within the heating arrangement 312 and thus zonal heating of an article inserted into the device. A single susceptor 314 is provided, however it will be appreciated that separate susceptors for each of the first and second inductor coils 316A, 316B may instead be provided.

[0092] In a similar manner to embodiments described above, a first temperature sensor 324, in the form of a thermocouple comprising first and second wires 324A, 324B and a second temperature sensor 326, in the form of a thermocouple comprising first and second wires 326A, 326B, are provided. The first temperature sensor 324 is arranged to measure a temperature of the first region (e.g. of the susceptor 314) which is adjacent the first inductor coil 316A and the second temperature sensor is arranged to measure a temperature of the second region (e.g. of the inductor coil 314) which is adjacent the second inductor coil 316B. Whilst the first and second temperature sensors 324, 226 are depicted in the form of thermocouples, it will be appreciated that any other form of temperature sensor may be utilised.

[0093] Figure 15 shows a temperature control scheme depicting temperature over time for the temperature measured by each of the first temperature sensor 324 and the second temperature 326. As shown in this Figure, during an initial period of time P0, from 0-t1, both the first and second inductor coils 316A, 316B may be operated and thus the temperature measured by the first and second temperature sensors 324, 326 may increase to a first temperature T1 and a fourth temperature T4 respectively. From point t1 to t2, i.e. during a first period of time P1, the controller of the device may operate based on the temperature detected by the first temperature sensor 324, and may not use any output from the second temperature sensor 326. This may provide a power sav-

ing during this period of time.

[0094] As shown in Figure 15, during the time period t1-t2, there are no temperature values recorded for the second temperature sensor 326. During this time, optionally, the second inductor coil 316B may not be operated (i.e. the supply of an A.C. current thereto may be stopped), which may further reduce power consumption. However, in some embodiments the second inductor coil 316B may continue to be operated, just without any temperature measurements thereof.

[0095] From time t2-t4, the second temperature sensor 326 may again be used, and the second inductor coil 316B may be operated to heat the region corresponding to the second temperature sensor 326 to a second temperature T2, as shown. During the time t3-t4, the temperature may continue to be measured and the first inductor coil 316A may be controlled so as to achieve a third temperature T3. Operating both inductor coils 316A, 316B during the initial period P0 may act to raise the temperature of the entire susceptor 314 thereby improving aerosol generating and thus initial inhalations from the article being heated.

[0096] As will be appreciated, in the embodiment depicted in Figure 15, there is at least a first period of time P1 where only the output from a single temperature sensor, i.e. the first temperature sensor 324, is measured/read. In other periods of time, the temperature reading may be from a plurality of different temperature sensors (e.g. the first and second temperature sensors 324, 326) and control of the heating arrangement 312 may thus be performed based on temperature measurements from a plurality of temperature sensors.

[0097] Figure 16 shows an alternative temperature control scheme depicting temperature over time for the temperature measured by each of the first temperature sensor 324 and the second temperature 326 for the arrangement shown in Figure 14. In a similar manner to that shown in Figure 14, during an initial period of time P0, from 0-t1, both the first and second inductor coils 316A, 316B are operated and thus the temperature measured by the first and second temperature sensors 324, 326 may be measured and increased to a first temperature T1 and a second temperature T4 respectively.

[0098] From point t1 to t2, i.e. during a first period of time P1, the controller of the device may operate based on the temperature detected by the second temperature sensor 326, and may not use any output from the first temperature sensor 324. This may provide a power saving. As shown in Figure 16, during this first period of time P1, there are no temperature values recorded for the first temperature sensor 324. During this first period of time, optionally, the first inductor coil 316A may stop (i.e. the supply of an A.C. current thereto may be stopped), which may further reduce power consumption. However, in some embodiments it may continue to be operated, just without any measurement thereof.

[0099] From time t2-t4, the first temperature sensor

324 may again be used, and the first inductor coil 316A may be operated to heat the region corresponding to the first temperature sensor 324 to a second temperature T2, as shown. During the time t3-t4, the temperature may continue to be measured and the second inductor coil 316B may be controlled so as to achieve a third temperature T3.

[0100] Operating both inductor coils 316A, 316B during the initial period P0 may act to raise the temperature of the entire susceptor 314 thereby improving aerosol generating and thus initial inhalations from the article being heated.

