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(54) AEROSOL GENERATING APPARATUS

(57) An aerosol generating apparatus is provided comprising a controller operatively connected to a heater. The heater is configured to heat, according to a power profile, an aerosol precursor provided in a consumable. The controller is configured to: measure usage data relating to a user operation of the aerosol generating apparatus during one or more initial consumable heating cycles; determine the power profile for the heater based on the usage data; and apply the power profile to the heater during a subsequent consumable heating cycle.

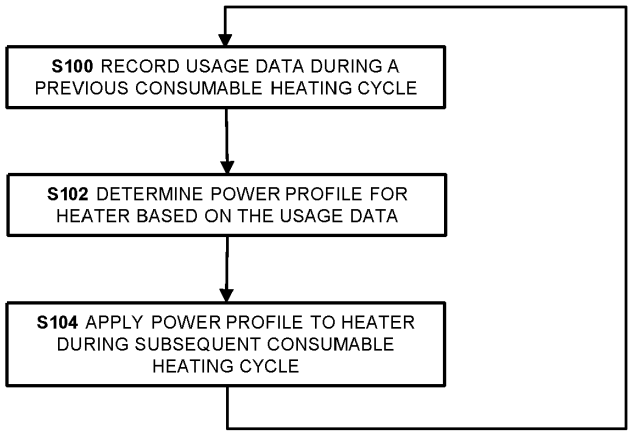

Fig. 4

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Description

FIELD

[0001] The present disclosure relates to an aerosol generating apparatus and to a method of controlling the power supply 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. Typically, the aerosol generating unit includes a heater which is driven by the power supply to generate the aerosol.

[0003] There are a number of different categories of aerosol generating apparatus including heated tobacco ("HT" or "heat not burn" - "HNB") apparatuses, in which the aerosol precursor is a solid substrate such as tobacco, and "vaping" apparatuses, in which the aerosol precursor is a vaporisable liquid, typically referred to (and referred to herein) as "e-liquid".

[0004] In both types of system the heater must be heated to a high enough temperature to generate an aerosol having particularly desired characteristics. However, this requires a significant amount of power from the power supply. Therefore, when the system is powered by a finite power source, such as a battery, the power drawn by the heater can have a significant effect on the length of time the apparatus is able to operate before the power source needs to be recharged. Accordingly, a drawback with known aerosol generating apparatuses is the limited operation length of the apparatus owing to the power draw of the heater.

[0005] HT apparatuses generally provide continuous heating of the aerosol precursor, including between puffs. Accordingly, the capacity of HT apparatuses to deliver multiple heating cycles is limited since the heater is continuously drawing power and the aerosol precursor is being exhausted, even when the user is not using the apparatus.

[0006] In spite of the effort already invested in the development of aerosol generating apparatuses/systems, further improvements are desirable.

SUMMARY

[0007] Broadly, the present invention provides an aerosol generating apparatus which is configured to reduce power consumption by adjusting a power supply to the heater according to a power profile which is tailored to how a specific user uses the aerosol generating apparatus. This enables the apparatus to be operated in a more power-efficient manner by predicting periods of inactivity when the heater does not need to operate at peak power.

[0008] Accordingly, in a first aspect of the present invention there is provided an aerosol generating apparatus, comprising a controller operatively connected to a heater, the heater being configured to heat, according to a power profile, an aerosol precursor provided in a consumable, wherein the controller is configured to:

measure usage data relating to a user operation of the aerosol generating apparatus during one or more initial consumable heating cycles;
determine the power profile for the heater based on the usage data; and apply the power profile to the heater during a subsequent consumable heating cycle.

[0009] Advantageously, by applying a power profile to the heater based on data relating to an initial (i.e., previous) consumable heating cycle, periods of inactivity, where the apparatus is not being inhaled from, may be predicted based on past user behaviours. Accordingly, the power supply to the heater may be reduced during periods of inactivity thereby increasing the power efficiency of the apparatus and increasing the battery lifetime.

[0010] Additionally, the power profile being based on the usage data measured during a consumable heating cycle can enable periods of activity, such as a user inhaling from the apparatus, to be predicted more accurately. For example, the power supply to the heater may be increased in preparation for an inhalation or reduced when no inhalation is predicted. Therefore, the apparatus can be more power efficient than apparatuses which do not determine data relating to a previous cycle, because the heater can reduce its power consumption for a longer time between inhalations and increase its temperature more slowly prior to inhalations thereby decreasing the overall power consumption of the aerosol generating apparatus.

[0011] In this way, the power profile for the heater may be tailored to a specific user of the apparatus, thereby optimising the operation of the apparatus for that user and extending the operation life of the apparatus without detracting from the user experience of the apparatus.

[0012] The aerosol generating apparatus may be configured for engagement with (i.e. the consumable may be in the form of) a heated tobacco (HT) consumable. In this respect, the aerosol generating apparatus may be referred to as a heat-not-burn (HNB) aerosol generating apparatus or a heated tobacco aerosol generating apparatus. The terms "heated tobacco" and "heat-not-burn" are used interchangeably herein to describe a consumable that is of the type that is heated rather than combusted (or are used interchangeably to describe an aerosol generating apparatus for use with such a consumable). In some HT systems, the substrate does not include tobacco. For example, the substrate may be formed with an alternative source of cellulose substrate,

with added nicotine, flavour, and/or aerosol precursor.

[0013] The aerosol precursor may comprise a solid substrate. For example, the solid substrate may comprise tobacco.

[0014] The controller (which may also be referred to herein as a processor) may form part of a control unit which is configured to control one or more functions of the aerosol generation apparatus. The controller may be a microcontroller which is mounted on a printed circuit board (PCB).

[0015] The control unit may also comprise a memory, e.g. non-volatile memory, which is in communication with the controller. The memory may include instructions, which, when implemented, cause the controller to perform certain tasks or steps of a method.

[0016] A consumable heating cycle, which may be referred to herein as a heating session or a consumable cycle, may be defined as a period during which the heater is activated for producing an aerosol from an aerosol precursor contained in one particular consumable or cartridge. The consumable heating cycle may be considered to have ended when the aerosol precursor is exhausted. When a new consumable is detected, or when a user exhausts the aerosol precursor and replaces the consumable, the user may initiate a new consumable heating cycle. In some examples a consumable heating cycle may be defined as the time between activation of the heater (e.g. by a user) and deactivation of the heater (e.g. by a user or a controller of the apparatus).

[0017] A consumable heating cycle may be limited to a predetermined period of time associated with a consumable. For example, the period of time may be determined based on how long the consumable can be heated for in a heating session before the aerosol precursor is exhausted. The controller may be configured to monitor an elapsed duration of a current consumable cycle and terminate the current consumable cycle when the elapsed duration has exceeded the predetermined period of time associated with that consumable.

[0018] For example, a consumable heating cycle may be at least 1 minute, more preferably at least 3 minutes, more preferably at least 5 minutes long.

[0019] The controller may be configured to detect the presence of a new consumable in the apparatus. Therefore the subsequent consumable heating cycle may be determined to have begun when a new consumable is detected.

[0020] The power profile may comprise information relating to power settings for the heater and time periods for applying those power settings to the heater. For example, determining the power profile may comprise determining a low power duration for operating the heater in a low power setting between inhalations (i.e., puffs) from the aerosol generating apparatus, the heater being operated in a high power setting during the inhalations. This duration may also be referred to herein as a "deadtime" or a "standby period" since it refers to a period between inhalations where the heater is not required to heat the aerosol precursor to a temperature suitable for generating an aerosol.

[0021] The heater may be operated at a low power setting for a low power duration which is determined by the controller. The heater temperature may be increased to a higher temperature which is closer to an operational temperature for generating the aerosol before a user inhales from the apparatus.

[0022] Therefore, the aerosol may be generated more quickly in response to an inhalation being detected compared to apparatuses in which the heater may only be activated in response to detecting an inhalation.

