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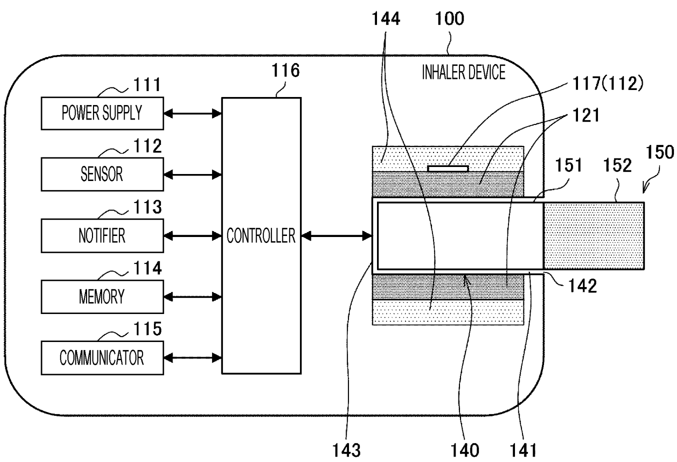
(54) **AEROSOL GENERATING SYSTEM AND CONTROL METHOD**

(57) [Problem] To provide a mechanism capable of further improving the quality of user experience. [Solution] An aerosol generating system comprising: a power source unit; a heating unit that heats an aerosol source by using power supplied from the power source unit; a temperature changing unit that changes the temperature in following with a temperature change of the heating unit; and a control unit that controls operation of the heating unit on the basis of the difference between the temperature of the heating unit and the temperature of the temperature changing unit, the difference therebetween being indicated by a first measured value measured as a parameter corresponding to the temperature of the heating unit and a second measured value measured as a parameter corresponding to the temperature of the temperature changing unit.

FIG. 1



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Description

Technical Field

[0001] The present disclosure relates to an aerosol generating system, and a control method.

Background Art

[0002] Inhaler devices that generate a substance to be inhaled by a user, such as electronic cigarettes and nebulizers, are in widespread use. For example, such an inhaler device generates, by use of a substrate, an aerosol to which a flavor component has been imparted. The substrate includes, for example, an aerosol source for generating the aerosol, and a flavor source for imparting the flavor component to the generated aerosol. The user is able to enjoy smoke taste by inhaling the aerosol that has been generated by the inhaler device and to which the flavor component has been imparted. The user's action of inhaling the aerosol is hereinafter referred to also as puff or puff action.

[0003] The smoke taste enjoyed by the user is affected significantly by the temperature at which the aerosol source is heated. It is thus desirable to heat the aerosol source at an appropriate temperature. In this regard, Patent Literature 1 below discloses providing a structural element whose resistance changes in response to a change in temperature, and using the structural element to control the temperature of a heating part.

Citation List

Patent Literature

[0004] Patent Literature 1: JP 6833157 B2

Summary of Invention

Technical Problem

[0005] The technique disclosed in Patent Literature 1 mentioned above, however, is still in the early days of development, and has room for improvements in various respects.

[0006] The present disclosure is directed to addressing the problem mentioned above. Accordingly, it is an object of the present disclosure to provide a mechanism capable of further improving the quality of user experience.

Solution to Problem

[0007] To address the problem mentioned above, an aspect of the present disclosure provides an aerosol generating system including a power supply, a heater, a temperature-variable unit, and a controller. The heater is configured to heat an aerosol source by using electric power supplied from the power supply. The temperature-variable unit is configured to change in temperature following a change in temperature of the heater. The controller is configured to, based on a difference between a temperature of the heater and a temperature of the temperature-variable unit, control operation of the heater, the temperature of the heater being indicated by a first measurement value measured as a parameter corresponding to the temperature of the heater, the temperature of the temperature-variable unit being indicated by a second measurement value measured as a parameter corresponding to the temperature of the temperature-variable unit.

[0008] The controller may be configured to, based on the difference between the temperature of the heater and the temperature of the temperature-variable unit, switch parameters that serve as a basis for controlling supply of electric power to the heater.

[0009] The controller may be configured to, based on the difference between the temperature of the heater and the temperature of the temperature-variable unit, switch parameters that serve as a basis for resuming the supply of electric power to the heater after temporarily stopping the supply of electric power to the heater.

[0010] The controller may be configured to, when the difference between the temperature of the heater and the temperature of the temperature-variable unit falls within a first range, resume the supply of electric power to the heater based on the second measurement value.

[0011] The controller may be configured to, when the difference between the temperature of the heater and the temperature of the temperature-variable unit exceeds the first range and falls within a second range greater than the first range, resume the supply of electric power to the heater based on an elapsed time.

[0012] The controller may be configured to, when the difference between the temperature of the heater and the temperature of the temperature-variable unit exceeds the second range, execute at least one of stopping of the supply of electric power to the heater or disabling of the supply of electric power to the heater.

[0013] The controller may be configured to set the first range and the second range based on the difference, acquired when heating is executed for a first time by the heater, between the temperature of the heater and the temperature of the temperature-variable unit.

[0014] The aerosol generating system may include a memory configured to store information. The controller may be configured to: based on control information, control the operation of the heater, the control information defining time-series transition of a target value of a temperature at which the aerosol source is heated; during a sampling period, acquire the difference between the temperature of the heater and the temperature of the temperature-variable unit, and cause the acquired difference to be stored into the memory, the sampling period being a portion of a period for which the time-series transition of the target temperature is defined by the control information, and based on the difference between the temperature of the heater and the temperature of the temperature-variable unit stored in the memory, control the operation of the heater.

[0015] The controller may be configured to: during the sampling period, acquire the difference between the temperature of the heater and the temperature of the temperature-variable unit a plurality of times, and cause a statistic to be stored into the memory, the statistic being a statistic on a plurality of the differences between the temperature of the heater and the temperature of the temperature-variable unit; and based on the statistic on the differences between the temperature of the heater and the temperature of the temperature-variable unit stored in the memory, control the operation of the heater.

[0016] The period for which the time-series transition of the target value is defined by the control information may include, partway through the period, a period during which the temperature of the heater is temporarily dropped. The controller may be configured to, in the period during which the temperature of the heater is dropped, stop the supply of electric power to the heater. The sampling period may be a period subsequent to the period during which the temperature of the heater is dropped.

[0017] The controller may be configured to set the sampling period, based on the first measurement value measured at a start of heating performed by the heater based on the control information.

[0018] The controller may be configured to set a timing of start of the sampling period earlier with increasing temperature of the heater as indicated by the first measurement value at the start of heating performed by the heater based on the control information.

[0019] The heater may be a resistance heating element configured to produce heat when subjected to an applied current. The first measurement value may be an electrical resistance of the resistance heating element. The temperature-variable unit may be a resistor configured to change in electrical resistance with a change in temperature. The second measurement value may be an electrical resistance of the resistor.

[0020] The aerosol generating system may further include a substrate containing the aerosol source.

[0021] To address the problem mentioned above, an aspect of the present disclosure provides a control method for controlling an aerosol generating system. The aerosol generating system includes a power supply, a heater, and a temperature-variable unit. The heater is configured to heat an aerosol source by using electric power supplied from the power supply. The temperature-variable unit is configured to change in temperature following a change in temperature of the heater. The control method includes, based on a difference between a temperature of the heater and a temperature of the temperature-variable unit, controlling operation of the heater. The temperature of the heater is indicated by a first measurement value measured as a parameter corresponding to the temperature of the heater. The temperature of the temperature-variable unit is indicated by a second measurement value measured as a parameter corresponding to the temperature of the temperature-variable unit.

Advantageous Effects of Invention

[0022] As has been described above, the present disclosure provides a mechanism capable of further improving the quality of user experience.

Brief Description of Drawings

[0023]

[FIG. 1] FIG. 1 is a schematic diagram of an inhaler device according to a configuration example.
[FIG. 2] FIG. 2 is a graph illustrating an example of transition of the temperature of a heater for a case where temperature control is performed based on a heating profile illustrated in Table 1.
[FIG. 3] FIG. 3 is an illustration for explaining an example of how operation of the heater is controlled in accordance with the embodiment.
[FIG. 4] FIG. 4 is a flowchart illustrating an exemplary procedure to be executed by the inhaler device in accordance with the embodiment.

Description of Embodiments

[0024] A preferred embodiment of the present disclosure is described below in detail with reference to the accompanying drawings. Herein and in the drawings, structural elements that are substantially identical to each other in functional configuration are designated by the same reference signs to omit redundant description.

1. Configuration example of inhaler device

[0025] An inhaler device generates a substance to be inhaled by a user. In the example described below, the substance generated by the inhaler device is an aerosol. Alternatively, the substance generated by the inhaler device may be gas.

[0026] FIG. 1 is a schematic diagram of the inhaler device according to a configuration example. As illustrated in FIG. 1, an inhaler device 100 according to the present configuration example includes a power supply 111, a sensor 112, a notifier 113, a memory 114, a communicator 115, a controller 116, a heater 121, a holder 140, and a heat insulator 144.

[0027] The power supply 111 stores electric power. The power supply 111 supplies electric power to the structural elements of the inhaler device 100 under the control of the controller 116. The power supply 111 may be a rechargeable battery such as a lithium ion secondary battery.