[0101] Figure 17 depicts a method 400 of operating an aerosol provision device (e.g. the aerosol provision device 4 shown in Figure 1 and described above) in accordance with an embodiment. At step 402, the method comprises controlling operation of a heating arrangement during a first period of time based on the temperature of a first region of the heating arrangement and not the temperature of any other region of the heating arrangement. In step 404, the method may further comprise controlling operation of the heating arrangement during a second period of time based on a temperature of a second region of the heating arrangement and not the temperature of any other region of the heating arrangement. In step 406, the method may further comprise controlling operation of the heating arrangement during a third period of time based on a temperature of a third region of the heating arrangement and not the temperature of any other region of the heating arrangement.

[0102] Any of the features of the devices discussed herein may similarly be employed by the method described above.

[0103] The various embodiments described herein are presented only to assist in understanding and teaching the claimed features. These embodiments are provided as a representative sample of embodiments only, and are not exhaustive and/or exclusive. It is to be understood that advantages, embodiments, examples, functions, features, structures, and/or other aspects described herein are not to be considered limitations on the scope of the invention as defined by the claims or limitations on equivalents to the claims, and that other embodiments may be utilised and modifications may be made without departing from the scope of the claimed invention. Various embodiments of the invention may suitably comprise, consist of, or consist essentially of, appropriate combinations of the disclosed elements, components, features, parts, steps, means, etc, other than those specifically described herein. In addition, this disclosure may include other inventions not presently claimed, but which may be claimed in future.

Claims

1. An aerosol provision device comprising:

a heating arrangement configured to heat an article comprising an aerosol generating material when the article is inserted into the device; a first temperature sensor arranged to detect the temperature of a first region of the heating arrangement; a second temperature sensor arranged to detect the temperature of a second region of the heating arrangement; and a controller configured to control operation of the heating arrangement, wherein during operation of the device; during a first period of time, the controller is configured to control operation of the heating arrangement based on the temperature detected by the first temperature sensor and not the temperature detected by the second temperature sensor.

2. An aerosol provision device according to claim 1, wherein during a second period of time, the controller is configured to control operation of the heating arrangement based on the temperature detected by the second temperature sensor and not the temperature detected by the first temperature sensor.
3. An aerosol provision device according to claim 1 or 2, wherein the controller is configured to control operation of the heating arrangement by controlling a magnitude of a current supplied to the heating arrangement.
4. An aerosol provision device according to any preceding claim, wherein the first region and second region are displaced along a length of the heating arrangement.
5. An aerosol provision device according to any preceding claim, wherein the first period of time and second period of time occur during a single inhalation from the aerosol provision device.
6. An aerosol provision device according to any preceding claim, wherein the heating arrangement comprises an inductive heating arrangement.
7. An aerosol provision device according to claim 6, wherein the inductive heating arrangement comprises a susceptor, shaped to receive the article during use, and at least one inductor coil surrounding the susceptor.
8. An aerosol provision device according to claim 7, wherein the first and second temperature sensors are arranged to detect the temperature of the susceptor.
9. An aerosol provision device according to any pre-

ceding claim, wherein during at least a period of time subsequent to the first and second periods of time, the heating arrangement is controlled based on:

a temperature detected by the first temperature sensor and not a temperature detected by the second temperature sensor; or
a temperature detected by the second temperature sensor and not a temperature detected by the first temperature sensor.

the temperature of any other region of the heating arrangement.

10. An aerosol provision device according to any preceding claim, further comprising a third temperature sensor arranged to detect the temperature of a third region of the heating arrangement, and wherein during a third period of time, the controller is configured to control operation of the heating arrangement based on the temperature detected by the third temperature sensor and not the temperature detected by the first or second temperature sensor.
11. An aerosol provision device according to any preceding claim, wherein during the first period of time, the heating arrangement is controlled such that the temperature detected by the first temperature sensor is at a first temperature for a first sub-period of time before changing to a second temperature for a second sub-period of time.
12. An aerosol provision device according to claim 11, wherein during the second period of time, the heating arrangement is controlled such that the temperature detected by the second temperature sensor rises from a third temperature to a fourth temperature during a third sub-period of time.
13. An aerosol provision system comprising:
an aerosol provision device according to any preceding claim; and
an article, comprising an aerosol generating material, for insertion into the aerosol provision device.
14. A method of operating an aerosol provision device comprising a heating arrangement for heating an article comprising an aerosol generating material, the method comprising:
controlling operation of the heating arrangement during a first period of time based on a temperature of a first region of the heating arrangement and not the temperature of any other region of the heating arrangement.
15. The method of claim 14, further comprising controlling operation of the heating arrangement during a second period of time based on a temperature of a second region of the heating arrangement and not