[0023] Applying the power profile to the heater may comprise detecting inhalations (also referred to as "puffs") from the aerosol generating apparatus and adjusting the supply of power to the heater (or the power consumption of the heater, or a setting of the heater) in-between inhalations to a low power setting.

[0024] The magnitude of the adjustment and/or the duration for which the low power setting is maintained may be defined by the power profile. An expected duration between inhalations may be predicted based on the usage data measured during the one or more initial consumable heating cycles. The expected duration may be used to determine a minimum low power duration for maintaining the heater in the low power setting after an inhalation.

[0025] Reducing the temperature of the heater (e.g., by adjusting the power to the heater) during the standby periods between puffs can increase the overall power efficiency of the apparatus. However, there is a risk that the heater will not be at a suitable temperature for generating aerosol when the user next inhales from the apparatus. Therefore, by determining the power profile based on usage data measured during the one or more initial consumable heating cycles, this risk is reduced because the power profile may be able to more accurately predict when a user might next inhale from the apparatus. Accordingly, the overall power consumption of the apparatus may be reduced without detriment (or with minimal detriment) to the user experience of the apparatus.

[0026] As discussed in detail below, adjusting the power consumption of the heater may include adjusting a temperature of the heater to a target temperature. For example, the controller may be configured to reduce the temperature of the heater from the first temperature to a second (standby) temperature in-between inhalations, wherein the low power setting for the heater mentioned above corresponds to the operation of the heater when the heater is at the second temperature. Similarly, the high power setting for the heater mentioned above can correspond to the operation of the heater when the heater is at the first temperature. Accordingly, the power profile may be a temperature profile for the heater.

[0027] More specifically, applying the power profile to the heater may comprise reducing the temperature of the heater from the first temperature to the second tempera-

ture after an inhalation. For example, the controller may be configured to detect inhalations from the aerosol generating apparatus during the subsequent consumable heating cycle, and adjust the power supply to the heater upon, or subsequent to, detecting the end of an inhalation such that the temperature of the heater is reduced from the first temperature to the second temperature.

[0028] The controller may be configured to adjust the temperature of the heater by restricting the power supply to the heater (e.g. partly reducing or fully preventing the supply of power to the heater). For example, the controller may be configured to apply pulse width modulation to the power supply to the heater, and the reduction in temperature may be performed by reducing the duty cycle of the power supply to the heater.

[0029] The first temperature may be an aerosol generating temperature for generating an aerosol from the aerosol former that has desired characteristics (for inhalation). The first temperature may, for example, be between 330°C and 360°C. The first temperature may be between 340°C and 350°C, and may be about 345°C.

[0030] The second temperature may be higher than an ambient temperature of the aerosol generation apparatus. That is, the heater may be configured to continuously heat the aerosol precursor, even between puffs. Therefore, the temperature of the aerosol precursor may be increased more quickly during a puff than if the heater were configured to be deactivated between puffs. This is particularly useful for HT apparatuses with a solid aerosol forming substrate which may be slower to heat than liquid precursors.

[0031] The second temperature may be above 50°C, or above 100°C. The second temperature may be less than 300°C, or less than 275°C, or less than 250°C, or less than 200°C, or less than 150°C, or less than 100°C. The second temperature may be below a minimum temperature for generating an aerosol from the aerosol former.

[0032] In some embodiments, the second temperature may be equal to or greater than 5°C lower than the first temperature. The second temperature may be more than 20°C lower than the first temperature, or more than 50°C lower, or more than 100°C lower.

[0033] The controller may be configured to reduce the temperature of the heater from the first temperature to the second temperature immediately following the end of an inhalation. A time between the end of the inhalation and the (i.e. start of the) reduction in temperature may be less than 3 seconds, or less than 2 seconds, or less than 1 second.

[0034] The controller may be configured to maintain the heater at the second temperature for a low temperature duration. The low temperature duration may be defined by the power profile for the heater. For example, determining the power profile for the heater may comprise determining a low temperature duration for maintaining the heater at the second temperature. Therefore, the low temperature duration may be based on the usage data measured during the one or more initial consumable heating cycles of the apparatus.

[0035] The controller may be configured to increase the temperature of the heater to the first temperature after the low temperature duration has elapsed. Therefore, the heater may be at a suitable temperature for producing an aerosol when the user next inhales from the apparatus.

[0036] In other examples, the controller may be configured to increase the temperature of the heater to a third temperature after the low temperature duration has elapsed. The third temperature may be lower than the first temperature (i.e. between the first and second temperatures).

[0037] The third temperature may be lower than an aerosol generating temperature. In other words, the third temperature may not be suitable for generating an aerosol (or at least generating an aerosol having desired characteristics) from the aerosol former. Alternatively, the third temperature may be an aerosol generating temperature (but may e.g. not be an optimal temperature for generating an aerosol having desired characteristics).

[0038] The third temperature may be less than 330°C, or less than 300°C, or less than 250°C, or less than 200°C. The third temperature may be greater than 100°C, or greater than 200°C, or greater than 250°C, or greater than 300°C.

[0039] The third temperature may be referred to as a priming temperature. Thus, the third temperature may be such that the power supply is capable of heating the heater from the third temperature to the first temperature in less than 2 seconds, or e.g. less than 1 second. In this way, the delay in temperature increase may be imperceptible to a user.

[0040] The controller may be configured to increase the temperature of the heater from the third temperature to the first temperature upon detection of an inhalation from the apparatus.

[0041] The aerosol generating apparatus may comprise a sensor. The aerosol generating apparatus may comprise a puff sensor (e.g. airflow sensor) for detecting inhalations. The puff sensor may be a pressure sensor or an acoustic sensor. The puff sensor may be configured to detect a user puffing (i.e. inhaling) from the aerosol generating apparatus (or from an aerosol-forming article engaged with the aerosol generating apparatus). The puff sensor may be configured to produce a signal indicative of a puff state. The puff sensor may be configured to produce a signal indicative of a characteristic of the puff (e.g. flow rate, length of time, etc.). The puff sensor may be configured to produce a signal indicative of the start and/or end of a puff.

[0042] Accordingly, the controller may be configured to reduce the temperature of the heater from the first temperature to the second temperature in response to a signal from the puff sensor indicative of the end of a puff.

[0043] The aerosol generating apparatus may comprise a temperature sensor for measuring a temperature

of the heater. Additionally or alternatively, the aerosol generating apparatus (e.g. the controller) may be configured to determine the temperature of the heater. For example, the aerosol generating apparatus maybe configured to determine the temperature of the heater based on an electrical resistance of the heater.

[0044] Accordingly, the controller may be configured to control the temperature of the heater based on a measured temperature from the temperature sensor or from resistance of the heater. Reducing and/or increasing the temperature of the heater to a particular desired temperature (e.g. first, second, or third temperature) may thus comprise altering the power supply to the heater to reduce/increase the temperature until the measured temperature passes (e.g. exceeds or falls below) the desired temperature. To achieve this, the controller may thus compare the measured temperatures with the desired (first, second or third) temperature.

[0045] Maintaining the temperature at the second temperature may comprise maintaining the temperature within a temperature range that includes the second temperature (i.e. but having upper and lower limits that are close to the second temperature).

[0046] The controller may be configured to apply pulse width modulation to the power supply. In this example, applying the power profile to the heater may comprise adjusting the duty cycle of the power supply. In other examples, the controller may be configured to adjust the power supply to the heater by modifying a current or a voltage of the heater. In other examples, the controller may be configured to adjust a target temperature of the heater such that the heater draws more or less power from the power supply depending on the target temperature.

[0047] Applying the power profile may comprise repeating the temperature reduction and temperature maintenance following each puff (inhalation) in a series of at least two puffs. The controller may be configured to repeat the temperature reduction and temperature maintenance for each puff in a consumable heating cycle.