[0028] The sensor 112 acquires various items of information regarding the inhaler device 100. In an example, the sensor 112 may be a pressure sensor such as a condenser microphone, a flow sensor, or a temperature sensor, and acquire a value generated in accordance with the user's inhalation. In another example, the sensor 112 may be an input device that receives information input by the user, such as a button or a switch.

[0029] In particular, the sensor 112 includes a thermistor 117 for detecting the temperature of the heater 121 from outside the heater 121. The thermistor 117 is an example of a temperature-variable unit that changes in temperature following a change in the temperature of the heater 121. The thermistor 117 is disposed near the heater 121, for example, disposed in close contact with the heater 121, and changes in temperature as heat is transferred from the heater 121. The temperature of the thermistor 117 is then detected as the temperature of the heater 121. The thermistor 117 includes a resistor that changes in electrical resistance with a change in temperature. The temperature of the thermistor 117 is calculated based on the electrical resistance of the resistor. The thermistor 117 may be implemented as, for example, a negative temperature coefficient (NTC) thermistor, a positive temperature coefficient (PTC) thermistor, or a critical temperature resistor (CTR) thermistor. As another alternative, a resistance thermometer made of, for example, platinum may be used as the temperature-variable unit. A resistance thermometer is sometimes referred to also as resistance temperature detector (RTD).

[0030] The notifier 113 provides information to the user. The notifier 113 may be a light-emitting device that emits light, a display device that displays an image, a sound output device that outputs sound, or a vibration device that vibrates.

[0031] The memory 114 stores various items of information for operation of the inhaler device 100. The memory 114 may be a non-volatile storage medium such as flash memory.

[0032] The communicator 115 is a communication interface capable of communication in conformity with any wired or wireless communication standard. Such a communication standard may be, for example, Wi-Fi (registered trademark), Bluetooth (registered trademark), or a standard using a low-power wide-area network (LPWAN).

[0033] The controller 116 functions as an arithmetic processing unit and a control circuit, and controls the overall operations of the inhaler device 100 in accordance with various programs. The controller 116 includes, for example, an electronic circuit such as a central processing unit (CPU) or a microprocessor.

[0034] The holder 140 has an internal space 141, and holds a stick substrate 150 with the stick substrate 150 partially accommodated in the internal space 141. The holder 140 has an opening 142 that allows the internal space 141 to communicate with the outside. The holder 140 holds the stick substrate 150 that is inserted into the internal space 141 through the opening 142. For example, the holder 140 may be a tubular body having the opening 142 and a bottom 143 on its ends, and may define the internal space 141 that is pillar-shaped. The holder 140 connects with an airflow path that supplies air to the internal space 141. For example, a side surface of the inhaler device 100 has an air inlet hole that is an inlet of air into the airflow path. For example, the bottom 143 has an air outlet hole that is an outlet of the air from the airflow path to the internal space 141.

[0035] The stick substrate 150 includes a substrate 151 and an inhalation port 152. The substrate 151 includes an aerosol source. The aerosol source is a liquid such as polyhydric alcohol or water. Examples of the polyhydric alcohol include glycerine and propylene glycol. The aerosol source may include a flavor component that is either derived from tobacco or not derived from tobacco. For the inhaler device 100 that is a medical inhaler such as a nebulizer, the aerosol source may include a medicine. According to the configuration example, the aerosol source is not limited to a liquid but may be a solid. With the stick substrate 150 held by the holder 140, the substrate 151 is at least partially accommodated in the internal space 141, and the inhalation port 152 at least partially protrudes from the opening 142. When the user inhales with the inhalation port 152 protruding from the opening 142 in his/her mouth, air flows into the internal space 141 through the airflow path (not illustrated), and the air and an aerosol generated from the substrate 151 reach the inside of the mouth of the user.

[0036] The heater 121 heats the aerosol source to atomize the aerosol source and generate the aerosol. The heater 121 heats the aerosol source by using electric power supplied from the power supply 111. In particular, the heater 121 is implemented as a resistance heating element that produces heat due to electrical resistance when subjected to an applied current. In the example illustrated in FIG. 1, the heater 121 has a film-like shape and surrounds the outer circumference of the holder 140. Subsequently, heat produced from the heater 121 heats the substrate 151 of the stick substrate 150 from the outer circumference, generating the aerosol. The heater 121 produces heat upon receiving electric power from the power supply 111. In an example, the electric power may be supplied in response to the sensor 112 detecting a start of the user's inhalation and/or an input of predetermined information. Subsequently, the supply of the electric power may be stopped in response to the sensor 112 detecting an end of the user's inhalation and/or an input of predetermined information.

[0037] The heat insulator 144 prevents heat from transferring from the heater 121 to the other structural elements. For example, the heat insulator 144 may be a vacuum heat insulator or an aerogel heat insulator.

[0038] The configuration example of the inhaler device 100 has been described above. Of course, the inhaler device 100 is not limited to the above configuration, and may be configured in various ways as exemplified below.

[0039] In an example, the heater 121 may have a blade-like shape, and may be disposed in such a way that the heater 121 protrudes from the bottom 143 of the holder 140 toward the internal space 141. In this case, the heater 121 having the blade-like shape is inserted into the substrate 151 of the stick substrate 150 and heats the substrate 151 of the stick substrate 150 from the inside. In another example, the heater 121 may be disposed in such a way that the heater 121 covers the bottom 143 of the holder 140. In still another example, the heater 121 may be implemented as a combination of two or more of the following heaters: a first heater that covers the outer circumference of the holder 140; a second heater having the blade-like shape; and a third heater that covers the bottom 143 of the holder 140.

[0040] In another example, the holder 140 may include an opening/closing mechanism that at least partially opens and closes an outer shell defining the internal space 141. Examples of the opening/closing mechanism include a hinge. In addition, the holder 140 may sandwich the stick substrate 150 inserted into the internal space 141, by opening and closing the outer shell. In that case, the heater 121 may be disposed at a location where the stick substrate 150 is sandwiched by the holder 140, and may produce heat while pressing the stick substrate 150.

[0041] The stick substrate 150 is an example of a substrate that contains the aerosol source, and that contributes to generation of an aerosol. The inhaler device 100 is an example of an aerosol generating device that heats the stick substrate 150 to generate an aerosol. An aerosol is generated by the combination of the inhaler device 100 and the stick substrate 150. Accordingly, the combination of the inhaler device 100 and the stick substrate 150 may be regarded as an aerosol generating system.

2. Technical features

2.1. Heating profile

[0042] The controller 116 controls operation of the heater 121, based on a heating profile. Control of operation of the heater 121 is achieved through control of supply of electric power from the power supply 111 to the heater 121. The heater 121 heats the stick substrate 150 by using electric power supplied from the power supply 111.

[0043] A heating profile represents control information for controlling the temperature at which the aerosol source is heated. The heating profile may represent control information for controlling the temperature of the heater 121. In one example, the heating profile may include a target value of the temperature (to be also referred to as target temperature hereinafter) at which the aerosol source is heated. The target temperature may change with the time elapsed from the start of heating. In that case, the heating profile includes information that defines time-series transition of the target temperature. In another example, the heating profile may include a parameter that defines the manner in which electric power is supplied to the heater 121 (to be also referred to as power supply parameter hereinafter). Examples of the power supply parameter include the voltage to be applied to the heater 121, the ON/OFF of supply of electric power to the heater 121, and the feedback control method to be employed. The ON/OFF of supply of electric power to the heater 121 may be regarded as the ON/OFF of the heater 121.

[0044] The controller 116 controls operation of the heater 121 in such a way that the temperature of the heater 121 (to be also referred to as "actual temperature" hereinafter) transitions in a manner similar to the target temperature defined in the heating profile. The heating profile is typically designed to optimize the flavor that the user tastes upon inhaling an aerosol generated from the stick substrate 150. Therefore, controlling operation of the heater 121 based on the heating profile allows for optimization of the flavor tasted by the user.

[0045] Temperature control of the heater 121 can be implemented by, for example, a known feedback control. The feedback control may be, for example, a proportional-integral-differential (PID) controller. The controller 116 may cause the electric power from the power supply 111 to be supplied to the heater 121 in the form of pulses based on pulse width modulation (PWM) or pulse frequency modulation (PFM). In that case, the controller 116 is capable of controlling the temperature of the heater 121 by adjusting the duty cycle or frequency of electric power pulses during the feedback control. Alternatively, the controller 116 may perform a simple ON/OFF control during the feedback control. For example, the controller 116 may be configured to: cause the heating with the heater 121 to be executed until the actual temperature reaches a target temperature; cause the heating with the heater 121 to be interrupted when the actual temperature reaches the target temperature, and cause the heating with the heater 121 to resume when the actual temperature drops below the target temperature.

[0046] In one example, the temperature of the heater 121 can be quantified by measuring or estimating the electrical resistance of the heater 121 (more precisely, the resistance heating element constituting the heater 121). This is because the electrical resistance of the resistance heating element changes with temperature. The electrical resistance of the resistance heating element can be estimated by, for example, measuring a voltage drop in the resistance heating element. A voltage drop in the resistance heating element can be measured by a voltage sensor that measures a potential difference applied to the resistance heating element. The electrical resistance of the resistance heating element constituting the heater 121 is an example of a first measurement value, which is measured as a value corresponding to the temperature of the heater 121. The temperature of the heater 121 calculated based on the measured first measurement value is referred to also as heater temperature hereinafter.