Fig. 1

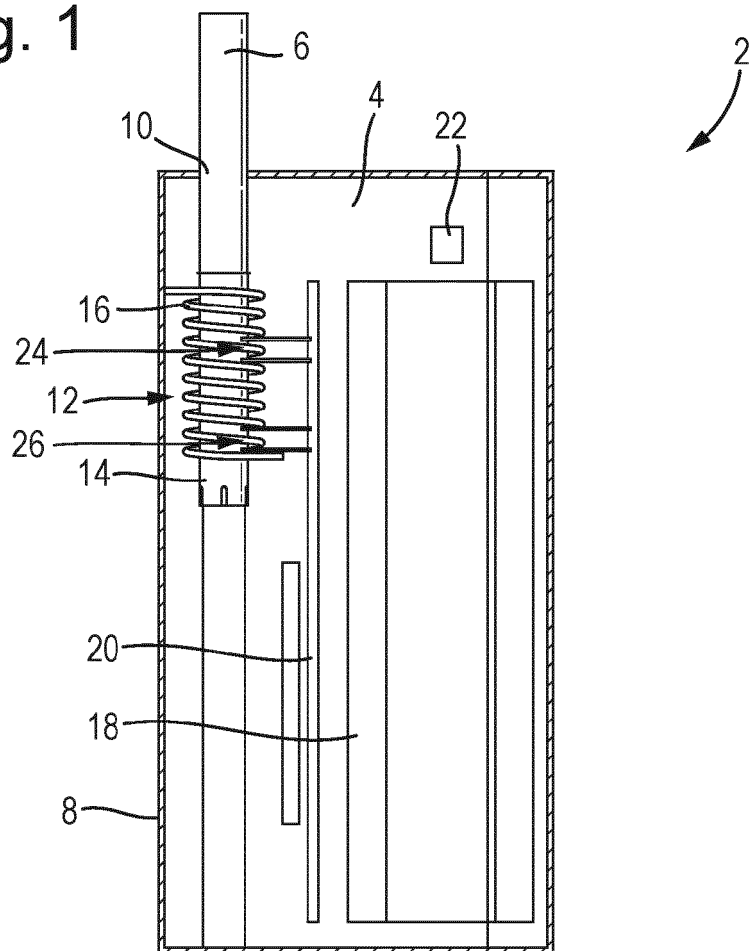


Fig. 2

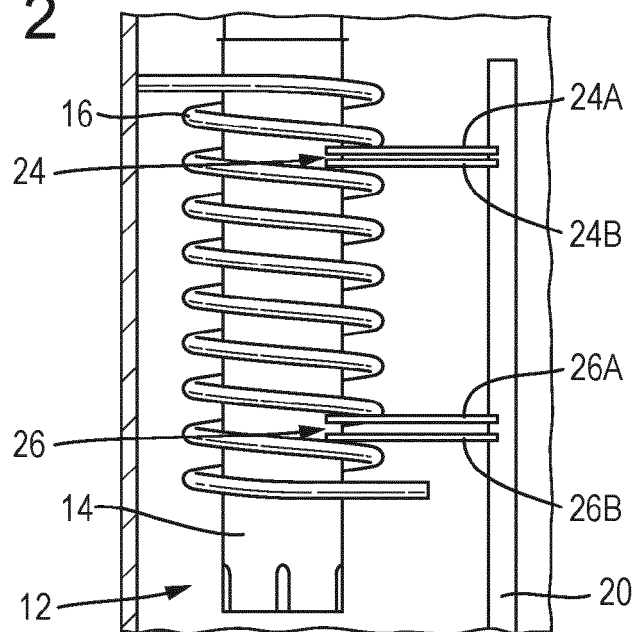


Fig. 3

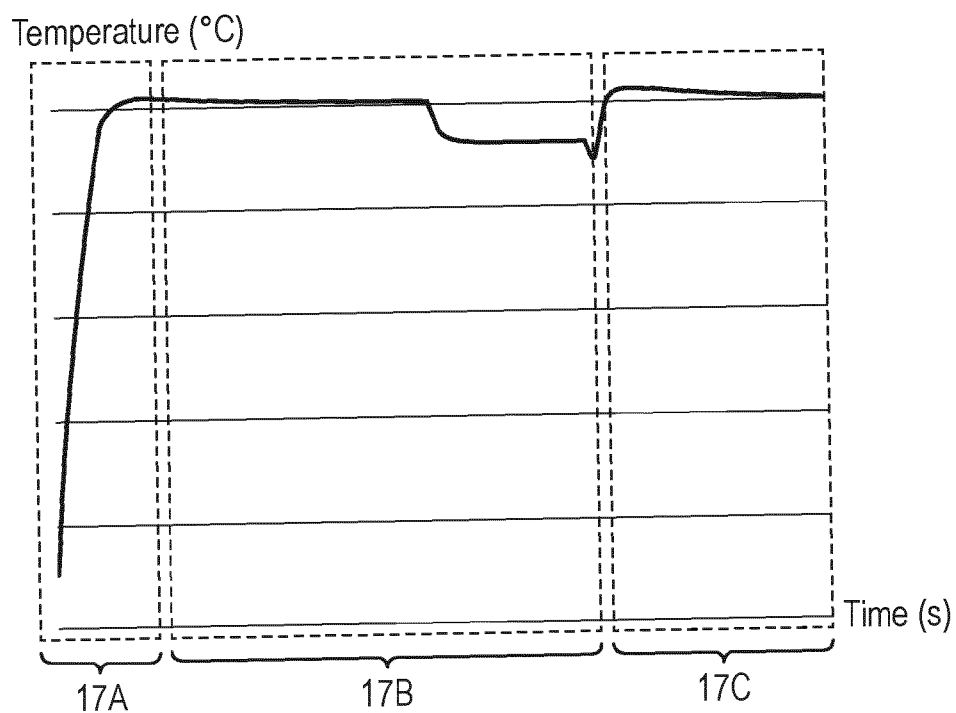


Fig. 4

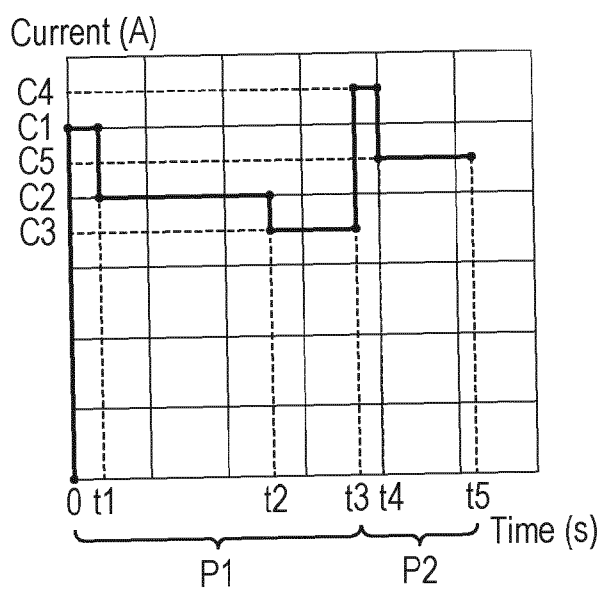