[0048] The one or more initial consumable heating cycles (which may be referred to as a previous consumable cycle(s)) may be one or more most recent consumable heating cycle of the aerosol generating apparatus. In other examples, the one or more initial consumable heating cycle may be one or more previous consumable heating cycles associated with a particular consumable inserted in the device or with a particular user of the device. Therefore, the usage data collected during the initial consumable heating cycle(s) may be referred to as historical usage data relating to one or more previous consumable heating cycles.

[0049] The one or more initial consumable heating cycles may be a plurality of previous consumable heating cycles. That is, the controller may be configured to measure data relating to a plurality of consumable heating cycles. For example, the plurality of consumable heating cycles may comprise a predetermined number of the most recent previous consumable cycles. By collecting data for a plurality of consumable cycles, a more accurate representation of user behaviour may be accumulated thereby increasing the effectiveness of the power profile at increasing power efficiency for that particular user.

[0050] The predetermined number of previous consumable cycles may include between two and ten, more preferably between three and eight, more preferably six of the most recent consumable heating cycles. The present inventors have found that this number of consumable heating cycles is desirable for representing an accurate picture of user behaviour when they are using the aerosol generating apparatus while also enabling the power profile to be adapted to changing user behaviours.

[0051] The usage data measured during to the one or more initial consumable heating cycles may comprise information relating to how the apparatus has been used in the one or more consumable heating cycles. The usage data may comprise one or more of: a frequency of inhalations from the apparatus, durations measured between inhalations, the shortest and/or longest durations recorded between inhalations, an average duration measured between inhalations, etc. The usage data may also include information relating to device settings during the one or more initial consumable heating cycles. For example, the usage data may comprise one or more of: a user identity, or a type of consumable, or a device mode used during the consumable heating cycle (e.g., a lower or higher temperature -mode).

[0052] Measuring the usage data may comprise detecting inhalations from the aerosol generating apparatus during the one or more initial consumable heating cycles and measuring elapsed time periods between consecutive inhalations. The elapsed time periods between consecutive inhalations may also be referred herein to as historical durations between inhalations.

[0053] When the power profile for the heater comprises a low temperature duration for maintaining the heater at the second temperature after an inhalation, the low temperature duration may be calculated based on the elapsed time periods measured during the one or more initial consumable heating cycles.

[0054] The controller may be configured to determine a shortest elapsed time period between inhalations during the one or more initial consumable heating cycles. In this example, the controller may be configured to set the low power duration to the shorted elapsed time period from the one or more initial consumable heating cycles. The shortest elapsed time period may give an indication of how soon the user might be expected to inhale from the apparatus again after a previous inhalation. Therefore, the apparatus can usefully maintain the heater at the second temperature for the shorted elapsed time period, thereby reducing power consumption and increasing the temperature of the heater in preparation for a subsequent inhalation.

[0055] In examples where the usage data is collected for a plurality of initial consumable heating cycles, the

controller may be configured to calculate an average shortest time period measured between inhalations for each of the plurality of consumable heating cycles. Therefore, the low temperature duration may be based on the average shortest time period between inhalations. The low temperature duration may be set to the calculated average shortest duration between inhalations.

[0056] For example, the low temperature duration may be calculated according to:

$$T_{duration} = \frac{\sum_{n=1}^{N} min(t_i)}{N}$$

where $T_{duration}$ is the low temperature duration, N is the number of previous consumable heating cycles, and *min* (t_i) is the shortest measured duration between inhalations for each, nth, consumable heating cycle.

[0057] The controller may be configured to measure additional usage data during the subsequent consumable cycle; and update the power profile for the heater based on the additional usage data. For example, the low temperature duration may be updated for each new consumable cycle based on the additional usage data.

[0058] The average of the shortest elapsed time periods between inhalations may be a rolling average of the shortest time periods from the most recent (n) consumable heating cycles. The rolling average may be updated after the subsequent consumable heating cycle. By updating the power profile after each cycle, changes in user behaviour of the apparatus may be reflected in the resulting power profile for the heater thereby ensuring that the heater is more likely to be a suitable temperature when the user inhales whilst still improving the power efficiency of the apparatus.

[0059] The controller may be configured to interrupt the low temperature duration upon detection of a second inhalation and return the heater to the first temperature for producing the aerosol. Therefore, if the second inhalation is detected before the low temperature duration following the end of the first inhalation has elapsed, then the heater will be triggered to heat up and generate the aerosol without waiting for the remainder of the low temperature duration to elapse.

[0060] The controller may be configured to update the low temperature duration for maintaining the heater at the second temperature if a user inhales from the apparatus before the low temperature duration has elapsed. In other words, the controller may be configured to detect a first inhalation during the subsequent consumable heating cycle, detect a second, consecutive, inhalation during the subsequent consumable heating cycle, and, if the second inhalation is detected before the low temperature duration following the end of the first inhalation has elapsed, determine a new value for the low temperature duration based on an elapsed duration between the first inhalation and the second inhalation. By updating the low power duration, the apparatus can adapt to changes in user behaviour.

[0061] In some examples, the controller may be configured to turn off the heater (and optionally the aerosol generating apparatus) if a second inhalation is not detected after a predetermined period of time. Therefore, the apparatus need not continue consuming battery power by maintaining the heater at the first temperature if the user does not take another puff.

[0062] The controller may be configured to determine an initial power profile for the heater for a first consumable heating cycle of the apparatus. The initial power profile may be a predetermined power profile stored in a memory of the apparatus. For example, the initial power profile may include a predetermined initial low temperature duration for maintaining the heater in the low power setting (i.e., at the second temperature) during the first consumable heating cycle. For example, the predetermined initial low temperature duration may be between 0.5 seconds and 10 seconds, more preferably between 0.5 second and 7 seconds, more preferably about 5 seconds.

[0063] As mentioned above, the initial power profile may be retrieved from memory. In some examples, the initial power profile may be based on device settings of the apparatus. For example, the user may select a mode of the device indicating how frequently they wish to inhale.

[0064] In some examples, the controller may be configured to reset the power profile to the initial power profile in a subsequent consumable heating cycle. For example, the user may reset the power profile (and hence the low temperature duration) using a button provided on the apparatus or by using an application on a smart phone. This may be useful, for example, if the apparatus is being given to a new user. The power profile for the heater may then be re-tailored to suit the new user.

[0065] The aerosol generating apparatus may comprise a user interface for receipt of a user input. The controller may be configured to store and/or update a parameter value in the memory based on a user input received via the user interface. The parameter value may e.g. be representative of the predetermined time period and/or second temperature.

[0066] The heater may comprise a heating element may be in the form of a rod that extends from a body of the aerosol generating apparatus. The heating element may extend from an end of the body that is configured for engagement with the aerosol-forming article.

[0067] In a second aspect of the present invention there is provided a method of controlling the power supply of an aerosol generating apparatus having a heater configured to heat an aerosol precursor provided in a consumable, the method comprising: measuring usage data relating to a user operation of the aerosol generating apparatus during one or more initial consumable heating cycles; determining a power profile for the heater based on the usage data; and applying the power profile to the heater during a subsequent consumable heating cycle.

[0068] The method may be performed using the aerosol generating apparatus according to the first aspect. Thus the method may be performed by the controller which is operatively connected to the heater. The controller may be configured to perform each method step or function described herein.

[0069] The aerosol generating apparatus may comprise a memory. The memory may be e.g. non-volatile memory. The memory may include instructions, which, when implemented, may cause the controller to perform certain tasks or steps of the second aspect.

[0070] The memory may be configured to store one or more parameters (e.g. the predetermined time period and/or the second temperature). The controller may be configured to retrieve one or more parameters from the memory and control the heater based on a value of the parameter. For example, the controller may be configured to retrieve a stored predetermined time period value from the memory and control the heater so as to have a low power duration dictated by the stored predetermined time period value. Similarly, the controller may be configured to retrieve a stored second temperature value from the memory and control the heater so as to have a second temperature dictated by the stored second temperature value.