[0047] In another example, the temperature of the heater 121 can be quantified by measuring or estimating the electrical resistance of the thermistor 117 (more precisely, the resistor constituting the thermistor 117). This is because the temperature of the thermistor 117 changes with a change in the temperature of the heater 121, and the electrical resistance of the resistor constituting the thermistor 117 changes with temperature. The electrical resistance of the resistor can be estimated by, for example, measuring a voltage drop in the resistor. A voltage drop in the resistor can be measured by a voltage sensor that measures a potential difference applied to the resistor. The electrical resistance of the resistor constituting the thermistor 117 is an example of a second measurement value, which is measured as a value corresponding to the temperature of the thermistor 117. The temperature of the thermistor 117 calculated based on the second measurement value is referred to also as thermistor temperature hereinafter.

[0048] A period from when the process of generating an aerosol by using the stick substrate 150 begins until the process ends is also referred to as "heating session" hereinafter. In other words, the heating session refers to a period during which operation of the heater 121 is controlled based on the heating profile. The heating session begins when heating based on the heating profile is started. The heating session ends when a sufficient amount of aerosol ceases to be generated. The heating session includes a preheating period, and a puff-enabled period subsequent to the preheating period. The puff-enabled period refers to a period during which a sufficient amount of aerosol is expected to be generated. The preheating period refers to a period from when heating is started until the puff-enabled period begins. The heating performed in the preheating period is referred to also as preheating.

[0049] An example of the heating profile is illustrated in Table 1 below.

[Table 1]

Table 1. Example of heating profile			
Period		Time-series transition of target temperature	Time-series transition of power supply parameter
Division	Duration		
STEP 0	-	Rise to 300°C (No time control)	ON
STEP 1	10 sec.	Maintained at 300°C	ON
STEP 2	-	Drop to 220°C (No time control)	OFF
STEP 3	-	Rise to 230°C (No time control)	ON
STEP 4	60 sec.	Maintained at 230°C	ON
STEP 5	60 sec.	Rise to 260°C	ON
STEP 6	60 sec.	Maintained at 260°C	ON
STEP 7	5 sec.	-	OFF

[0050] As illustrated in Table 1, the heating profile is divided into a plurality of periods. For each period, the time-series transition of a target temperature, and the time-series transition of a power supply parameter may be defined. In the example illustrated in Table 1, the heating profile is divided into a total of eight periods including STEP 0 to STEP 7. For each STEP, the time-series transition of the target temperature, and the time-series transition of the power supply parameter are defined. Each STEP defined in the heating profile is an example of a unit period according to the embodiment.

[0051] Depending on the case, a time control is to be performed in some STEPs. A time control refers to a control in which the corresponding STEP is triggered to end when a predetermined time (i.e., a duration defined for each STEP) elapses. If a time control is to be performed, the rate of change in the temperature of the heater 121 may be controlled in such a way that the temperature of the heater 121 reaches a target temperature at the end of the duration. Alternatively, if a time control is to be performed, the rate of change in the temperature of the heater 121 may be controlled in such a way that the temperature of the heater 121 reaches a target temperature partway through the duration, and then the temperature of the heater 121 is maintained at the target temperature until the duration elapses. In the example illustrated in Table 1 mentioned above, a time control is to be performed for STEPs 1 and 4 to 7.

[0052] Depending on the case, no time control is to be performed in some STEPs. If no time control is to be performed, the corresponding STEP is triggered to end when the temperature of the heater 121 reaches a predetermined temperature (i.e., a target temperature set for each STEP). Accordingly, STEPs in which no time control is to be performed have a duration that increases or decreases in accordance with the rate of temperature change. In the example illustrated in Table 1 mentioned above, no time control is to be performed in STEPs 0, 2, and 3.

[0053] Reference is now made to FIG. 2 to describe transition of the temperature of the heater 121 for a case where the controller 116 performs temperature control in accordance with the heating profile illustrated in Table 1. FIG. 2 is a graph illustrating an example of transition of the temperature of the heater 121 for a case where temperature control is performed based on the heating profile illustrated in Table 1. The horizontal axis in a graph 20 represents time (seconds). The vertical axis in the graph 20 represents the temperature of the heater 121. A line 21 represents transition of the temperature of the heater 121. As illustrated in FIG. 2, the temperature of the heater 121 transitions in a manner similar to the transition of target temperature defined in the heating profile. An example of the heating profile is described below with reference to Table 1 and FIG. 2.

[0054] As illustrated in Table 1 and FIG. 2, in STEP 0, the temperature of the heater 121 rises from an initial temperature to 300°C. The initial temperature refers to the temperature of the heater 121 at the start of heating. In STEP 0, no time control is to be performed. Accordingly, STEP 0 is triggered to end when the temperature of the heater 121 reaches 300°C. In the example illustrated in FIG. 2, STEP 0 ends in 20 seconds. Subsequently, in STEP 1, the temperature of the heater 121 is maintained at 300°C. The preheating period ends with the end of STEP 1, and the puff-enabled period starts with the start of STEP 2.

[0055] For the user, a shorter preheating time is more desirable. Inadequate heating of the stick substrate 150, however, can result in moisture remaining within the stick substrate 150 without evaporating. When the user takes a puff in such a state, this may cause hot water vapor to be delivered into the user's mouth. It is therefore desirable to rapidly raise the temperature of the heater 121 to 300°C in STEP 0, and ensure that STEP 1 has a reasonably long duration.

[0056] As illustrated in Table 1 and FIG. 2, in STEP 2, the temperature of the heater 121 drops to 220°C. In STEP 2, no time control is to be performed. Accordingly, STEP 2 is triggered to end when the temperature of the heater 121 reaches 220°C. In the example illustrated in FIG. 2, STEP 2 ends in 10 seconds. In STEP 2, supply of electric power to the heater 121 is turned off. This allows the temperature of the heater 121 to drop as quickly as possible. Dropping the temperature of the heater 121 partway through the heating session in this way helps to prevent the aerosol source from being consumed rapidly. This in turn makes it possible to prevent the aerosol source from being depleted partway through the heating session.

[0057] As illustrated in Table 1 and FIG. 2, then, in STEP 3, the temperature of the heater 121 rises to 230°C. In STEP 3, no time control is to be performed. Accordingly, STEP 3 is triggered to end when the temperature of the heater 121 reaches 230°C. In the example illustrated in FIG. 2, STEP 3 ends in 5 seconds. As described above, the dropping of the temperature of the heater 121 is followed by a period in which the temperature is raised again. This makes it possible to prevent the temperature of the heater 121 from decreasing excessively.

[0058] As illustrated in Table 1 and FIG. 2, then, in STEP 4 to STEP 6, the temperature of the heater 121 rises stepwise to 260°C. Raising the temperature of the heater 121 slowly in this way makes it possible to mitigate the overall power consumption of the heating session while maintaining adequate generation of aerosol.

[0059] As illustrated in Table 1 and FIG. 2, in STEP 7, the temperature of the heater 121 drops. In STEP 7, supply of electric power to the heater 121 is turned off. For STEP 7, a duration is defined, but no target temperature is defined. Accordingly, STEP 7 is triggered to end when the duration ends. In STEP 7, a sufficient amount of aerosol may be generated due to the residual heat remaining in the stick substrate 150. Accordingly, in the present example, the puff-enabled period, that is, the heating session ends with the end of STEP 7.

[0060] The notifier 113 may notify the user of information indicating the timing when preheating ends. For example, the notifier 113 may, prior to the end of preheating, notify the user of information that gives advance notice of the end of preheating, or may, at the timing when preheating ends, notify the user of information indicating that preheating has ended. Such notification may be provided to the user by, for example, lighting of an LED or vibration. By using such notification as a reference, the user is able to start taking a puff immediately after the preheating ends.

[0061] Likewise, the notifier 113 may notify the user of information indicating the timing when the puff-enabled period ends. For example, the notifier 113 may, prior to the end of the puff-enabled period, notify the user of information that gives advance notice of the end of the puff-enabled period, or may, at the timing when the puff-enabled period ends, notify the user of information indicating that the puff-enabled period has ended. Such notification may be provided to the user by, for example, lighting of an LED or vibration. By using such notification as a reference, the user is able to take a puff until the puff-enabled period ends.

[0062] The heating profile described above is intended to be an illustrative example only, and various other examples are conceivable. In one example, the number of STEPs, the duration of each individual STEP, and the target temperature may be changed as appropriate.

2. 2. Technical Problems

[0063] In the example illustrated in Table 1 and FIG. 2, for STEPs in which supply of electric power to the heater 121 is performed, the controller 116 may control operation of the heater 121 by checking the heater temperature and the target temperature against each other. In contrast, for STEPs such as STEP 2 in which supply of electric power to the heater 121 is not performed, it is difficult to acquire the heater temperature. Accordingly, the controller 116 may control operation of the heater 121 by checking the thermistor temperature and the target temperature against each other.

[0064] The measurement accuracy for the electrical resistance of the thermistor 117 may deteriorate in some cases. One exemplary cause for this is the aging of the thermistor 117. In that case, for a period during which operation of the heater 121 is controlled based on the thermistor temperature as in STEP 2, it is difficult to properly control operation of the heater 121. Further, the thermistor temperature may be used for a protection feature such as stopping the heating performed by the heater 121 when thermal runway occurs, which is a phenomenon where the temperature of the heater 121 rises too much. If the measurement accuracy for the electrical resistance of the thermistor 117 deteriorates, this may potentially make it difficult for the protection feature to work properly. Such deterioration of the measurement accuracy for the electrical resistance of the thermistor 117, therefore, may cause deterioration of the quality of user experience.