Fig. 5

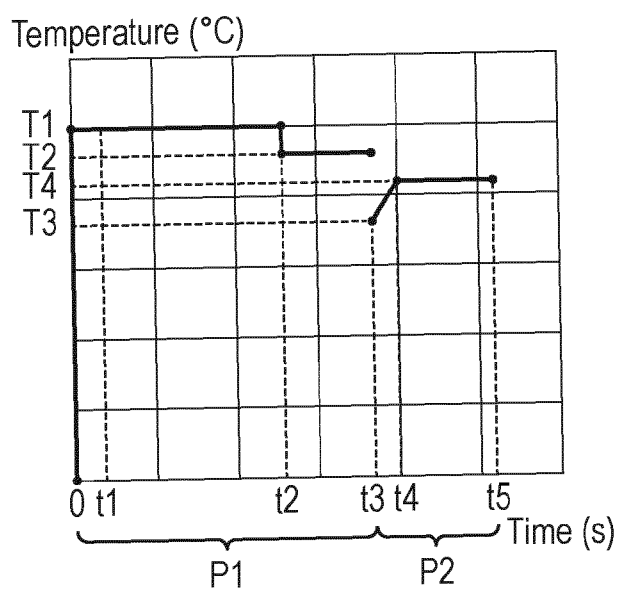


Fig. 6

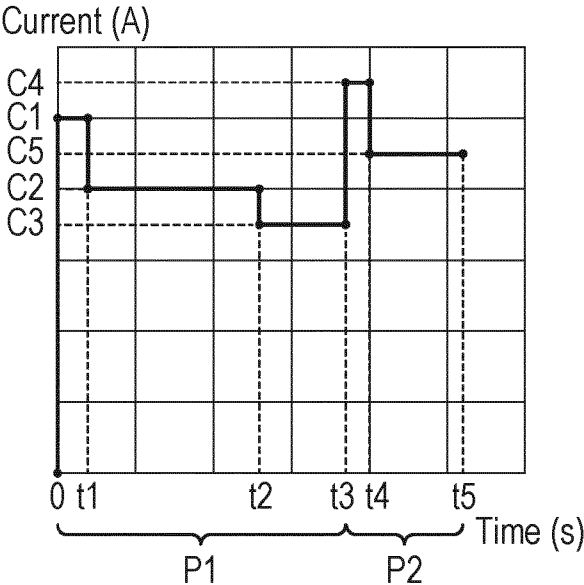


Fig. 7

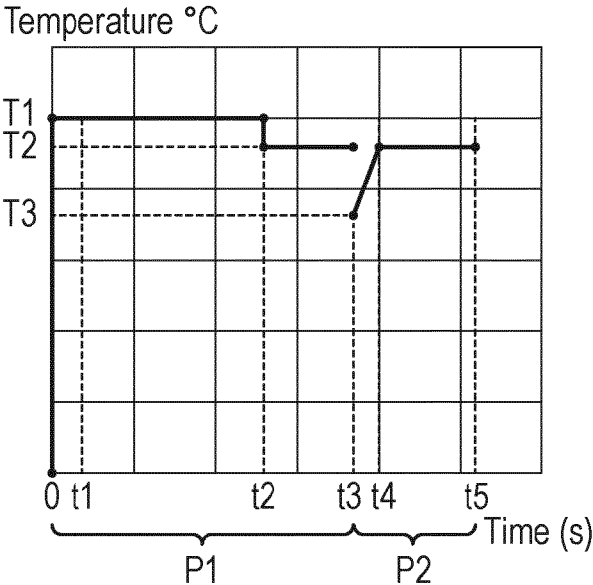


Fig. 8

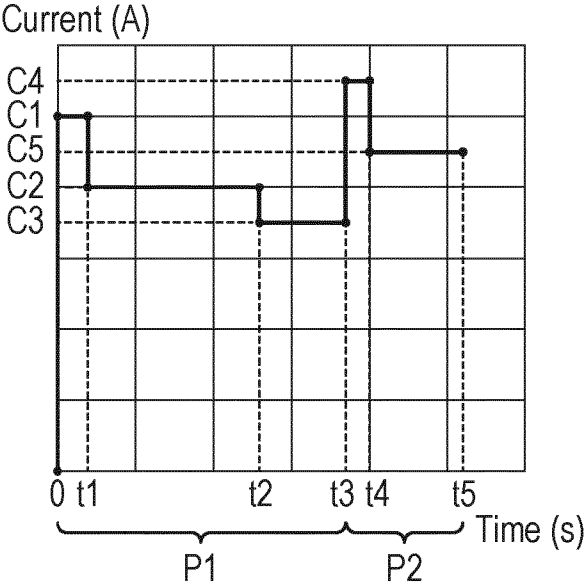