[0071] According to an additional aspect, there is provided a method of using the apparatus according to the first aspect, the method comprising inserting a consumable comprising an aerosol forming precursor article into the apparatus; and heating the precursor using the heater.

[0072] In some embodiments, the method may comprise inserting the consumable into a cavity within a body of the apparatus and penetrating the consumable with a heating element of the heater upon insertion of the consumable.

[0073] The present disclosure may provide electrical circuitry and/or a computer program configured to cause an aerosol generating apparatus/system to perform any method or method step disclosed herein. A computer-readable medium comprising the computer program is also disclosed.

[0074] In a further aspect of the present invention there is provided a computer-readable memory comprising instructions which when executed perform the method of the second aspect.

[0075] For the avoidance of doubt, it would be clear to the skilled person that the apparatus of the present aspect may include any features described herein for any other aspect of this disclosure.

[0076] In a further aspect of the present invention, there is provided a system (e.g. a smoking substitute system) comprising a smoking substitute apparatus according to the first aspect and an HNB consumable. The HNB consumable may comprise an aerosol-forming substrate at an upstream end of the HNB consumable. The HNB consumable may be in the form of a smoking substitute article, e.g. heated tobacco (HT) consumable (also known as a heat-not- burn (HNB) consumable).

[0077] 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

[0078] 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 solid precursor.

Fig. 3 is a schematic diagram showing an example implementation of the apparatus of Fig. 2.

Fig. 4 is a flowchart illustrating a method of controlling a power supply of an aerosol generating apparatus according to aspects of the present invention.

Fig. 5 is a flowchart illustrating a method of updating a power profile for a heater of an aerosol generating apparatus according to aspects of the present invention;

Fig. 6 is a flowchart illustrating a method of controlling a heater of an aerosol generating apparatus according to aspects of the present invention; and

Fig. 7 is a chart depicting the temperature of a heater, controlled according to the method of Fig. 6.

DETAILED DESCRIPTION OF EMBODIMENTS

[0079] 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.

[0080] 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.

[0081] Any patents, published patent applications, and non-patent publications mentioned in the specification are hereby incorporated by reference in their entirety.

[0082] 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.

[0083] 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.

[0084] 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).

[0085] 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.

[0086] 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.

[0087] The present disclosure may be better understood in view of the following explanations, wherein the terms used that are separated by "or" may be used interchangeably:

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

[0088] 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).

[0089] 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.

[0090] As used herein, an "**aerosol generating system**" may be a system that includes an aerosol generating apparatus and optionally other circuitry/components associated with the function of the apparatus, e.g. one or more external devices and/or one or more external components (here "external" is intended to mean external to the aerosol generating apparatus).

[0091] As used herein, an "external device" and "external component" may include one or more of a: a charging device, a mobile device (which may be connected to the aerosol generating apparatus, e.g. via a wireless or wired connection); a networked-based computer (e.g. a remote server); a cloud-based computer; any other server system.

[0092] An example aerosol generating system may be a system for managing an aerosol generating apparatus. Such a system may include, for example, a mobile device, a network server, as well as the aerosol generating apparatus.

[0093] 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.

[0094] 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.

[0095] 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.

[0096] 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.

[0097] 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.

[0098] 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.

[0099] 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.

[0100] 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.

[0101] As used herein, a "**heating system**" (or "heater") 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.

[0102] 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.

[0103] As used herein, an "**information carrying medium**" may include one or more arrangements for storage of information on any suitable medium. Examples include: a computer readable medium; a Radio

Frequency Identification (RFID) transponder; codes encoding information, such as optical (e.g. a bar code or QR code) or mechanically read codes (e.g. a configuration of the absence or presents of cut-outs to encode a bit, through which pins or a reader may be inserted).

[0104] As used herein "**heat-not-burn**" ("**HNB**"), "**heated tobacco**" ("HT"), or "**heated precursor**" may refer to the heating of a precursor, typically tobacco, without combustion, or without substantial combustion (i.e. localised combustion may be experienced of limited portions of the precursor, including of less than 5% of the total volume).

[0105] As used herein, a "**processing resource**" (or "**processor**" or **"controller")** may refer to one or more units for processing data, examples of which may include an ASIC, microcontroller, FPGA, microprocessor, digital signal processor (DSP) capability, state machine or other suitable component. A processing resource may be configured to execute a computer program, e.g. which may take the form of machine readable instructions, which may be stored on a non-transitory memory and/or programmable logic. The processing resource may have various arrangements corresponding to those discussed for the circuitry, e.g. on-board and/or off board the apparatus as part of the system. As used herein, any machine executable instructions, or computer readable media, may be configured to cause a disclosed method to be carried out, e.g. by an aerosol generating apparatus or system as disclosed herein, and may therefore be used synonymously with the term method.

[0106] As used herein, a "**computer readable medium/media**" (or **"memory"** or "**data storage**") may include any medium capable of storing a computer program, and may take the form of any conventional non-transitory memory, for example one or more of: random access memory (RAM); a CD; a hard drive; a solid state drive; a memory card; a DVD. The memory may have various arrangements corresponding to those discussed for the circuitry /processor. The present disclosure includes a computer readable medium configured to cause an apparatus or system disclosed herein to perform a method as disclosed herein.

[0107] 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.

[0108] Electrical circuitry (not shown in figure 1) may be implemented to control the interoperability of the power supply 4 and aerosol generating unit 6.

[0109] 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.

[0110] Fig. 2 shows an implementation of the apparatus 1 of Fig. 1, where the aerosol generating apparatus 1 is configured to generate aerosol by a heat not-burn / heated tobacco process.

[0111] In this example, the apparatus 1 includes a device body 50 and a consumable 70.

[0112] In this example, the body 50 includes the power supply 4 and a heater 52. The heater 54 includes at least one heating element 54. The body may additionally include any one or more of electrical circuitry 56, a memory 58, a wireless interface 60, one or more other components 62.

[0113] The electrical circuitry 56 may include a controller for controlling one or more operations of the body 50, e.g. based on instructions stored in the memory 58.

[0114] The wireless interface 60 may be configured to communicate wirelessly with an external (e.g. mobile) device, e.g. via Bluetooth.

[0115] The other component(s) 62 may include an actuator, 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).

[0116] The body 50 is configured to engage with the consumable 70 such that the at least one heating element 54 of the heater 52 penetrates into the solid precursor 6 of the consumable. In use, a user may activate the aerosol generating apparatus 1 to cause the heater 52 of the body 50 to cause the at least one heating element 54 to heat the solid precursor 6 of the consumable (without combusting it) by conductive heat transfer, to generate an aerosol which is inhaled by the user.

[0117] Fig. 3 shows an example implementation of the aerosol generating device 1 of Fig. 2.

[0118] As depicted in Fig. 3, the consumable 70 is implemented as a stick, which is engaged with the body 50 by inserting the stick into an aperture at a top end 53 of the body 50, which causes the at least one heating element 54 of the heater 52 to penetrate into the solid precursor 6.

[0119] The consumable 70 includes the solid precursor 6 proximal to the body 50, and a filter distal to the body 50. The filter serves as the mouthpiece of the consumable 70 and thus the apparatus 1 as a whole. The solid precursor 6 may be a reconstituted tobacco formulation.

[0120] In this example, the at least one heating element 54 is a rod-shaped element with a circular transverse profile. Other heating element shapes are possible, e.g., the at least one heating element 54 may be blade-shaped (with a rectangular transverse profile) or tube-shaped (e.g. with a hollow transverse profile).

[0121] In this example, the body 50 includes a cap 51. In use the cap 51 is engaged at a top end 53 of the body 50. Although not apparent from Fig. 3, the cap 51 is moveable relative to the body 50. In particular, the cap 51 is slidable and can slide along a longitudinal axis of the body 50.