[0065] Accordingly, the embodiment provides a mechanism for preventing deterioration of the quality of user experience associated with deterioration of the measurement accuracy for the electrical resistance of the thermistor 117.

2.3. Control of operation of heater 121

(1) Control based on difference between heater temperature and thermistor temperature

[0066] The controller 116 controls operation of the heater 121 based on the difference between the heater temperature and the thermistor temperature, which are respectively indicated by the electrical resistance of the heater 121 and the electrical resistance of the thermistor 117. More specifically, first, the controller 116 calculates the heater temperature based on the electrical resistance of the heater 121, and calculates the thermistor temperature based on the electrical resistance of the thermistor 117. Subsequently, the controller 116 determines deterioration of the measurement accuracy for the electrical resistance of the thermistor 117, based on the difference between the heater temperature and the thermistor temperature. The controller 116 then controls operation of the heater 121, based on the degree of the deterioration of the measurement accuracy for the electrical resistance of the thermistor 117. The configuration mentioned above makes it possible to prevent the quality of user experience from deteriorating due to deterioration of the measurement accuracy for the electrical resistance of the thermistor 117.

[0067] The controller 116 may, based on the difference between the heater temperature and the thermistor temperature, switch parameters that serve as the basis for controlling supply of electric power to the heater 121. This configuration allows operation of the heater 121 to be controlled based on an appropriate parameter.

[0068] In particular, the controller 116 may, based on the difference between the heater temperature and the thermistor temperature, switch parameters that serve as the basis for resuming supply of electric power to the heater 121 after the supply of electric power to the heater 121 is temporarily stopped. As described above with reference to Table 1 and FIG. 2, the heating session includes, partway through the heating session, a period during which the temperature of the heater 121 is temporarily dropped as in STEP 2. In the period during which the temperature of the heater 121 is temporarily dropped, the controller 116 stops the supply of electric power to the heater 121. Subsequently, the controller 116 resumes the supply of electric power to the heater 121. In particular, the controller 116 resumes the supply of electric power, at the timing based on a parameter selected based on the difference between the heater temperature and the thermistor temperature. This configuration makes it possible to properly control a drop in the temperature of the heater 121.

[0069] A specific example of control is described below with reference to FIG. 3. FIG. 3 is an illustration for explaining an example of how operation of the heater 121 is controlled in accordance with the embodiment. In FIG. 3, the difference between the heater temperature and the thermistor temperature is represented by the vertical axis, and descriptions of control performed in accordance with the difference between the heater temperature and the thermistor temperature are given along the vertical axis.

[0070] As illustrated in FIG. 3, the controller 116 may, when the difference between the heater temperature and the thermistor temperature falls within a first range, resume supply of electric power to the heater 121 based on the thermistor temperature. The first range is set as a range such that when the difference between the heater temperature and the thermistor temperature falls within the first range, the heater temperature and the thermistor temperature may be regarded as being equal. In one example, the first range is a range of $\pm 3°C$. For example, when the difference between the heater temperature and the thermistor temperature falls within the first range, the controller 116 is triggered to resume supply of electric power to the heater 121 upon the thermistor temperature dropping to a target temperature that the heating profile defines as the target temperature at the end of STEP 2. According to this configuration, even for a period in which it is difficult to acquire the heater temperature as in STEP 2, it is possible, by referring to the thermistor temperature instead, to cause the heater 121 to transition in temperature as defined in the heating profile.

[0071] As illustrated in FIG. 3, the controller 116 may, when the difference between the heater temperature and the thermistor temperature exceeds the first range and falls within a second range greater than the first range, resume supply of electric power to the heater 121 based on elapsed time. The second range is set as a range such that when the difference between the heater temperature and the thermistor temperature falls within the second range, no problem such as thermal runaway can be expected to arise. In one example, the second range is a range of $\pm 10°C$. For example, when the difference between the heater temperature and the thermistor temperature exceeds the first range and falls within the second range, the controller 116 is triggered to resume supply of electric power to the heater 121 upon elapse of a predetermined time from the start of STEP 2. The predetermined time may be defined in the heating profile. Alternatively, the predetermined time may be calculated based on the amount of decrease in target temperature in STEP 2. According to this configuration, even when an error existing between the heater temperature and the thermistor temperature makes it difficult to perform control based on the thermistor temperature, the temperature of the heater 121 is allowed to transition within a range such that the temperature does not significantly deviate from a target temperature defined in the heating profile.

[0072] As illustrated in FIG. 3, the controller 116 may, when the difference between the heater temperature and the thermistor temperature exceeds the second range, execute at least one of disabling of supply of electric power to the heater 121 or stopping of supply of electric power to the heater 121. Stopping supply of electric power to the heater 121 refers to the concept of stopping supply of electric power to the heater 121 while the supply of electric power is executed. Disabling supply of electric power to the heater 121 refers to the concept of, in addition to stopping supply of electric power to the heater 121, not executing supply of electric power to the heater 121. This configuration makes it possible to prevent thermal runaway or other problems from occurring even when the protection feature does not work properly due to deterioration of the measurement accuracy for the electrical resistance of the thermistor 117.

(2) Acquisition timing for difference between heater temperature and thermistor temperature

[0073] The controller 116 may, during a sampling period constituting a portion of the heating session, acquire the difference between the heater temperature and the thermistor temperature, and cause the acquired difference to be stored into the memory 114. The controller 116 may then control operation of the heater 121, based on the difference between the heater temperature and the thermistor temperature stored in the memory 114. Typically, when the controller 116 acquires the difference between the heater temperature and the thermistor temperature in a given heating session, the controller 116 uses the difference for controlling operation of the heater 121 in the next and subsequent heating sessions. For example, the controller 116 may, during a sampling period provided once per multiple heating sessions, acquire the difference between the heater temperature and the thermistor temperature, and use the acquired difference between the heater temperature and the thermistor temperature for subsequent heating sessions. This configuration makes it possible to reduce the processing load on the inhaler device 100. Of course, the difference between the heater temperature and the thermistor temperature acquired in a given heating session may be used for controlling operation of the heater 121 in the same heating session.

[0074] The controller 116 may, during a sampling period, acquire the difference between the heater temperature and the thermistor temperature a plurality of times, and cause a statistic to be stored into the memory 114. The statistic is a statistic on a plurality of the differences between the heater temperature and the thermistor temperature. The controller 116 may then control operation of the heater 121, based on the statistic on the differences between the heater temperature and the thermistor temperature that has been stored into the memory 114. The statistic may be a value calculated by various statistical methods, such as an average, a weighted average, or a median. The configuration mentioned above makes it possible to determine deterioration of the measurement accuracy for the electrical resistance of the thermistor 117.

[0075] Desirably, the sampling period is a period subsequent to a period during which the temperature of the heater 121 is temporarily dropped. For the example described above with reference to Table 1 and FIG. 2, desirably, the sampling period is a period from STEP 3 onward. In STEP 0 and STEP 1, the heater temperature is rising rapidly or has just experienced a rapid rise. This means that at this point, there is naturally a large difference between the heater temperature and the thermistor temperature. This is because although the thermistor temperature follows the heater temperature, the thermistor temperature rises with a delay. That is, in STEP 0 and STEP 1, the difference between the heater temperature and the thermistor temperature is the sum of the following two values: a value attributable to deterioration of the measurement accuracy for the electrical resistance of the thermistor 117; and a value attributable to a delay in the rise of the thermistor temperature. In contrast, from STEP 3 onward, the thermistor temperature is considered to have sufficiently risen to a point such that the thermistor temperature gradually approaches the heater temperature. That is, from STEP 3 onward, the difference between the heater temperature and the thermistor temperature is considered to have converged to one that does not include a value attributable to a delay in the rise of the thermistor temperature but includes only a value attributable to deterioration of the measurement accuracy for the electrical resistance of the thermistor 117. The configuration mentioned above therefore makes it possible to determine, with improved accuracy, deterioration of the measurement accuracy for the electrical resistance of the thermistor 117.

[0076] In some cases, so-called chain smoking is done, which involves performing heating a plurality of times while replacing the stick substrate 150 at short intervals. In the case of chain-smoking, the heater 121 is at a higher initial temperature when performing heating for the second time onward, compared to the initial temperature of the heater 121 when performing heating for the first time. The higher the initial temperature, the earlier the timing at which the difference between the heater temperature and the thermistor temperature converges.

[0077] Accordingly, the controller 116 may set the sampling period based on the initial temperature of the heater 121. In particular, the controller 116 may set the timing of the start of the sampling period earlier with increasing initial temperature of the heater 121. The initial temperature of the heater 121 may be the heater temperature at the start of heating, that is, at the start of heating performed by the heater 121 based on the heating profile. For example, the controller 116 may, when the heater temperature at the start of heating is less than a predetermined threshold, set STEP 5 and STEP 6 as the sampling period. The controller 116 may, when the heater temperature at the start of heating is greater than or equal to the predetermined threshold, set STEP 3 to STEP 6 as the sampling period. The configuration mentioned above makes it possible to ensure a long sampling period for a case where the difference between the heater temperature and the thermistor temperature converges early due to chain smoking. This in turn makes it possible to accurately determine deterioration of the measurement accuracy for the electrical resistance of the thermistor 117.

