



(11)

EP 4 245 169 A1

(12)

EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:

20.09.2023 Bulletin 2023/38

(51) International Patent Classification (IPC):

A24F 40/465 ^(2020.01)

(21) Application number: **21926561.8**

(52) Cooperative Patent Classification (CPC):

A24F 40/465

(22) Date of filing: **18.02.2021**

(86) International application number:

PCT/JP2021/006179

(87) International publication number:

WO 2022/176126 (25.08.2022 Gazette 2022/34)

(84) Designated Contracting States:

**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**

• **KAWASAKI, Reijiro**
Tokyo 130-8603 (JP)

(71) Applicant: **Japan Tobacco Inc.**
Tokyo 105-6927 (JP)

(74) Representative: **Hoffmann Eitle**
Patent- und Rechtsanwälte PartmbB
Arabellastraße 30
81925 München (DE)

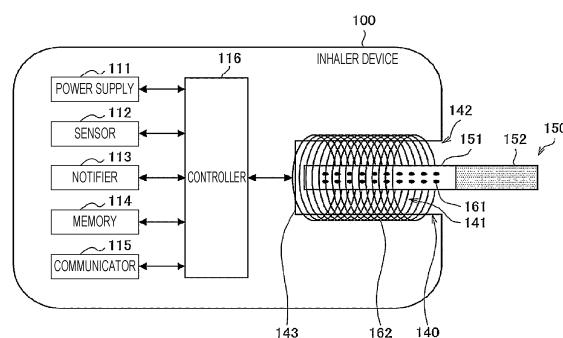
(72) Inventors:

• **SERITA, Kazutoshi**
Tokyo 130-8603 (JP)

(54) **INHALATION DEVICE, PROGRAM, AND SYSTEM**

(57) [Problem] To provide a contrivance that makes it possible to generate a suitable aerosol in an induction-heating-type inhalation device. [Solution] This inhalation device comprises: a power supply unit that supplies electric power; a magnetic induction source that produces a fluctuating magnetic field using the electric power supplied from the power supply unit; a control unit that controls the supply of power to the magnetic induction source; a retention unit that has an internal space and an opening through which the internal space communicates with the outside, the retention unit retaining an aerosol-source-containing substrate that is inserted into the internal space through the opening; and a temperature sensor that detects the temperature in the operation environment of the inhalation device. The magnetic induction source is disposed at a position such that the fluctuating magnetic field produced by the magnetic induction source penetrates a susceptor disposed in thermal contact with the aerosol source contained in the substrate being retained by the retention unit. The susceptor generates heat when penetrated by the fluctuating magnetic field. The control unit controls the supply of power to the magnetic induction source on the basis of the temperature detected by the temperature sensor.

FIG. 1



Description

Technical Field

5 **[0001]** The present invention relates to an inhaler device, a program, and a system.

Background Art

10 **[0002]** Inhaler devices, such as e-cigarettes and nebulizers, for generating a substance to be inhaled by users are widespread. For example, the inhaler devices generate an aerosol having a flavor component imparted thereto, by using a substrate including an aerosol source for generating the aerosol, a flavor source for imparting the flavor component to the generated aerosol, and the like. Users can enjoy the flavor by inhaling the aerosol having the flavor component imparted thereto, which is generated by the inhaler devices. An action of a user inhaling an aerosol is hereinafter referred to as a puff or a puff action.

15 **[0003]** Inhaler devices using an external heat source such as a heating blade had been dominant until recently. In recent years, however, inhaler devices of induction heating type have been attracting attention. For example, Patent Literature 1 below discloses a technique of estimating a temperature of a susceptor included in a substrate from an apparent ohmic resistance when the susceptor is heated by induction heating.

20 Citation List

Patent Literature

25 **[0004]** Patent Literature 1: JP 6623175 B2

Summary of Invention

Technical Problem

30 **[0005]** Inhaler devices using an external heat source measure and control a temperature of the external heat source to implement appropriate generation of an aerosol. In contrast, inhaler devices of induction heating type have difficulty in directly measuring and controlling the temperature of the susceptor and thus in implementing appropriate generation of an aerosol. As disclosed in Patent Literature 1 above or the like, the technique of estimating a temperature of a susceptor has been developed. However, there is room for improvement in the accuracy of such a technique.