[0122] The body 50 also includes an actuator 55 on an outer surface of the body 50. In this example, the actuator 55 has the form of a button.

[0123] The body 50 also includes a user interface device configured to convey information to a user. Here, the user interface device is implemented as a plurality of lights 57, which may e.g. be configured to illuminate when the apparatus 1 is activated and/or to indicate a charging state of the power supply 4. Other user interface devices are possible, e.g. to convey information haptically or audibly to a user.

[0124] The body may also include an airflow sensor which detects airflow in the aerosol generating apparatus 1 (e.g. caused by a user inhaling through the consumable 70). This may be used to count puffs, for example.

[0125] In this example, the consumable 70 includes a flow path which transmits aerosol generated by the at least one heating element 54 to the mouthpiece of the consumable.

[0126] In this example, the aerosol generating unit 4 is provided by the above-described heater 52 and the delivery system 8 is provided by the above-described flow path and mouthpiece of the consumable 70.

[0127] Fig. 4 shows a method of controlling a power supply of an aerosol generating apparatus according to aspects of the present invention, such as an HT device.

[0128] At step S100 the controller measures and stores usage data during at least one previous consumable heating cycle of the aerosol generating apparatus. Preferably, usage data is collected for a plurality of previous consumable heating cycles. The collected data includes at least a minimum elapsed time period recorded between puffs (i.e., inhalations) from the apparatus during the previous consumable heating cycle.

[0129] At step S102 the controller determines a power profile for the heater based on the collected usage data. The power profile comprises information relating to temperature values for the heater and temperature durations for maintaining the heater at those temperatures.

[0130] The temperature values for the heater include a first (operational) temperature for when the user is inhaling from the apparatus and the heater is operating in a high power setting, a second (standby) temperature for when the heater is operating in a low power setting between inhalations, and, optionally, a third (preheating) temperature which is higher than the second temperature and lower than the first temperature for when the heater is primed for an inhalation to happen.

[0131] The temperature durations of the power profile include a low temperature duration for maintaining the heater at the second temperature after an inhalation from the apparatus. The low temperature duration may also be referred to as a deadtime since the apparatus is not expected to be in use for generating an aerosol during this time.

[0132] Determining the power profile based on the collected data comprises calculating a minimum low temperature duration based on the elapsed time periods between inhalations that were recorded during the previous consumable heating cycles. This step is described in more detail below in relation to Fig. 5.

[0133] At step S104, the controller applies the power profile to heater during a subsequent consumable heating cycle. As described below in relation to Fig. 6, applying the power profile comprises detecting inhalations (puffs) during the subsequent consumable heating cycle, and in response to detecting the end of each inhalation, reducing the temperature of the heater from the first temperature to the second temperature.

[0134] The heater is maintained at the second temperature for at least the low temperature duration that was determined in step S102. In some examples, the controller is configured to return the temperature of the heater to the first temperature after the low temperature duration has elapsed. In other examples, as described below in relation to Fig. 6, the controller is configured to increase the temperature of the heater to a third (priming) temperature, which is lower than the first temperature, after the low temperature duration has elapsed.

[0135] However, if a user inhales from the apparatus before the low temperature duration has elapsed, then the controller is configured increase the temperature of the heater to the first temperature immediately. In this case, the controller is also configured to reset the previously determined low temperature duration to the current elapsed duration since the previous inhalation.

[0136] Fig. 5 is a flowchart illustrating a method of measuring and storing usage data during previous consumable heating cycles and updating the power profile for the heater based on the measured usage data.

[0137] At step S200 the controller records how much time has elapsed between puffs (i.e., inhalations of an aerosol from the apparatus). The apparatus comprises a puff detector, for example an airflow detector, which is configured to send a signal to the controller indicating when the user is inhaling from the apparatus. By comparing when the user is inhaling from the apparatus to a system clock, the controller can calculate how long the user has waited after each puff before taking another puff from the apparatus.

[0138] At step S202 the controller determines whether the current consumable heating cycle has ended. This may include determining if the consumable is empty, and/or if a new consumable has been inserted in the apparatus, and/or if the apparatus has been turned off since the last inhalation from the apparatus. If the consumable cycle has not yet ended, then the controller continues to record the durations between puffs.

[0139] If the consumable heating cycle has ended, then the controller moves to step S203 where the shortest duration between recorded puffs is determined for the previous consumable heating cycle. The shortest recorded duration is added to a database of shortest recorded durations from a plurality of previous consumable heating cycles. For example, the database may comprise the shortest recorded durations between puffs for the

previous six consumable heating cycles.

[0140] At step S204 the controller uses the database of recorded shortest durations to calculate an average shortest duration for the plurality of previous consumable heating cycles. The average indicates the average minimum time that the user of the apparatus tends to wait between puffs. In some examples, the average may be calculated for all of the previous consumable heating cycles of the apparatus. In other examples, the average may be a continuous average which is calculated and updated for a predetermined plurality of the previous consumable heating cycles.

[0141] At step S206 the controller updates the power profile for the heater by setting the low temperature duration for maintaining the heater at the second temperature to the average shortest duration that was calculated in step S204.

[0142] At step S208 a new consumable heating cycle is started by the user, for example by turning on the apparatus or by inserting a new consumable in the apparatus. The updated power profile is applied to the heater during the new consumable cycle and the controller returns to step S200 to begin recording durations between puffs during the new consumable heating cycle.

[0143] Fig. 6 is a flowchart illustrating a method of controlling a heater of an aerosol generating apparatus according to aspects of the present invention. Specifically, Fig. 6 shows a method of applying the calculated power profile to the heater of the aerosol generating apparatus during a consumable heating cycle.

[0144] At step S300, the controller detects the end of an inhalation (i.e., a puff) from the apparatus by a user. The occurrence of the end of the puff may be determined by the end of a signal from a puff sensor indicative of the presence of a puff. During the puff, the temperature of the heater is a first temperature which is suitable for producing an aerosol from the aerosol precursor.

[0145] In response to the detecting of the end of the inhalation, the controller moves to step S302 where the temperature of the heater is reduced from the first temperature (the temperature of the heating element during the puff) to a second temperature.

[0146] In step S304, the temperature of the heater is maintained for at least the low temperature duration or until the user takes another puff of the apparatus. The low temperature duration and the first and second temperatures are defined in the power profile which was determined as described above in relation to Fig. 5.

[0147] However, if the present consumable heating cycle is a first consumable heating cycle of the apparatus, then the controller is configured to apply an initial power profile to the heater. The initial power profile comprises a predetermined low temperature duration for maintaining the temperature of the heater at the second temperature after a puff. For example, the initial low temperature duration may be between 0.5 seconds and 10 seconds.

[0148] At step S306 the temperature of the heater is optionally increased to a third temperature after the low temperature duration has elapsed. The third temperature may be referred to as primer temperature which is higher than the second temperature and lower than the first temperature.

[0149] The temperature of the heater is maintained at the third temperature until the start of a subsequent puff is detected in step S308. In response to detection the puff, the temperature of the heater is increased to the first temperature at step S310. Therefore, the heater is returned to the first temperature, which is suitable for producing an aerosol, for the duration of the puff.

[0150] Fig. 7 is a temperature/time chart depicting a portion of a heating characteristics of the heater during a consumable cycle. In this example, the chart shows the temperature of the heater during two inhalations from the apparatus by a user. Although, for illustrative purposes, changes in temperature are depicted as being instantaneous, it may be appreciated that such changes would occur over a period of time (depending on the rate at which the heater is able to increase/decrease in temperature).

[0151] At time t0 the temperature of the heater is the ambient (environmental) temperature TA (e.g. 25°C). At t1, the user activates the aerosol generating apparatus, which causes the controller to increase the temperature of the heater to a priming temperature (i.e., the third temperature) T3, which may be approximately 250°C. This temperature T3 may be above a minimum aerosol generating temperature at which an aerosol is able to be generated from an aerosol former by the heater. Alternatively, the priming temperature may be chosen such that the heater is able to be heated from the priming temperature to a first temperature T1 (i.e. the temperature during a puff) within a particular time period.