[0078] The controller 116 may set the sampling period based on, together with or instead of the heater temperature at the start of heating, another item of information affected by whether the user chain-smokes. In one exemplary configuration, the controller 116 may set the sampling period based on the thermistor temperature at the start of heating. In that case, the controller 116 may set the timing of the start of the sampling period earlier with increasing thermistor temperature at the start of heating. In another exemplary configuration, the controller 116 may set the sampling period based on the elapsed time from the previous execution of the heating based on
the heating profile to the current execution of the heating. In that case, the controller 116 may set the timing of the start of the sampling period earlier with decreasing elapsed time from the previous execution of the heating based on the heating profile to the current execution of the heating. Either of the configurations mentioned above makes it possible to ensure a long sampling period for a case where the difference between the heater temperature and the thermistor temperature converges early due to chain smoking. This in turn makes it possible to accurately determine deterioration of the thermistor 117.

(3) Absorption of individual variability

[0079] The controller 116 may set the first range and the second range based on the difference, acquired when the heating with the heater 121 is executed for the first time, between the heater temperature and the thermistor temperature. For example, the controller 116 sets the range of ±3°C as the first range, and the range of ±10°C as the second range, with reference to the difference, acquired when the heating with the heater 121 is executed for the first time, between the heater temperature and the thermistor temperature. The expression "when the heating with the heater 121 is executed for the first time" refers to, for example, the timing when heating is executed for the first time after shipping and purchase of the inhaler device 100. The difference, acquired when the heating with the heater 121 is executed for the first time, between the heater temperature and the thermistor temperature corresponds to the individual variability of the heaters 121 or thermistors 117. This configuration makes it possible to absorb the individual variability of the heaters 121 or thermistors 117, and properly control operation of the heater 121.

[0080] Another approach for absorbing the individual variability of the heaters 121 or thermistors 117 may be to, prior to shipment from the factory, calibrate the calculation method for the heater temperature or thermistor temperature, in such a way that the heater temperature and the thermistor temperature coincide with each other or the difference between the heater temperature and the thermistor temperature falls within a predetermined range. Calibrating the calculation method for the heater temperature refers to establishing the correspondence relation between the electrical resistance of the heater 121, and the heater temperature calculated from the electrical resistance. Calibrating the calculation method for the thermistor temperature refers to establishing the correspondence relation between the electrical resistance of the thermistor 117, and the thermistor temperature calculated from the electrical resistance. One example is to calibrate the calculation method for the heater temperature or thermistor temperature, in such a way that at the timing when the heater temperature reaches a given target temperature defined in the heating profile, the heater temperature and the thermistor temperature coincide with each other or the difference between the heater temperature and the thermistor temperature falls within a predetermined range. Calibration may be performed with respect to a plurality of target temperatures defined in the heating profile.

(4) Procedure

[0081] A procedure to be executed by the inhaler device 100 according to the embodiment is now described below with reference to FIG. 4. FIG. 4 is a flowchart illustrating an exemplary procedure to be executed by the inhaler device 100 in accordance with the embodiment.

[0082] As illustrated in FIG. 4, first, the controller 116 acquires a user operation indicating an instruction to start heating (step S102). An example of a user operation indicating an instruction to start heating is an operation that the user performs on the inhaler device 100, such as operating, for example, a switch provided to the inhaler device 100. Another example of a user operation indicating an instruction to start heating is insertion of the stick substrate 150 into the inhaler device 100.

[0083] Subsequently, the controller 116 determines whether the difference between the heater temperature and the thermistor temperature acquired from the previous heating session falls within the second range (step S104). For example, the controller 116 makes this determination by referring to the difference between the heater temperature and the thermistor temperature that has been acquired from the previous heating session and stored in the memory 114.

[0084] If the controller 116 determines that the difference between the heater temperature and the thermistor temperature acquired from the previous heating session does not fall within the second range (step S104: NO), the controller 116 disables the heating (step S108). That is, the controller 116 terminates the processing without executing supply of electric power to the heater 121.

[0085] If the controller 116 determines that the difference between the heater temperature and the thermistor temperature acquired from the previous heating session falls within the second range (step S104: YES), the controller 116 starts the heating. That is, the controller 116 starts the supply of electric power to the heater 121.

[0086] Subsequently, the controller 116 acquires the initial temperature of the heater 121 (step S110). For example, the controller 116 acquires the heater temperature at the start of supply of electric power to the heater 121.

[0087] Subsequently, the controller 116 sets the sampling period based on the initial temperature of the heater 121 (step S112).

[0088] Subsequently, the controller 116 determines whether to temporarily turn heating off (step S114). For example, the controller 116 determines to, in response to the start of STEP 2 in the heating profile illustrated in Table 1, temporarily stop the supply of electric power to the heater 121 to thereby temporarily turn heating off.

[0089] If it is determined not to temporarily turn heating off (step S114: NO), the processing proceeds to step S126.

[0090] If it is determined to temporarily turn heating off (step S114: YES), the controller 116 stops the supply of electric power to the heater 121 to thereby turn heating off (step S116).

[0091] Subsequently, the controller 116 determines whether the difference between the heater temperature and the thermistor temperature acquired from the previous heating session falls within the first range (step S118). For example, the controller 116 makes this determination by referring to the difference between the heater temperature and the thermistor temperature that has been acquired from the previous heating session and stored in the memory 114.

[0092] If the controller 116 determines that the difference between the heater temperature and the thermistor temperature acquired from the previous heating session falls within the first range (step S118: YES), the controller 116 resumes heating based on the thermistor temperature (step S120). For example, if heating is temporarily turned off in STEP 2, the controller 116 is triggered to terminate STEP 2 and resume the supply of electric power to the heater 121, when the thermistor temperature drops to a preset target temperature at the end of STEP 2. The processing then proceeds to step S124.

[0093] If the controller 116 determines that the difference between the heater temperature and the thermistor temperature acquired from the previous heating session does not fall within the first range (step S118: NO), the controller 116 resumes heating based on elapsed time (step S122). For example, the controller 116 is triggered to terminate STEP 2 and resume the supply of electric power to the heater 121, when the elapsed time from the temporary turning-off of heating in STEP 2 has reached a predetermined time. The processing then proceeds to step S124.

[0094] In step S124, during the sampling period, the controller 116 acquires the difference between the heater temperature and the thermistor temperature, and causes the acquired difference to be stored into the memory 114 (step S124).

[0095] Subsequently, the controller 116 determines whether the termination condition has been met (step S126). An example of the termination condition is that the duration of STEP 7 has elapsed. Another example of the termination condition is that the number of puffs taken since the start of heating has reached a predetermined number of puffs.

[0096] If it is determined that the termination condition has not been met (step S126: NO), the processing returns to step

S114.

[0097] If it is determined that the termination condition has been met (step S126: YES), the controller 116 terminates the heating performed based on the heating profile (step S128). The procedure then ends.

3. Supplemental Remarks

[0098] Although the preferred embodiment of the present disclosure has been described above in detail with reference to the accompanying drawings, this is not intended to limit the present disclosure to the specific example disclosed. Those having ordinary knowledge in the technical field to which the present disclosure belongs would obviously conceive of various exemplary modifications or alterations within the scope of the technical ideas recited in the claims, and it is to be understood that such modifications or alterations also obviously fall within the technical scope of the present disclosure.

[0099] For example, although the embodiment mentioned above is directed to an example in which the heating profile includes a target value for the temperature of the heater 121, this is not intended to limit the present disclosure to such an example. It may suffice that the heating profile includes a target value for a parameter corresponding to the temperature of the heater 121. An example of a parameter corresponding to the temperature of the heater 121 is the electrical resistance of the heater 121, or the electrical resistance of the thermistor 117.

[0100] For example, although the above embodiment is directed to an example in which the heater 121 is implemented as a resistance heating element, and produces heat due to electrical resistance, this is not intended to limit the present disclosure to such an example. In an alternative example, the heater 121 may include an electromagnetic induction source such as a coil that generates a magnetic field, and a susceptor that produces heat due to induction heating. The stick substrate 150 may be heated by the susceptor. In this cause, the controller 116 causes an alternating magnetic field to be generated through application of an alternating current to the electromagnetic induction source, and causes the alternating magnetic field to penetrate into the susceptor to thereby cause the susceptor to produce heat. The susceptor that produces heat due to induction heating may be provided to the inhaler device 100. In this case, the temperature at which the aerosol source is heated, which is the temperature controlled based on the heating profile, is the temperature of the susceptor. The temperature of the susceptor can be estimated based on the electrical resistance of the electromagnetic induction source.

[0101] The series of processes to be executed by individual devices described herein may be implemented by any one of software, hardware, and a combination of software and hardware. Programs constituting software are, for example, pre-stored in a recording medium (more specifically, a computer-readable non-transitory storage medium) disposed inside or outside the devices. Each program is, for example, loaded into a RAM at the time of execution by a computer that controls the devices described herein, and is executed by a processing circuit such as a CPU. Examples of the recording medium mentioned above include magnetic disks, optical disks, magneto-optical disks, and flash memories. The computer program mentioned above may be, for example, distributed via a network without use of a recording medium. Examples of the computer mentioned above may include an integrated circuit designed for a specific application such as an ASIC, a general-purpose processor that executes a function by reading a software program, and a computer that runs on a server and that is used for cloud computing. The series of processes to be executed by the devices described herein may be processed in a distributed manner by a plurality of computers.