35 **[0006]** Accordingly, the present invention has been made in view of the issue described above, and it is an object of the present invention to provide a mechanism that enables an inhaler device of induction heating type to appropriately generate an aerosol.

Solution to Problem

40 **[0007]** To overcome the issue described above, an aspect of the present invention provides an inhaler device including: a power supply configured to supply electric power; an electromagnetic induction source configured to generate a varying magnetic field by using the electric power supplied from the power supply; a controller configured to control electric power supply to the electromagnetic induction source; a holder having an internal space and an opening that allows the internal space to communicate with outside and configured to hold a substrate inserted into the internal space through the opening, the substrate including an aerosol source; and a temperature sensor configured to detect a temperature of an operating environment of the inhaler device, in which the electromagnetic induction source is disposed at a position where the varying magnetic field generated by the electromagnetic induction source penetrates a susceptor that is disposed in thermal proximity to the aerosol source included in the substrate held by the holder, the susceptor is configured to produce heat upon being penetrated by the varying magnetic field, and the controller is configured to control the electric power supply to the electromagnetic induction source, based on the temperature detected by the temperature sensor.

[0008] The controller may be configured to control the electric power supply to the electromagnetic induction source, based on an operation history of the inhaler device.

55 **[0009]** The controller may be configured to control the electric power supply to the electromagnetic induction source, based on a number of times of electric power supply to the electromagnetic induction source.

[0010] The controller may be configured to control the electric power supply to the electromagnetic induction source, based on an interval of electric power supply to the electromagnetic induction source.

[0011] The controller may be configured to control the electric power supply to the electromagnetic induction source, based on a type of the substrate held by the holder.

[0012] The controller may be configured to control, based on a heating profile, the electric power supply to the electromagnetic induction source, the heating profile being information that defines a time-series change in a target temperature that is a target value of a temperature of the susceptor.

[0013] The controller may be configured to adjust, based on the temperature detected by the temperature sensor, a time-series change, in an amount of electric power to be supplied to the electromagnetic induction source, determined in advance in accordance with the time-series change in the target temperature defined in the heating profile, and control the electric power supply to the electromagnetic induction source in accordance with the adjusted time-series change in the amount of electric power to be supplied to the electromagnetic induction source.

[0014] The controller may be configured to adjust, based on an operation history of the inhaler device, a time-series change, in an amount of electric power to be supplied to the electromagnetic induction source, determined in advance in accordance with the time-series change in the target temperature defined in the heating profile, and control the electric power supply to the electromagnetic induction source in accordance with the adjusted time-series change in the amount of electric power to be supplied to the electromagnetic induction source.

[0015] The controller may be configured to adjust, based on a number of times of electric power supply to the electromagnetic induction source, the time-series change, in the amount of electric power to be supplied to the electromagnetic induction source, determined in advance in accordance with the time-series change in the target temperature defined in the heating profile, and control the electric power supply to the electromagnetic induction source in accordance with the adjusted time-series change in the amount of electric power to be supplied to the electromagnetic induction source.

[0016] The controller may be configured to adjust, based on an interval of electric power supply to the electromagnetic induction source, the time-series change, in the amount of electric power to be supplied to the electromagnetic induction source, determined in advance in accordance with the time-series change in the target temperature defined in the heating profile, and control the electric power supply to the electromagnetic induction source in accordance with the adjusted time-series change in the amount of electric power to be supplied to the electromagnetic induction source.

[0017] The controller may be configured to adjust, based on a type of the substrate, a time-series change, in an amount of electric power to be supplied to the electromagnetic induction source, determined in advance in accordance with the time-series change in the target temperature defined in the heating profile, and control the electric power supply to the electromagnetic induction source in accordance with the adjusted time-series change in the amount of electric power to be supplied to the electromagnetic induction source.

[0018] The controller may be configured to change the heating profile to be used, and an amount by which the time-series change, in the amount of electric power to be supplied to the electromagnetic induction source, determined in advance in accordance with the time-series change in the target temperature defined in the heating profile, is adjusted may be different for each heating profile to be used.

[0019] The inhaler device may include a plurality of the electromagnetic induction sources, and the controller may be configured to control electric power supply to each of the plurality of electromagnetic induction sources, based on the heating profile that is different for each of the electromagnetic induction sources.