[0152] At time t2 the user initiates a puff 401a (inhale) on the apparatus, which is detected by a puff sensor. In response to the detection of the start of the puff 401a, the controller controls a power supply to the heater to increase the temperature of the heater from the priming temperature T3 to a first temperature T1. The first temperature T1 is a temperature at which an aerosol having desired properties may be generated from the aerosol former. The first temperature T1 is maintained for the duration of the puff 401a (from time t2 to time t3).

[0153] At time t3 the end of the puff 401a is detected and, in response, the method of Fig. 6 is implemented by the controller. That is, the controller controls the heater to reduce the temperature of the heater to a second temperature T2. The second temperature T2 is then maintained for a period (from time t3 to t4), which is the low temperature duration 400 calculated as described above for determining the power profile for the heater.

[0154] By maintaining the temperature of the heater at the reduced second temperature T2 for the low power duration 400, the power consumption of the heater may be reduced. As the low power duration 400 is immediately after the end of the puff 401a, it is unlikely a user will begin another puff during this time period (and, as such, any

detriment to the experience of the user is minimised).

[0155] At time t4, after the low temperature duration 400, the temperature of the heater is increased again to the priming (third) temperature T3. This ensures that, when a user takes a subsequent puff 401b, the heater is at a temperature at which it is either capable of generating an aerosol from the aerosol former, or can be heated to such a temperature within a desired time period (i.e. a time period small enough so as not to be noticeable by a user).

[0156] At time t5, the user takes a second puff 401b, which is longer than the first puff 401a. The end of this puff is detected at t6 and the method of Fig. 6 is again implemented. That is, the temperature of the heater is reduced by the controller to the second temperature T2 and maintained for the low power duration 400 (from time t6 to t7). Notably, as the low temperature duration is determined for the current consumable cycle it is the same for both the first 401a and second 401b puffs.

[0157] Following the low temperature duration 400, the temperature of the heater is again increase to the third temperature T3. As should be appreciated, the method of Fig. 6 may be repeated for each subsequent puff until the present consumable cycle is ended and the heater is deactivated.

[0158] As well as adjusting the temperature of the heater according to the power profile, the controller is also configured to simultaneously record usage data of the apparatus (i.e., the elapsed time between puffs) during the present consumable cycle in order to update the power profile for future consumable cycles as described above in relation to Fig. 5. Accordingly, the low power duration and hence the power savings of the apparatus may be tailored and updated to anticipate the habits of a specific user of the apparatus.

Claims

1. An aerosol generating apparatus (1), comprising a controller operatively connected to a heater (52), the heater (52) being configured to heat, according to a power profile, an aerosol precursor (6) provided in a consumable, wherein the controller is configured to:

   measure usage data relating to a user operation of the aerosol generating apparatus (1) during one or more initial consumable heating cycles;
   determine the power profile for the heater (52) based on the usage data; and
   apply the power profile to the heater (52) during a subsequent consumable heating cycle.

2. The aerosol generating apparatus (1) of claim 1 wherein the one or more one initial consumable heating cycles is a plurality of initial consumable heating cycles.

3. The aerosol generating apparatus (1) of claims 1 or 2 wherein applying the power profile to the heater (52) includes:

   detecting an inhalation from the aerosol generating apparatus (1) by a user during the subsequent consumable heating cycle, and
   adjusting a power supply to the heater (52) upon detecting the end of the inhalation to reduce the temperature of the heater (52) from a first temperature to a second temperature.

4. The aerosol generating apparatus (1) of claim 3 wherein determining the power profile for the heater (52) comprises:
   determining a low temperature duration for maintaining the heater (52) at the second temperature.

5. The aerosol generating apparatus (1) of claim 4 wherein applying the power profile comprises:
   increasing the temperature of the heater (52) to the first temperature after the low temperature duration has elapsed.

6. The aerosol generating apparatus (1) claim 4 wherein applying the power profile comprises:
   increasing the temperature of the heater (52) to a third temperature after the low temperature duration has elapsed, wherein the third temperature is lower than the first temperature.

7. The aerosol generating apparatus (1) of claim 6 wherein applying the power profile comprises:
   increasing the temperature of the heater (52) from the third temperature to the first temperature upon detection of an inhalation from the apparatus.

8. The aerosol generating apparatus (1) of any of claims 4 to 7, wherein measuring the usage data includes measuring elapsed time periods between consecutive inhalations during the one or more initial consumable heating cycles;
   wherein the low temperature duration for maintaining the heater (52) at the second temperature is determined based on the shortest of the elapsed time periods measured between inhalations.

9. The aerosol generating apparatus (1) of claim 8 wherein the low temperature duration is based on an average of the shortest elapsed time periods measured during each of a plurality of the most recent initial consumable heating cycles.

10. The aerosol generating apparatus (1) of claim 9 wherein the plurality of most recent consumable heating cycles includes between two and ten of the most recent consumable heating cycles.

11. The aerosol generating apparatus (1) of any of claims 4 to 10 wherein the controller is configured to:

detect a first inhalation during the subsequent consumable heating cycle,
detect a second, consecutive, inhalation during the subsequent consumable heating cycle, and, if the second inhalation is detected before the low temperature duration following the end of the first inhalation has elapsed, determine a new value for the low temperature duration based on an elapsed duration between the first inhalation and the second inhalation.

12. The aerosol generating apparatus (1) of any of claims 4 to 11 wherein the controller is further configured to:

determine a predetermined initial power profile for the heater (52) for a first consumable heating cycle of the apparatus,
wherein the predetermined initial power profile comprises a predetermined initial low temperature duration for maintaining the heater (52) at the second temperature during the first consumable heating cycle.

13. The aerosol generating apparatus (1) of any preceding claim wherein the controller is configured to apply pulse width modulation to a power supply (4) for the heater (52), and applying the power profile to the heater (52) comprises adjusting the duty cycle of the pulse width modulation.

14. The aerosol generating apparatus (1) of any preceding claim wherein the aerosol generating apparatus (1) is a heated tobacco (HT) apparatus and the consumable is a HT consumable.

15. A method of controlling a power supply of the aerosol generating apparatus according to any preceding claim, wherein the method comprises:

measuring usage data relating to a user operation of the aerosol generating apparatus during to one or more initial consumable heating cycles;
determine the power profile for the heater based on the usage data; and
apply the power profile to the heater during a subsequent consumable heating cycle.

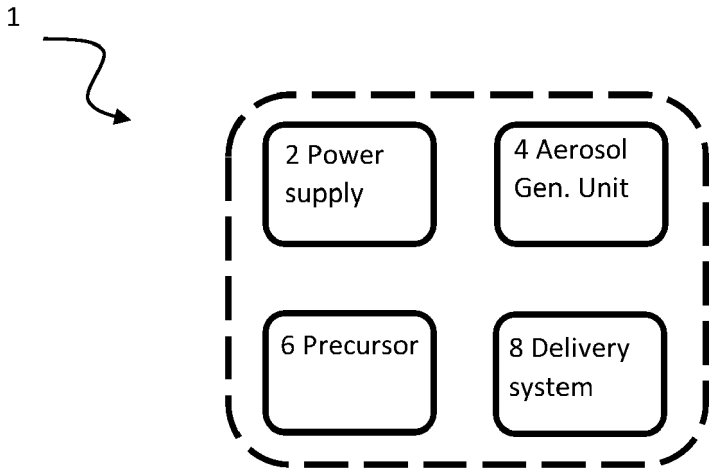
1
2 Power supply
4 Aerosol Gen. Unit
6 Precursor
8 Delivery system