[0102] The processes described herein with reference to the flowchart and the sequence diagrams do not necessarily have to be executed in the illustrated order. Some of the process steps may be executed in parallel. Additional process steps may be employed, or a subset of the process steps may be omitted.

[0103] Configurations described below also belong to the technical scope of the present disclosure.

(1) An aerosol generating system including:

a power supply;
a heater configured to heat an aerosol source by using electric power supplied from the power supply;
a temperature-variable unit configured to change in temperature following a change in temperature of the heater; and
a controller configured to, based on a difference between a temperature of the heater and a temperature of the temperature-variable unit, control operation of the heater, the temperature of the heater being indicated by a first measurement value measured as a parameter corresponding to the temperature of the heater, the temperature of the temperature-variable unit being indicated by a second measurement value measured as a parameter corresponding to the temperature of the temperature-variable unit.

(2) The aerosol generating system according to the item (1),
in which the controller is configured to, based on the difference between the temperature of the heater and the temperature of the temperature-variable unit, switch parameters that serve as a basis for controlling supply of electric power to the heater.

(3) The aerosol generating system according to the item (2),
in which the controller is configured to, based on the difference between the temperature of the heater and the temperature of the temperature-variable unit, switch parameters that serve as a basis for resuming the supply of electric power to the heater after temporarily stopping the supply of electric power to the heater.
(4) The aerosol generating system according to the item (3),
in which the controller is configured to, when the difference between the temperature of the heater and the temperature of the temperature-variable unit falls within a first range, resume the supply of electric power to the heater based on the second measurement value.
(5) The aerosol generating system according to the item (4),
in which the controller is configured to, when the difference between the temperature of the heater and the temperature of the temperature-variable unit exceeds the first range and falls within a second range greater than the first range, resume the supply of electric power to the heater based on an elapsed time.
(6) The aerosol generating system according to the item (5),
in which the controller is configured to, when the difference between the temperature of the heater and the temperature of the temperature-variable unit exceeds the second range, execute at least one of stopping of the supply of electric power to the heater or disabling of the supply of electric power to the heater.
(7) The aerosol generating system according to the item (5) or (6),
in which the controller is configured to set the first range and the second range based on the difference, acquired when heating is executed for a first time by the heater, between the temperature of the heater and the temperature of the temperature-variable unit.
(8) The aerosol generating system according to any one of the items (1) to (7),

in which the aerosol generating system includes a memory configured to store information, and
in which the controller is configured to,

based on control information, control the operation of the heater, the control information defining time-series transition of a target value of a temperature at which the aerosol source is heated,
during a sampling period, acquire the difference between the temperature of the heater and the temperature of the temperature-variable unit, and cause the acquired difference to be stored into the memory, the sampling period being a portion of a period for which the time-series transition of the target temperature is defined by the control information, and
based on the difference between the temperature of the heater and the temperature of the temperature-variable unit stored in the memory, control the operation of the heater.

(9) The aerosol generating system according to the item (8),
in which the controller is configured to

during the sampling period, acquire the difference between the temperature of the heater and the temperature of the temperature-variable unit a plurality of times, and cause a statistic to be stored into the memory, the statistic being a statistic on a plurality of the differences between the temperature of the heater and the temperature of the temperature-variable unit, and
based on the statistic on the differences between the temperature of the heater and the temperature of the temperature-variable unit stored in the memory, control the operation of the heater.

(10) The aerosol generating system according to the item (8) or (9),

in which the period for which the time-series transition of the target value is defined by the control information includes, partway through the period, a period during which the temperature of the heater is temporarily dropped,
in which the controller is configured to, in the period during which the temperature of the heater is dropped, stop the supply of electric power to the heater, and
in which the sampling period is a period subsequent to the period during which the temperature of the heater is dropped.

(11) The aerosol generating system according to the item (10),
in which the controller is configured to set the sampling period, based on the first measurement value measured at a start of heating performed by the heater based on the control information.
(12) The aerosol generating system according to the item (11),
in which the controller is configured to set a timing of start of the sampling period earlier with increasing temperature of

the heater as indicated by the first measurement value at the start of heating performed by the heater based on the control information.

(13) The aerosol generating system according to any one of the items (1) to (12),

in which the heater is a resistance heating element configured to produce heat when subjected to an applied current,
in which the first measurement value is an electrical resistance of the resistance heating element,
in which the temperature-variable unit is a resistor configured to change in electrical resistance with a change in temperature, and
in which the second measurement value is an electrical resistance of the resistor.

(14) The aerosol generating system according to any one of the items (1) to (13), further including
a substrate containing the aerosol source.

(15) A control method for controlling an aerosol generating system, the aerosol generating system including

a power supply,
a heater configured to heat an aerosol source by using electric power supplied from the power supply, and
a temperature-variable unit configured to change in temperature following a change in temperature of the heater,
the control method including
based on a difference between a temperature of the heater and a temperature of the temperature-variable unit, controlling operation of the heater, the temperature of the heater being indicated by a first measurement value measured as a parameter corresponding to the temperature of the heater, the temperature of the temperature-variable unit being indicated by a second measurement value measured as a parameter corresponding to the temperature of the temperature-variable unit.

Reference Signs List

[0104]

100 inhaler device

111 power supply

112 sensor

113 notifier

114 memory

115 communicator

116 controller

117 thermistor

121 heater

140 holder

141 internal space

142 opening

143 bottom

144 heat insulator

150 stick substrate

151 substrate

152 inhalation port

Claims

1. An aerosol generating system comprising:

a power supply;
a heater configured to heat an aerosol source by using electric power supplied from the power supply;
a temperature-variable unit configured to change in temperature following a change in temperature of the heater; and
a controller configured to, based on a difference between a temperature of the heater and a temperature of the temperature-variable unit, control operation of the heater, the temperature of the heater being indicated by a first measurement value measured as a parameter corresponding to the temperature of the heater, the temperature of the temperature-variable unit being indicated by a second measurement value measured as a parameter corresponding to the temperature of the temperature-variable unit.

2. The aerosol generating system according to claim 1,
wherein the controller is configured to, based on the difference between the temperature of the heater and the temperature of the temperature-variable unit, switch parameters that serve as a basis for controlling supply of electric power to the heater.

3. The aerosol generating system according to claim 2,
wherein the controller is configured to, based on the difference between the temperature of the heater and the temperature of the temperature-variable unit, switch parameters that serve as a basis for resuming the supply of electric power to the heater after temporarily stopping the supply of electric power to the heater.

4. The aerosol generating system according to claim 3,
wherein the controller is configured to, when the difference between the temperature of the heater and the temperature of the temperature-variable unit falls within a first range, resume the supply of electric power to the heater based on the second measurement value.

5. The aerosol generating system according to claim 4,
wherein the controller is configured to, when the difference between the temperature of the heater and the temperature of the temperature-variable unit exceeds the first range and falls within a second range greater than the first range, resume the supply of electric power to the heater based on an elapsed time.

6. The aerosol generating system according to claim 5,
wherein the controller is configured to, when the difference between the temperature of the heater and the temperature of the temperature-variable unit exceeds the second range, execute at least one of stopping of the supply of electric power to the heater or disabling of the supply of electric power to the heater.

7. The aerosol generating system according to claim 5 or 6,
wherein the controller is configured to set the first range and the second range based on the difference, acquired when heating is executed for a first time by the heater, between the temperature of the heater and the temperature of the temperature-variable unit.

8. The aerosol generating system according to any one of claims 1 to 7,

wherein the aerosol generating system comprises a memory configured to store information, and
wherein the controller is configured to,

based on control information, control the operation of the heater, the control information defining time-series transition of a target value of a temperature at which the aerosol source is heated,
during a sampling period, acquire the difference between the temperature of the heater and the temperature of the temperature-variable unit, and cause the acquired difference to be stored into the memory, the sampling period being a portion of a period for which the time-series transition of the target temperature is

defined by the control information, and
based on the difference between the temperature of the heater and the temperature of the temperature-variable unit stored in the memory, control the operation of the heater.

9. The aerosol generating system according to claim 8,
wherein the controller is configured to

during the sampling period, acquire the difference between the temperature of the heater and the temperature of the temperature-variable unit a plurality of times, and cause a statistic to be stored into the memory, the statistic being a statistic on a plurality of the differences between the temperature of the heater and the temperature of the temperature-variable unit, and
based on the statistic on the differences between the temperature of the heater and the temperature of the temperature-variable unit stored in the memory, control the operation of the heater.

10. The aerosol generating system according to claim 8 or 9,

wherein the period for which the time-series transition of the target value is defined by the control information includes, partway through the period, a period during which the temperature of the heater is temporarily dropped,
wherein the controller is configured to, in the period during which the temperature of the heater is dropped, stop the supply of electric power to the heater, and
wherein the sampling period is a period subsequent to the period during which the temperature of the heater is dropped.

11. The aerosol generating system according to claim 10,
wherein the controller is configured to set the sampling period, based on the first measurement value measured at a start of heating performed by the heater based on the control information.

12. The aerosol generating system according to claim 11,
wherein the controller is configured to set a timing of start of the sampling period earlier with increasing temperature of the heater as indicated by the first measurement value at the start of heating performed by the heater based on the control information.

13. The aerosol generating system according to any one of claims 1 to 12,

wherein the heater is a resistance heating element configured to produce heat when subjected to an applied current,
wherein the first measurement value is an electrical resistance of the resistance heating element,
wherein the temperature-variable unit is a resistor configured to change in electrical resistance with a change in temperature, and
wherein the second measurement value is an electrical resistance of the resistor.