[0020] Controlling the electric power supply to the electromagnetic induction source includes stopping the electric power supply to the electromagnetic induction source.

[0021] The inhaler device may include a plurality of the temperature sensors.

[0022] The plurality of temperature sensors include at least two or more of the temperature sensor disposed in proximity to the power supply, the controller, or the holder, and the temperature sensor disposed in proximity to a region in which a temperature changes in response to inhalation performed by a user.

[0023] To overcome the issue described above, another aspect of the present invention provides a program to be executed by a computer that controls an inhaler device, the inhaler device including: a power supply configured to supply electric power; an electromagnetic induction source configured to generate a varying magnetic field by using the electric power supplied from the power supply; a controller configured to control electric power supply to the electromagnetic induction source; a holder having an internal space and an opening that allows the internal space to communicate with outside and configured to hold a substrate inserted into the internal space through the opening, the substrate including an aerosol source; and a temperature sensor configured to detect a temperature of an operating environment of the inhaler device, the electromagnetic induction source being disposed at a position where the varying magnetic field generated by the electromagnetic induction source penetrates a susceptor that is disposed in thermal proximity to the aerosol source included in the substrate held by the holder, the susceptor being configured to produce heat upon being penetrated by the varying magnetic field, the program causing controlling the electric power supply to the electromagnetic induction source, based on the temperature detected by the temperature sensor to be performed.

[0024] To overcome the issue described above, another aspect of the present invention provides a system including: an inhaler device; and a substrate, the substrate including an aerosol source, the inhaler device including: a power supply configured to supply electric power; an electromagnetic induction source configured to generate a varying magnetic

field by using the electric power supplied from the power supply; a controller configured to control electric power supply to the electromagnetic induction source; a holder having an internal space and an opening that allows the internal space to communicate with outside and configured to hold the substrate inserted into the internal space through the opening; and a temperature sensor configured to detect a temperature of an operating environment of the inhaler device, in which the electromagnetic induction source is disposed at a position where the varying magnetic field generated by the electromagnetic induction source penetrates a susceptor that is disposed in thermal proximity to the aerosol source included in the substrate held by the holder, the susceptor is configured to produce heat upon being penetrated by the varying magnetic field, and the controller is configured to control the electric power supply to the electromagnetic induction source, based on the temperature detected by the temperature sensor.

[0025] The susceptor may be included in the substrate.

Advantageous Effects of Invention

[0026] As described above, the present invention provides a mechanism that enables an inhaler device of induction heating type to appropriately generate an aerosol.

Brief Description of Drawings

[0027]

[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 a time-series change in an actual temperature of a susceptor heated by induction heating based on a heating profile presented by Table 1.

[Fig. 3] Fig. 3 is a diagram schematically illustrating an example of a physical configuration inside the inhaler device according to the present embodiment.

[Fig. 4] Fig. 4 is a flowchart illustrating an example of a procedure of a process performed by the inhaler device according to the present embodiment.

Description of Embodiments

[0028] A preferred embodiment of the present invention will be described in detail below with reference to the accompanying drawings. In the specification and the drawings, structural elements having substantially the same functional configuration are denoted by the same reference numerals, and redundant description thereof will be omitted.

<1. Configuration example of inhaler device>

[0029] An inhaler device according to the present configuration example heats a substrate including an aerosol source by induction heating (IH) to generate an aerosol. The present configuration example will be described below with reference to Fig. 1.

[0030] Fig. 1 is a schematic diagram of the inhaler device according to the 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 susceptor 161, an electromagnetic induction source 162, and a holder 140. A user performs inhalation while a stick substrate 150 is held by the holder 140. Each structural element will be sequentially described below.

[0031] The power supply 111 stores electric power. The power supply 111 supplies electric power to each structural element of the inhaler device 100. The power supply 111 may be, for example, a rechargeable battery such as a lithium ion secondary battery. The power supply 111 may be charged by being connected to an external power supply through a Universal Serial Bus (USB) cable or the like. In addition, the power supply 111 may be charged, by using a wireless power transmission technology, without being connected to a power-transmitting device. Further, the power supply 111 alone may be removed from the inhaler device 100 and replaced with a new power supply 111.