Fig. 9

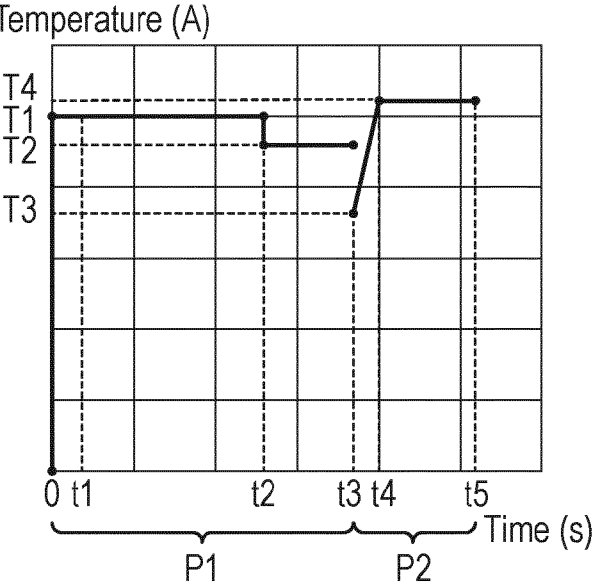


Fig. 10

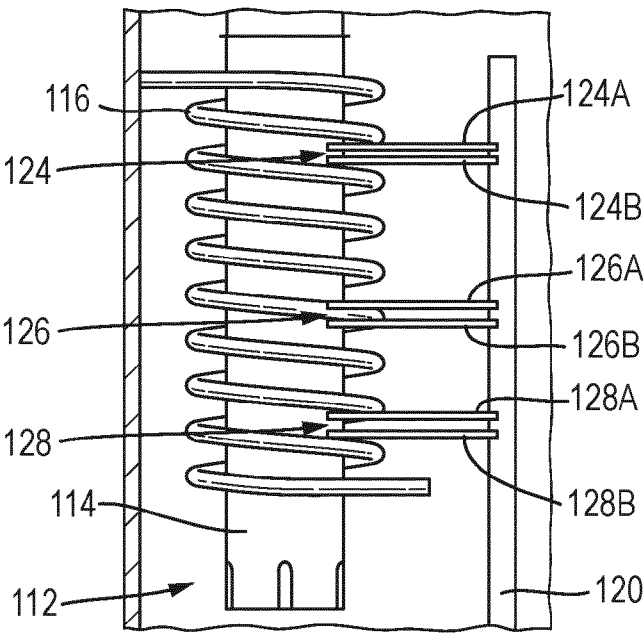


Fig. 11

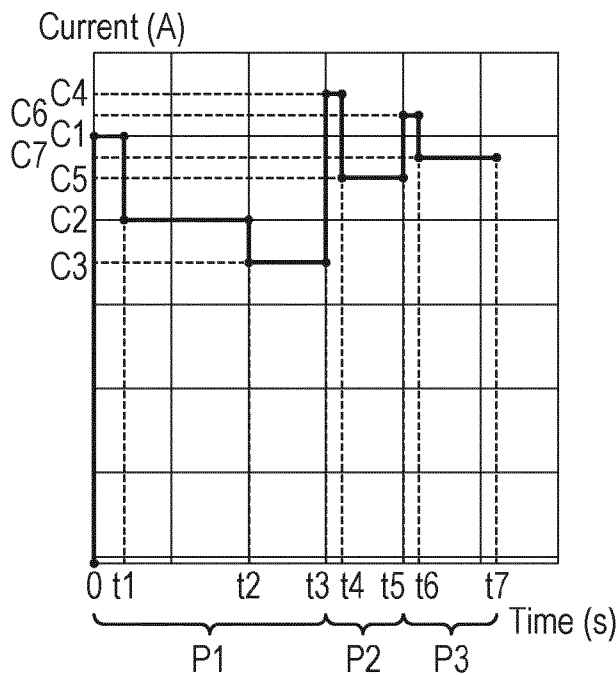


Fig. 12