14. The aerosol generating system according to any one of claims 1 to 13, further comprising
a substrate containing the aerosol source.

15. A control method for controlling an aerosol generating system, the aerosol generating system including

a power supply,
a heater configured to heat an aerosol source by using electric power supplied from the power supply, and
a temperature-variable unit configured to change in temperature following a change in temperature of the heater,
the control method comprising
based on a difference between a temperature of the heater and a temperature of the temperature-variable unit, controlling operation of the heater, the temperature of the heater being indicated by a first measurement value measured as a parameter corresponding to the temperature of the heater, the temperature of the temperature-variable unit being indicated by a second measurement value measured as a parameter corresponding to the temperature of the temperature-variable unit.

FIG. 1

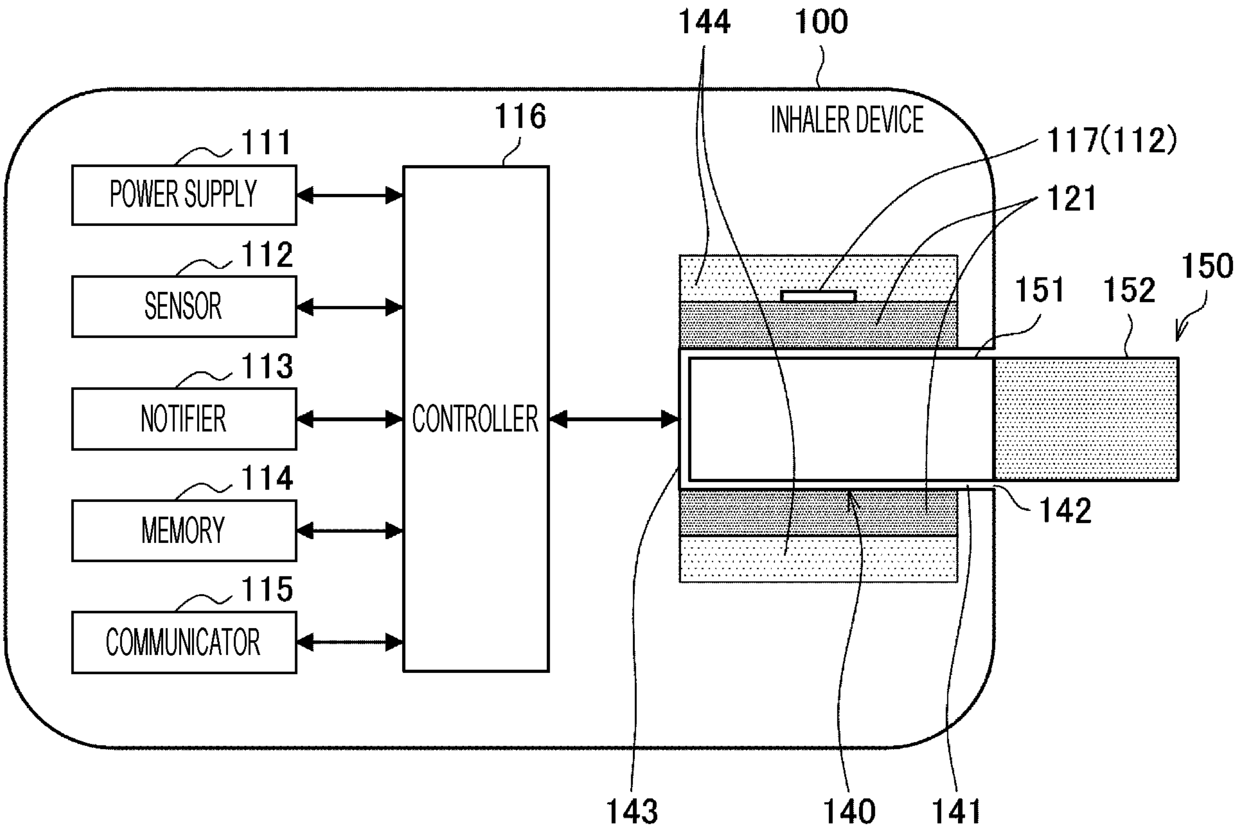

144
100
INHALER DEVICE
116
111
POWER SUPPLY
112
SENSOR
113
NOTIFIER
114
MEMORY
115
COMMUNICATOR
CONTROLLER
117(112)
121
151
152
150
142
143
140
141

FIG. 2

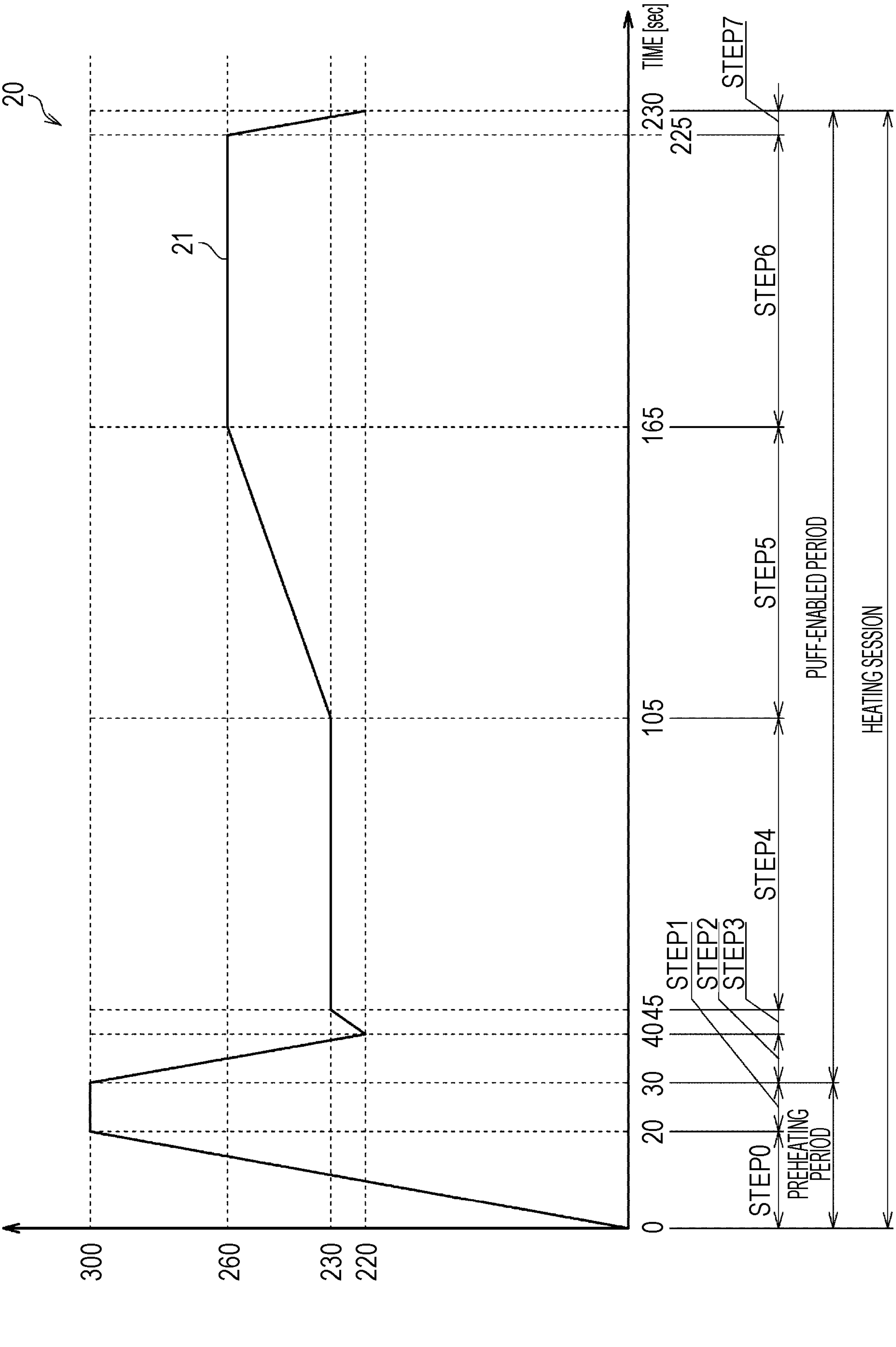

TEMPERATURE [°C]
300
260
230
220
TIME [sec]
0
20
30
40
45
105
165
225
230
20
21
STEP0
PREHEATING PERIOD
STEP1
STEP2
STEP3
STEP4
STEP5
STEP6
STEP7
PUFF-ENABLED PERIOD
HEATING SESSION