[0032] The sensor 112 detects various items of information regarding the inhaler device 100. The sensor 112 outputs the detected items of information to the controller 116. In an example, the sensor 112 may be a pressure sensor such as a condenser microphone, a flow sensor, or a temperature sensor. In response to detecting a numerical value in accordance with inhalation performed by a user, the sensor 112 outputs information indicating that the user has performed the inhalation to the controller 116. 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. In particular, the sensor 112 may include a button for inputting an instruction to start/stop generation of an aerosol. The sensor 112 outputs the information input by the user to the controller 116. In another example, the sensor 112 may be a temperature sensor that detects a temperature of the susceptor 161.

The temperature sensor detects the temperature of the susceptor 161 based on, for example, an electrical resistance value of the electromagnetic induction source 162. The sensor 112 may detect the temperature of the stick substrate 150 held by the holder 140, based on the temperature of the susceptor 161.

[0033] The notifier 113 notifies the user of information. In an example, the notifier 113 may be a light-emitting device such as a light-emitting diode (LED). In this case, the notifier 113 emits different patterns of light when the power supply 111 needs to be charged, when the power supply 111 is being charged, when the inhaler device 100 has an anomaly, and so on. The pattern of light is a concept including a color, turn-on/turn-off timings, and so on. The notifier 113 may be, along with or instead of the light-emitting device, a display device that displays an image, a sound output device that outputs sound, or a vibration device that vibrates. In addition, the notifier 113 may notify the user of information indicating that the user can perform inhalation. The user is notified of the information indicating that the user can perform inhalation, in response to the temperature of the stick substrate 150 that produces heat by electromagnetic induction reaching a predetermined temperature.

[0034] 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 a flash memory. An example of the items of information stored in the memory 114 is items of information related to an operating system (OS) of the inhaler device 100, such as details of control performed on the various structural elements by the controller 116. Another example of the items of information stored in the memory 114 is items of information related to inhalation performed by the user, such as the number of times of inhalation, an inhalation time, and an accumulated inhalation time period.

[0035] The communicator 115 is a communication interface for transmitting and receiving information between the inhaler device 100 and another device. The communicator 115 performs communication in conformity with any wired or wireless communication standard. Such a communication standard may be, for example, a wireless local area network (LAN), a wired LAN, Wi-Fi (registered trademark), or Bluetooth (registered trademark). In an example, the communicator 115 transmits the items of information related to inhalation performed by the user to a smartphone to cause the smartphone to display the information related to inhalation performed by the user. In another example, the communicator 115 receives information of a new OS from a server to update the information of the OS stored in the memory 114.

[0036] 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 is implemented by an electronic circuit such as a central processing unit (CPU) or a microprocessor, for example. In addition, the controller 116 may include a read-only memory (ROM) that stores a program to be used, an arithmetic parameter, and the like, and a random access memory (RAM) that temporarily stores a parameter that changes as appropriate and the like. The inhaler device 100 performs various processes under the control of the controller 116. Electric power supply from the power supply 111 to each of the other structural elements, charging of the power supply 111, detection of information by the sensor 112, notification of information by the notifier 113, storage and reading of information to and from the memory 114, and transmission and reception of information by the communicator 115 are an example of the processes controlled by the controller 116. Other processes performed by the inhaler device 100, such as input of information to each structural element and a process based on information output from each structural element are also controlled by the controller 116.

[0037] The holder 140 has an internal space 141, and holds the stick substrate 150 in a manner such that the stick substrate 150 is partially accommodated in the internal space 141. The holder 140 has an opening 142 that allows the internal space 141 to communicate with 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 that is a bottom surface, and may define the pillar-shaped internal space 141. The holder 140 has, in at least a portion of the tubular body in the height direction, an inside diameter that is smaller than an outside diameter of the stick substrate 150 to be able to hold the stick substrate 150 by pressing the stick substrate 150 inserted into the internal space 141 from the outer circumference. The holder 140 also has a function of defining a flow path of air that passes through the stick substrate 150. For example, the bottom 143 has an air inlet hole that is an inlet of air into the flow path. On the other hand, the opening 142 serves as an air outlet hole that is an outlet of air from the flow path.

[0038] The stick substrate 150 is a stick-shaped member. The stick substrate 150 includes a substrate 151 and an inhalation port 152.