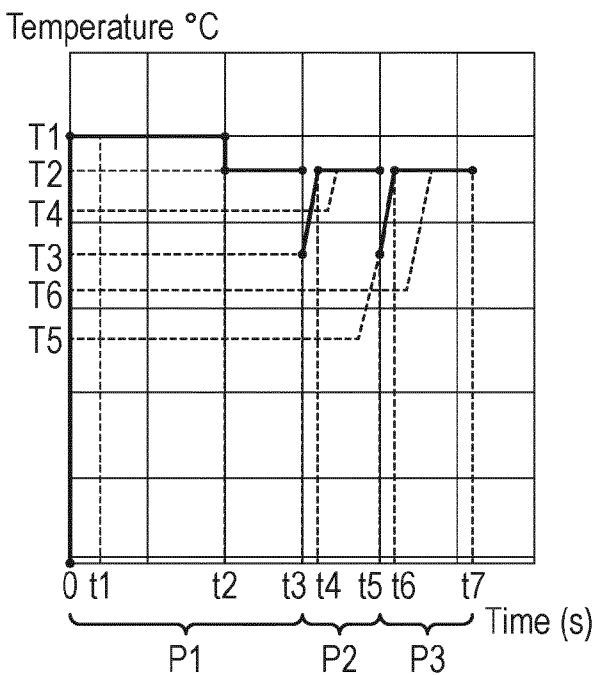


Fig. 13

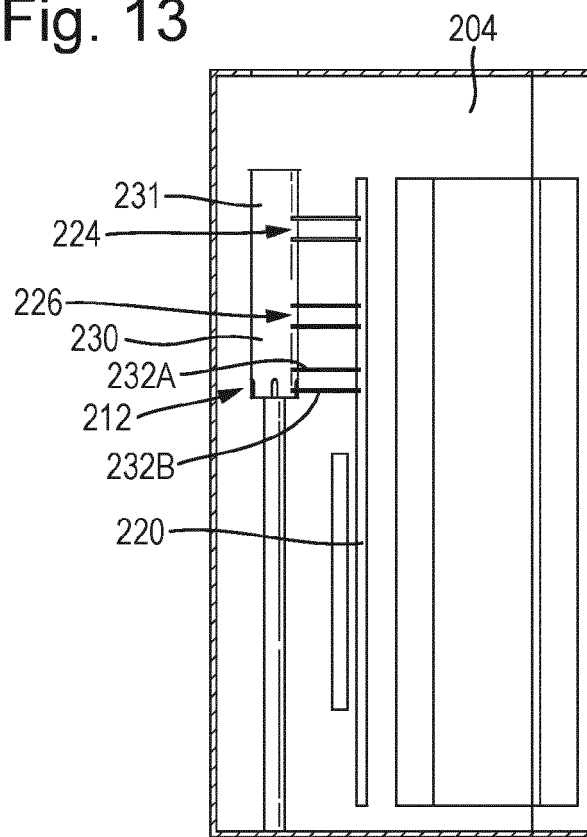


Fig. 14

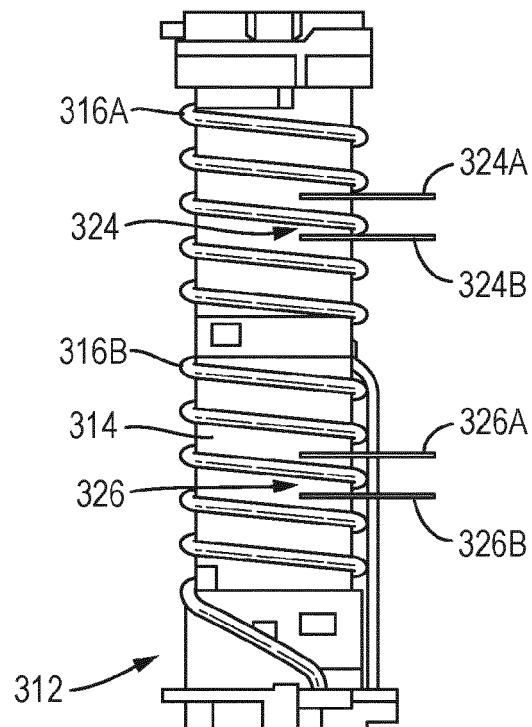


Fig. 15

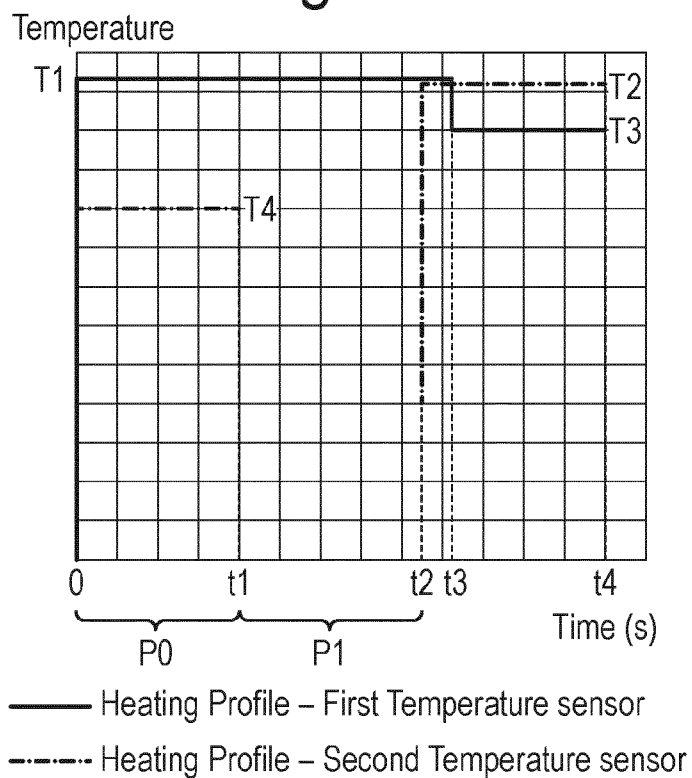


Fig. 16