FIG. 3

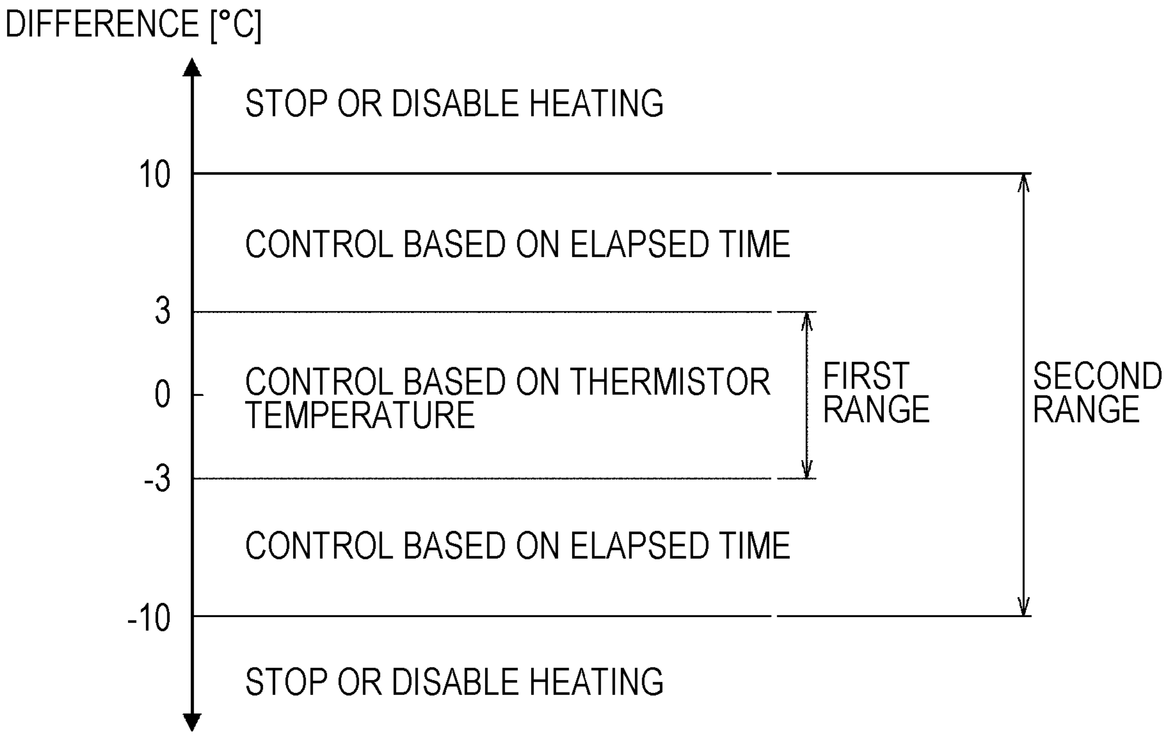
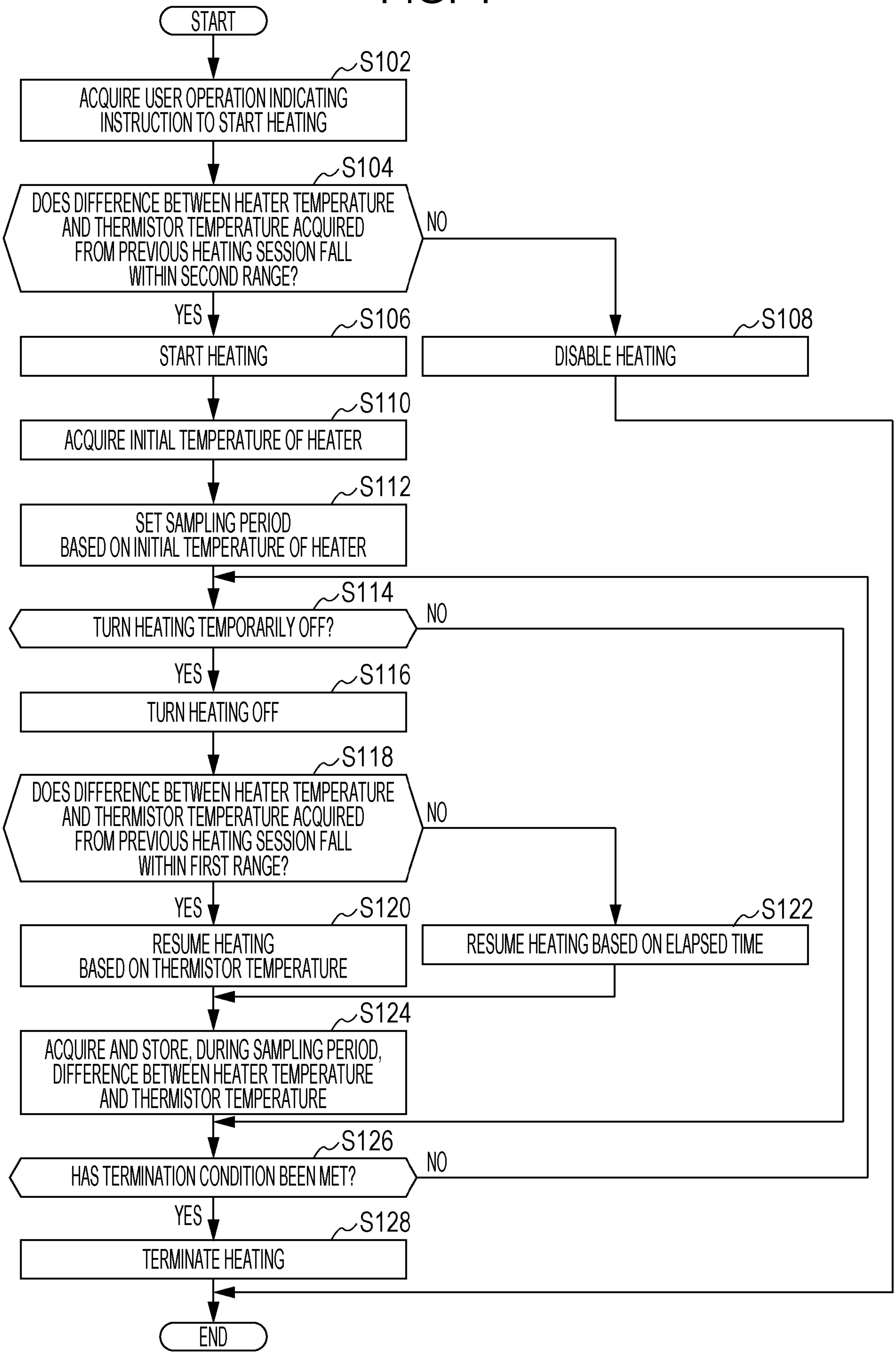

DIFFERENCE [°C]
STOP OR DISABLE HEATING
10
CONTROL BASED ON ELAPSED TIME
3
0
CONTROL BASED ON THERMISTOR TEMPERATURE
-3
CONTROL BASED ON ELAPSED TIME
-10
STOP OR DISABLE HEATING
FIRST RANGE
SECOND RANGE

FIG. 4


START
S102
ACQUIRE USER OPERATION INDICATING INSTRUCTION TO START HEATING
S104
DOES DIFFERENCE BETWEEN HEATER TEMPERATURE AND THERMISTOR TEMPERATURE ACQUIRED FROM PREVIOUS HEATING SESSION FALL WITHIN SECOND RANGE?
NO
YES
S106
START HEATING
S108
DISABLE HEATING
S110
ACQUIRE INITIAL TEMPERATURE OF HEATER
S112
SET SAMPLING PERIOD BASED ON INITIAL TEMPERATURE OF HEATER
S114
TURN HEATING TEMPORARILY OFF?
NO
YES
S116
TURN HEATING OFF
S118
DOES DIFFERENCE BETWEEN HEATER TEMPERATURE AND THERMISTOR TEMPERATURE ACQUIRED FROM PREVIOUS HEATING SESSION FALL WITHIN FIRST RANGE?
NO
YES
S120
RESUME HEATING BASED ON THERMISTOR TEMPERATURE
S122
RESUME HEATING BASED ON ELAPSED TIME
S124
ACQUIRE AND STORE, DURING SAMPLING PERIOD, DIFFERENCE BETWEEN HEATER TEMPERATURE AND THERMISTOR TEMPERATURE
S126
HAS TERMINATION CONDITION BEEN MET?
NO
YES
S128
TERMINATE HEATING
END

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2022/020344

A. CLASSIFICATION OF SUBJECT MATTER

A24F 40/57(2020.01)i
FI: A24F40/57

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A24F40/57

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2022
Registered utility model specifications of Japan 1996-2022
Published registered utility model applications of Japan 1994-2022

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 3357359 A2 (SHENZHEN FIRST UNION TECHNOLOGY CO., LTD.) 08 August 2018 (2018-08-08) see in particular, paragraphs [0023], [0025]-[0029], fig. 1, 2	1, 8-9, 13-15
A	entire text, all drawings	2-7, 10-12
A	JP 2021-510504 A (PHILIP MORRIS PRODUCTS S. A.) 30 April 2021 (2021-04-30) entire text, all drawings	1-15
A	JP 2020-195298 A (JAPAN TOBACCO INC.) 10 December 2020 (2020-12-10) entire text, all drawings	1-15

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
05 July 2022	**19 July 2022**

Name and mailing address of the ISA/JP	Authorized officer
Japan Patent Office (ISA/JP) **3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915** **Japan**	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2022/020344

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
EP 3357359 A2	08 August 2018	US 2018/0325179 A1	
		CN 206808677 U	
JP 2021-510504 A	30 April 2021	US 2020/0367570 A1 entire text, all drawings	
		WO 2019/138043 A1	
		CN 111511234 A	
		KR 10-2020-0106928 A	
JP 2020-195298 A	10 December 2020	JP 6625258 B1	
		US 2020/0375260 A1 entire text, all drawings	
		EP 3744189 A1	
		CN 112006334 A	
		KR 10-2020-0138019 A	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP 6833157 B **[0004]**