[0039] The substrate 151 includes an aerosol source. The aerosol source is heated to be atomized, so that an aerosol is generated. The aerosol source may be a material derived from tobacco, such as shredded tobacco or a processed material obtained by forming a tobacco raw material into a granular, sheet-like, or powdery shape. In addition, the aerosol source may include a material that is not derived from tobacco, such as a material made from a plant other than tobacco (for example, mint or an herb). In an example, the aerosol source may include a flavor component such as menthol. For the inhaler device 100 that is a medical inhaler, the aerosol source may include a medicine to be inhaled by a patient. The aerosol source is not limited to a solid and may be a liquid such as polyhydric alcohol and water. Examples of the polyhydric alcohol include glycerine and propylene glycol. At least a portion of the substrate 151 is accommodated in the internal space 141 of the holder 140 when the stick substrate 150 is held by the holder 140.

[0040] The inhalation port 152 is to be held in a mouth of the user during inhalation. At least a portion of the inhalation port 152 protrudes from the opening 142 when the stick substrate 150 is held by the holder 140. When a user performs inhalation while holding, in their mouth, the inhalation port 152 protruding from the opening 142, air flows into the holder 140 through the air inlet hole (not illustrated). The air that has flowed in passes through the internal space 141 of the holder 140, that is, the substrate 151, and reaches the inside of the mouth of the user together with the aerosol generated from the substrate 151.

[0041] The stick substrate 150 further includes the susceptor 161. The susceptor 161 produces heat by electromagnetic induction. The susceptor 161 may be made of a conductive material such as metal. In an example, the susceptor 161 is a piece of metal. The susceptor 161 is disposed in proximity to the aerosol source. In the example illustrated in Fig. 1, the susceptor 161 is included in the substrate 151 of the stick substrate 150.

[0042] The susceptor 161 is disposed in thermal proximity to the aerosol source. The susceptor 161 being in thermal proximity to the aerosol source means that the susceptor 161 is disposed at a position where heat produced by the susceptor 161 is transferred to the aerosol source. For example, the susceptor 161 is included in the substrate 151 along with the aerosol source and is surrounded by the aerosol source. This configuration enables the heat produced by the susceptor 161 to be efficiently used for heating the aerosol source.

[0043] Note that, the susceptor 161 may be untouchable from outside of the stick substrate 150. For example, the susceptor 161 may be distributed in a central part of the stick substrate 150, but does not have to be distributed near the outer circumference of the stick substrate 150.

[0044] The electromagnetic induction source 162 causes the susceptor 161 to produce heat by electromagnetic induction. For example, the electromagnetic induction source 162 is a coiled conductive wire wound around the outer circumference of the holder 140. Upon being supplied with an alternating current from the power supply 111, the electromagnetic induction source 162 generates a magnetic field. The electromagnetic induction source 162 is disposed at a position where the internal space 141 of the holder 140 overlaps with the generated magnetic field. Thus, when a magnetic field is generated while the stick substrate 150 is held by the holder 140, an eddy current is generated in the susceptor 161 to generate Joule heat. The aerosol source included in the stick substrate 150 is heated by the Joule heat to be atomized, so that an aerosol is generated. In an example, when the sensor 112 detects a predetermined user input, electric power may be supplied and an aerosol may be generated. When the temperature of the stick substrate 150 that is heated by induction heating using the susceptor 161 and the electromagnetic induction source 162 reaches a predetermined temperature, the user can perform inhalation. When the sensor 112 detects a predetermined user input thereafter, electric power supply may be stopped. In another example, electric power may be supplied and an aerosol may be generated, while the sensor 112 detects inhalation performed by the user.

[0045] Fig. 1 illustrates an example of the susceptor 161 included in the substrate 151 of the stick substrate 150. However, the present configuration example is not limited to such an example. For example, the holder 140 may function as the susceptor 161. In this case, the magnetic field generated by the electromagnetic induction source 162 generates an eddy current in the holder 140, so that Joule heat is generated. The aerosol source included in the stick substrate 150 is heated by the Joule heat to be atomized, so that an aerosol is generated.

[0046] The combination of the inhaler device 100 and the stick substrate 150 may be regarded as a single system because an aerosol can be generated by combining the inhaler device 100 and the stick substrate 150.

<2. Induction heating>

[0047] Induction heating will be described in detail below.