Fig. 1

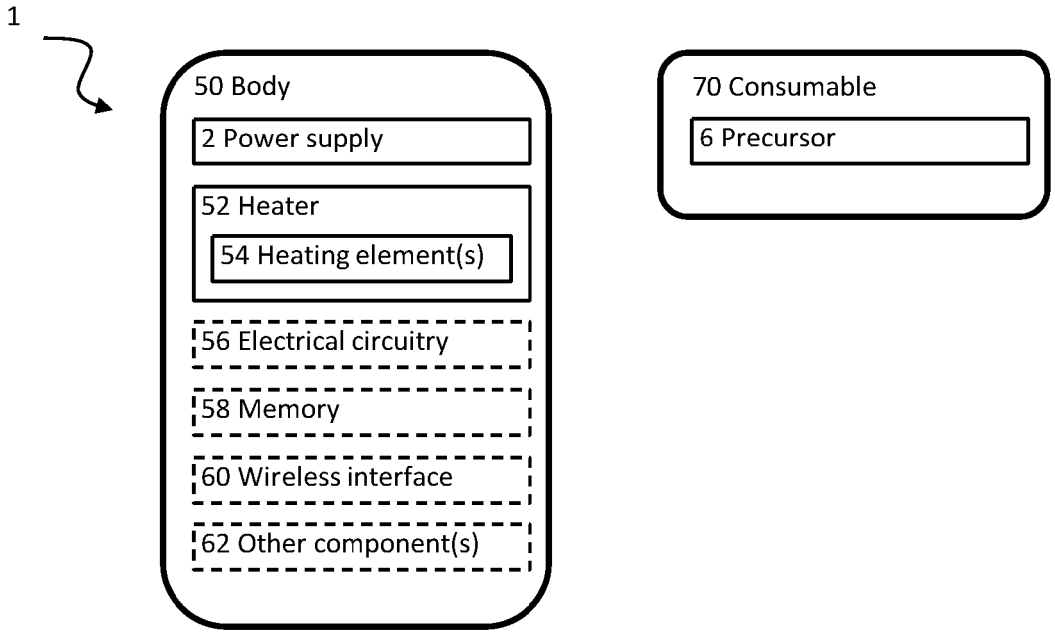
1
50 Body
2 Power supply
52 Heater
54 Heating element(s)
56 Electrical circuitry
58 Memory
60 Wireless interface
62 Other component(s)
70 Consumable
6 Precursor

Fig. 2

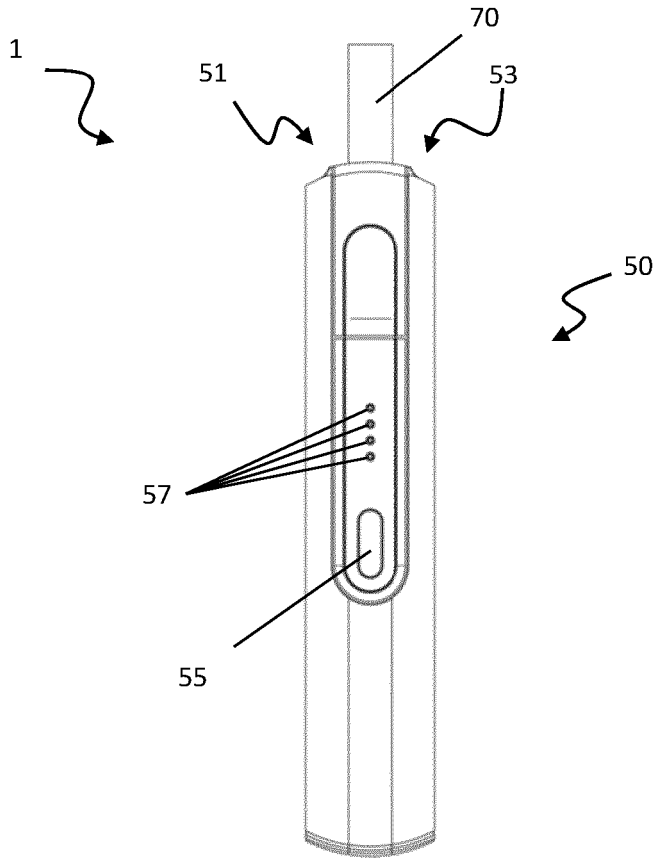
1
70
51
53
50
57
55

Fig. 3

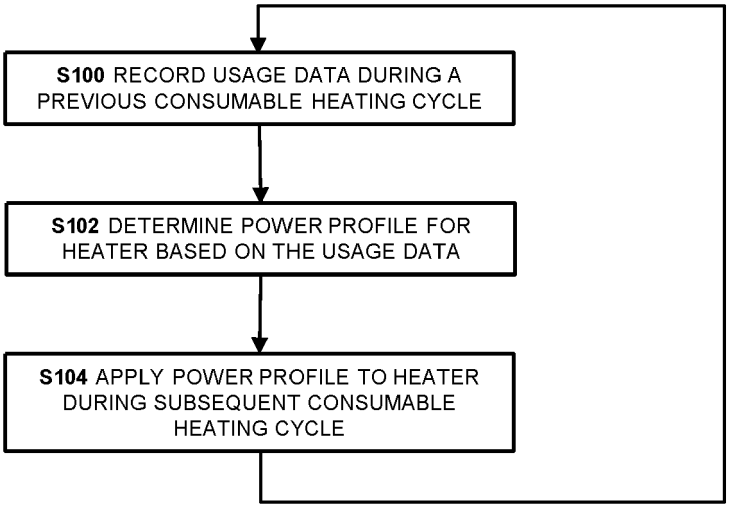
S100 RECORD USAGE DATA DURING A PREVIOUS CONSUMABLE HEATING CYCLE
S102 DETERMINE POWER PROFILE FOR HEATER BASED ON THE USAGE DATA
S104 APPLY POWER PROFILE TO HEATER DURING SUBSEQUENT CONSUMABLE HEATING CYCLE

Fig. 4

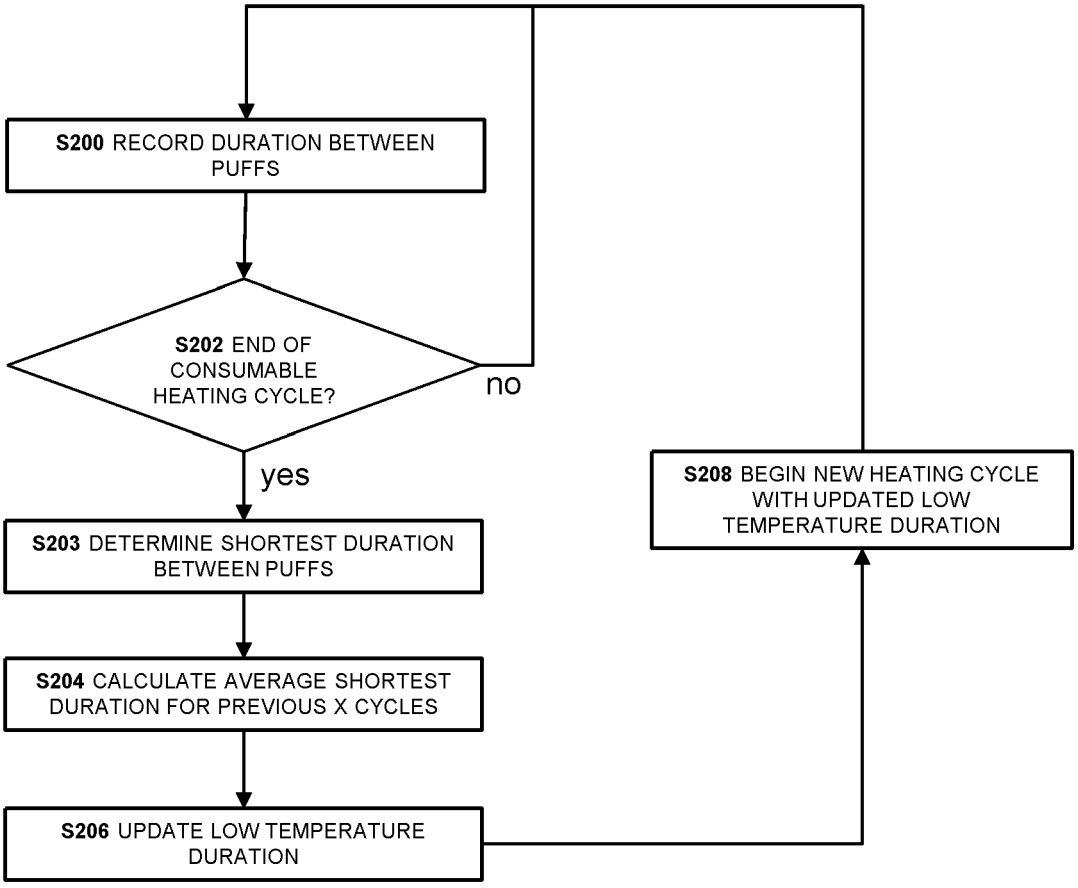
S200 RECORD DURATION BETWEEN PUFFS
S202 END OF CONSUMABLE HEATING CYCLE?
no
yes
S203 DETERMINE SHORTEST DURATION BETWEEN PUFFS
S204 CALCULATE AVERAGE SHORTEST DURATION FOR PREVIOUS X CYCLES
S206 UPDATE LOW TEMPERATURE DURATION
S208 BEGIN NEW HEATING CYCLE WITH UPDATED LOW TEMPERATURE DURATION