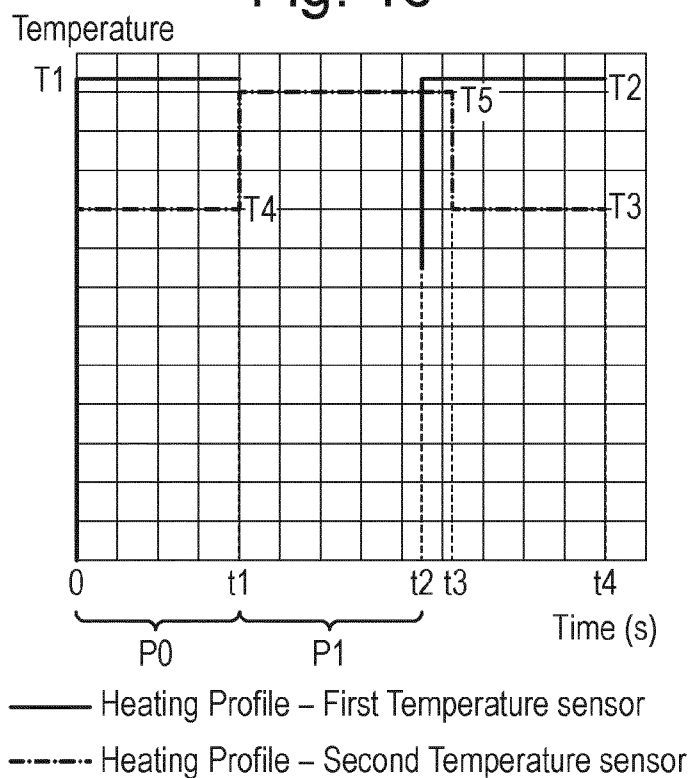
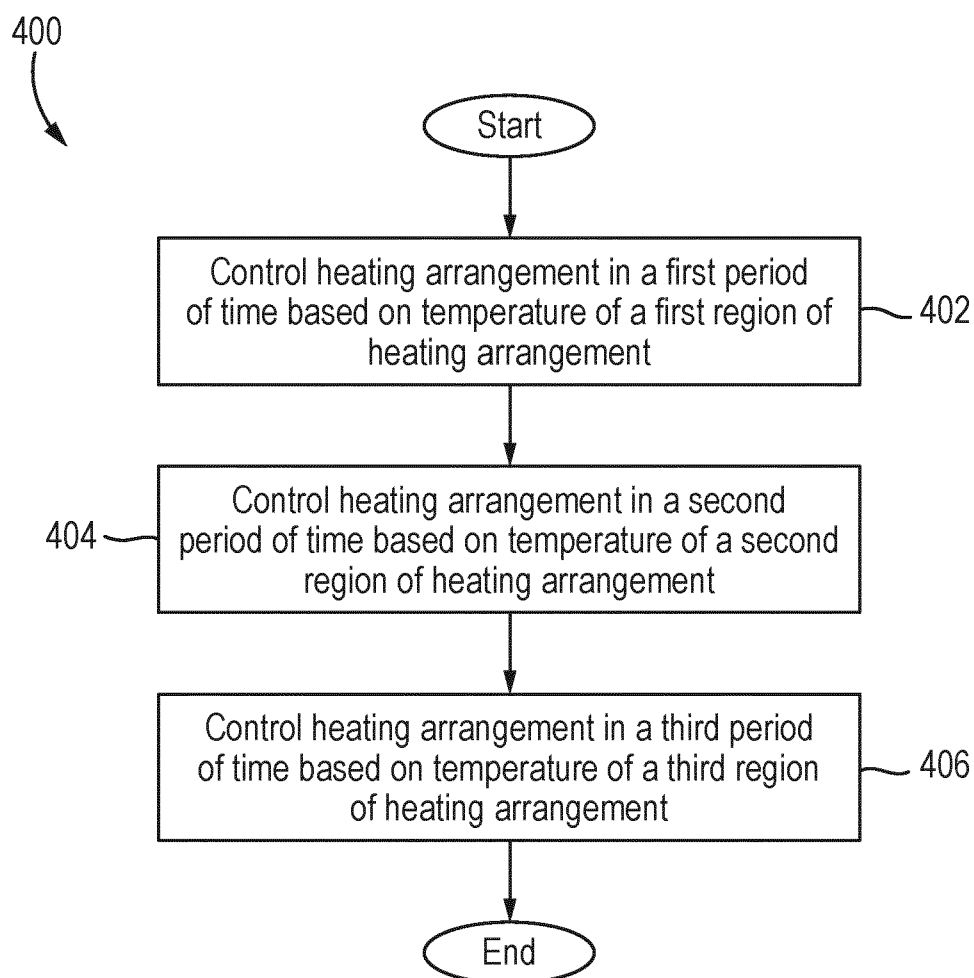


Fig. 17





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Application Number

EP 24 15 7443

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The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
Munich		16 September 2024	Anticoli, Claud
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