[0048] Induction heating is a process of heating a conductive object by causing a varying magnetic field to penetrate the object. Induction heating involves a magnetic field generator that generates a varying magnetic field, and a to-be-heated object that is conductive and is to be heated when exposed to the varying magnetic field. An example of the varying magnetic field is an alternating magnetic field. The electromagnetic induction source 162 illustrated in Fig. 1 is an example of the magnetic field generator. The susceptor 161 illustrated in Fig. 1 is an example of the to-be-heated object.

[0049] The magnetic field generator and the to-be-heated object are disposed at relative positions such that a varying magnetic field generated from the magnetic field generator penetrates the to-be-heated object. When a varying magnetic field is generated from the magnetic field generator in this state, an eddy current is induced in the to-be-heated object. The eddy current flows through the to-be-heated object, which produces Joule heat according to the electrical resistance of the to-be-heated object, so that the to-be-heated object is heated. Such heating is also referred to as Joule heating, ohmic heating, or resistive heating.

[0050] The to-be-heated object may be magnetic. In this case, the to-be-heated object is further heated by magnetic hysteresis heating. Magnetic hysteresis heating is a process of heating a magnetic object by causing a varying magnetic field to penetrate the object. When a magnetic field penetrates a magnetic body, magnetic dipoles included in the magnetic body are aligned along the magnetic field. Thus, when a varying magnetic field penetrates a magnetic body, the orientation of the magnetic dipoles changes in accordance with the applied varying magnetic field. Such reorientation

of the magnetic dipoles produces heat in the magnetic body, so that the to-be-heated object is heated.

[0051] Magnetic hysteresis heating typically occurs at a temperature of the Curie point or lower and does not occur at a temperature higher than the Curie point. The Curie point is the temperature at which a magnetic body loses magnetic properties thereof. For example, when the temperature of a to-be-heated object that is ferromagnetic at a temperature of the Curie point or lower exceeds the Curie point, a reversible phase transition from ferromagnetism to paramagnetism occurs in the magnetism of the to-be-heated object. When the temperature of the to-be-heated object exceeds the Curie point, magnetic hysteresis heating no longer occurs. Thus, the temperature increase rate slows down.

[0052] The to-be-heated object is desirably made of a conductive material. Further, the to-be-heated object is desirably made of a ferromagnetic material. This is because the combination of resistive heating and magnetic hysteresis heating can increase the heating efficiency in the latter case. For example, the to-be-heated object may be made of one or more materials selected from a material group including aluminum, iron, nickel, cobalt, conductive carbon, copper, and stainless steel.

[0053] In both resistance heating and magnetic hysteresis heating, heat is produced inside the to-be-heated object rather than by thermal conduction from an external heat source. This thus can implement a rapid temperature increase and a uniform heat distribution in the to-be-heated object. This can be implemented by appropriately designing the material and shape of the to-be-heated object and the magnitude and direction of the varying magnetic field. That is, a rapid temperature increase and a uniform heat distribution can be implemented in the stick substrate 150 by appropriately designing the distribution of the susceptor 161 included in the stick substrate 150. This thus can reduce the time for preheating and improve the quality of a flavor tasted by the user.

[0054] Since induction heating directly heats the susceptor 161 included in the stick substrate 150, the substrate can be heated more efficiently than when the stick substrate 150 is heated from the outer circumference or the like by an external heat source. When heating is performed using an external heat source, the temperature of the external heat source inevitably becomes higher than that of the stick substrate 150. In contrast, when induction heating is performed, the temperature of the electromagnetic induction source 162 does not become higher than that of the stick substrate 150. Thus, the temperature of the inhaler device 100 can be maintained to be lower than that in the case of using an external heat source. This is a great advantage in terms of user safety.

[0055] The electromagnetic induction source 162 generates a varying magnetic field by using electric power supplied from the power supply 111. In an example, the power supply 111 includes a direct current (DC) power supply and a DC/alternate current (AC) inverter, and supplies an alternating current to the electromagnetic induction source 162. In this case, the electromagnetic induction source 162 can generate an alternating magnetic field.