Fig. 5

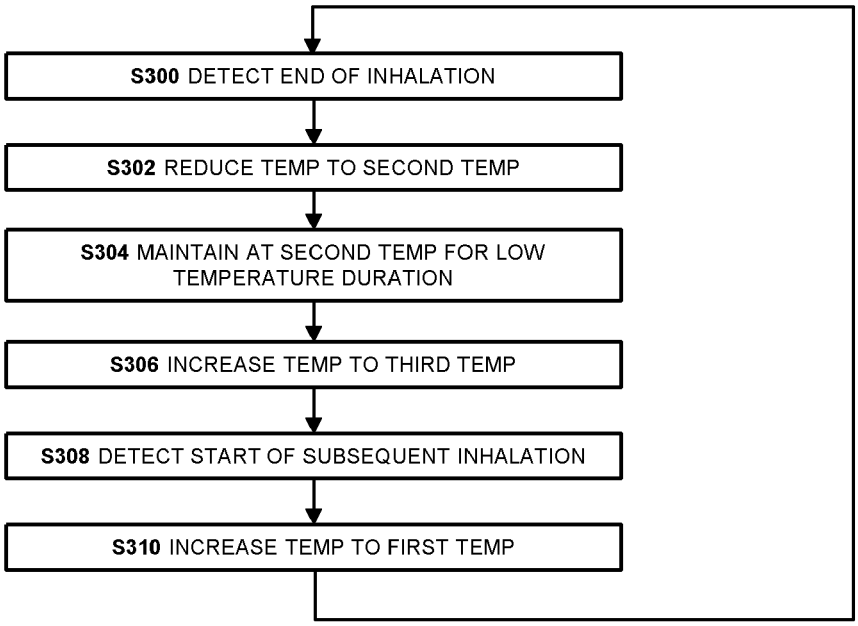
S300 DETECT END OF INHALATION
S302 REDUCE TEMP TO SECOND TEMP
S304 MAINTAIN AT SECOND TEMP FOR LOW TEMPERATURE DURATION
S306 INCREASE TEMP TO THIRD TEMP
S308 DETECT START OF SUBSEQUENT INHALATION
S310 INCREASE TEMP TO FIRST TEMP

Fig. 6

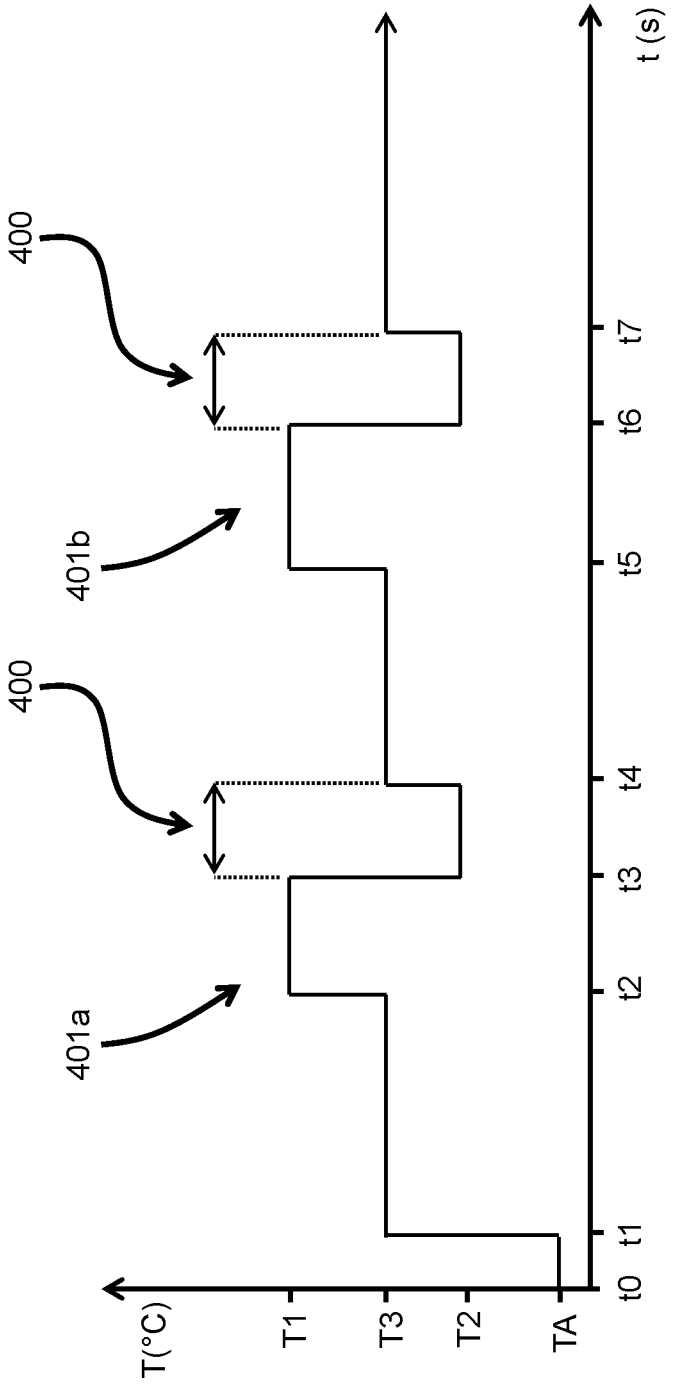

Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 23 20 1033

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X Y A	WO 2022/139227 A1 (KT & G CORP [KR]) 30 June 2022 (2022-06-30) * figures 5, 10 * * paragraphs [0005], [0258], [0120], [0121], [0151] - [0153], [0194], [0196], [0049], [0116], [0076] *	1,2, 13-15 3-5,11, 12 6-10	INV. A24F40/57 A24F40/50 ADD. A24F40/20
Y	US 2022/395028 A1 (LEE WON KYEONG [KR] ET AL) 15 December 2022 (2022-12-15) * figures * * paragraph [0004] * * paragraph [0088] * * paragraph [0095] * * paragraph [0097] - paragraph [0100] * * paragraph [0102] - paragraph [0105] * * paragraph [0118] * * paragraph [0127] - paragraph [0134] *	3-5,11, 12	
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A24F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	13 March 2024	Kirchmayr, Katrin

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