[0056] The electromagnetic induction source 162 is disposed at a position where the varying magnetic field generated from the electromagnetic induction source 162 penetrates the susceptor 161 disposed in thermal proximity to the aerosol source included in the stick substrate 150 held by the holder 140. The susceptor 161 produces heat upon being penetrated by the varying magnetic field. The electromagnetic induction source 162 illustrated in Fig. 1 is a solenoid coil. The solenoid coil is disposed such that the conductive wire is wound around the outer circumference of the holder 140. When a current is applied to the solenoid coil, a magnetic field is generated in a central space surrounded by the coil, that is, the internal space 141 of the holder 140. As illustrated in Fig. 1, the susceptor 161 is surrounded by the coil when the stick substrate 150 is held by the holder 140. Thus, the varying magnetic field generated from the electromagnetic induction source 162 penetrates the susceptor 161 and heats the susceptor 161 by induction heating.

<3. Technical features>

(1) Heating profile

[0057] The inhaler device 100 controls electric power supply to the electromagnetic induction source 162 based on a heating profile. The heating profile is information that defines a time-series change in a target temperature that is a target value of the temperature. The heating profile includes one or more combinations of an elapsed time from the start of heating and a target temperature to be reached at the elapsed time. The inhaler device 100 controls electric power supply to the electromagnetic induction source 162 such that a real temperature (hereinafter, also referred to as an actual temperature) of the susceptor 161 changes in the same manner as the time-series change in the target temperature defined in the heating profile. An example of the target to be controlled is a voltage. Consequently, an aerosol is generated as planned in the heating profile. The heating profile is typically designed to optimize a flavor tasted by a user when the user inhales the aerosol generated from the stick substrate 150. Thus, by controlling the operation of the electromagnetic induction source 162 based on the heating profile, the flavor tasted by the user can be optimized.

[0058] A time section from the start to the end of a process of generating an aerosol by using the stick substrate 150, more specifically, a time section in which the electromagnetic induction source 162 operates based on the heating profile, is also referred to as a heating session hereinafter. The start of the heating session is a timing at which heating based on the heating profile is started. The end of the heating session is a timing at which a sufficient amount of aerosol is no

longer generated. The heating session is constituted by a preheating period which is a first part and a puffable period which is a latter part. The puffable period is a period in which a sufficient amount of aerosol is expected to be generated. The preheating period is a period from the start of heating to the start of the puffable period. Heating performed in the preheating period is also referred to as preheating.

[0059] Table 1 below presents an example of the heating profile.

[Table 1]

[0060]

Table 1. Example of heating profile

Time section	Elapsed time from start of heating Target	temperature
Initial temperature rise section	25 s	295°C
	35 s	295°C
Intermediate temperature drop section	45 s	230°C
Temperature re-rise section	180 s	230°C
	260 s	260°C
	355 s	260°C
Heating termination section	Thereafter	-

[0061] A time-series change in the actual temperature of the susceptor 161 when the controller 116 controls electric power supply to the electromagnetic induction source 162 in accordance with the heating profile presented by Table 1 will be described with reference to Fig. 2. Fig. 2 is a graph illustrating an example of a time-series change in the actual temperature of the susceptor 161 heated by induction heating based on the heating profile presented by Table 1. The horizontal axis of this graph represents time (seconds). The vertical axis of the graph represents the temperature of the susceptor 161. A line 21 in this graph represents a time-series change in the actual temperature of the susceptor 161. Points 22 (22A to 22F) in this graph each correspond to a target temperature defined in the heating profile. As illustrated in Fig. 2, the actual temperature of the susceptor 161 changes in the same manner as the time-series change in the target temperature defined in the heating profile.

[0062] As presented by Table 1, the heating profile first includes an initial temperature rise section. The initial temperature rise section is a time section included at the beginning of the heating profile, and is a section in which the target temperature set at the end of the section is higher than an initial temperature. The initial temperature is a temperature expected as the temperature of the susceptor 161 before heating is started. An example of the initial temperature is any temperature such as 0°C. Another example of the initial temperature is a temperature corresponding to an ambient temperature. As illustrated in Fig. 2, according to the target temperature set in the initial temperature rise section, the actual temperature of the susceptor 161 reaches 295°C after 25 seconds from the start of heating, and is maintained at 295°C until after 35 seconds from the start of heating. Accordingly, the temperature of the stick substrate 150 is expected to reach a temperature at which a sufficient amount of aerosol is to be generated. Since the actual temperature quickly rises to 295°C immediately after the start of heating, preheating can be finished early and the puffable period can be started early. Fig. 2 illustrates an example in which the initial temperature rise section coincides with the preheating period. However, the initial temperature rise section and the preheating period may differ from each other.

[0063] As presented by Table 1, the heating profile next includes an intermediate temperature drop section. The intermediate temperature drop section is a time section after the initial temperature rise section, and is a time section in which the target temperature set at the end of the time section is lower than the target temperature set at the end of the initial temperature rise section. As illustrated in Fig. 2, according to the target temperature set in the intermediate temperature drop section, the actual temperature of the susceptor 161 drops from 295°C to 230°C from 35 seconds to 45 seconds after the start of heating. In this section, electric power supply to the electromagnetic induction source 162 may be stopped. Even in such a case, a sufficient amount of aerosol is generated by residual heat of the susceptor 161 and the stick substrate 150. If the susceptor 161 is maintained at a high temperature, the aerosol source included in the stick substrate 150 is rapidly consumed. This may cause inconvenience that a flavor tasted by the user becomes too strong. However, by providing the intermediate temperature drop section in midstream, such inconvenience can be avoided and the quality of the user's puff experience can be improved.

[0064] As presented by Table 1, the heating profile next includes a temperature re-rise section. The temperature re-rise section is a time section after the intermediate temperature drop section, and is a time section in which the target

temperature set at the end of the time section is higher than the target temperature set at the end of the intermediate temperature drop section. As illustrated in Fig. 2, according to the target temperature set in the temperature re-rise section, the actual temperature of the susceptor 161 increases stepwise from 230°C to 260°C from 45 seconds to 355 seconds after the start of heating. If the temperature of the susceptor 161 is continuously decreased, the temperature of the stick substrate 150 also decreases. Thus, the amount of generated aerosol decreases, and the flavor tasted by the user may deteriorate. However, by causing the actual temperature to re-rise after dropping, deterioration of the flavor tasted by the user can be prevented even in the latter part of the heating session.

[0065] As presented by Table 1, the heating profile lastly includes a heating termination section. The heating termination section is a time section after the temperature re-rise section, and is a time section in which heating is not performed. No target temperature may be set. As illustrated in Fig. 2, the actual temperature of the susceptor 161 drops after 355 seconds from the start of heating. Electric power supply to the electromagnetic induction source 162 may be terminated after 355 seconds from the start of heating. Even in such a case, a sufficient amount of aerosol is generated for a while by residual heat of the susceptor 161 and the stick substrate 150. In the example illustrated in Fig. 2, the puffable period, that is, the heating session ends after 365 seconds from the start of heating.

[0066] The user may be notified of the start timing and the end timing of the puffable period. The user may also be notified of a timing that is before the end of the puffable period by a predetermined time (for example, the end timing of the temperature re-rise section). In this case, the user can perform a puff in the puffable period with reference to the notification.

(2) Control of electric power supply based on disturbance factor

[0067] As described above, the controller 116 controls electric power supply to the electromagnetic induction source 162, based on the heating profile. At this time, the controller 116 controls electric power supply to the electromagnetic induction source 162 such that an actual amount of electric power supplied to the electromagnetic induction source 162 changes in the same manner as a time-series change in an amount of electric power to be supplied to the electromagnetic induction source 162, which is determined in advance in accordance with the time-series change in the target temperature defined in the heating profile. Thus, an aerosol can be appropriately generated as planned in the heating profile, and a flavor tasted by the user can be optimized.

[0068] The time-series change in the amount of electric power supplied to the electromagnetic induction source 162, which is determined in advance in accordance with the heating profile, is hereinafter also referred to as an electric power supply profile. The electric power supply profile includes one or more combinations of an elapsed time from the start of heating and an amount of electric power at the elapsed time. Typically, the amount of heat produced by the susceptor 161 increases as the amount of electric power supplied increases, and the amount of heat produced by the susceptor 161 decreases as the amount of electric power supplied decreases. The electric power supply profile is determined in advance according to the heating profile in the standard environment such that the actual temperature of the susceptor 161 changes in the same manner as the time-series change in the target temperature defined in the heating profile. The electric power supply profile is stored in the memory 114 in advance in association with the heating profile, for example.

[0069] The standard environment is a standard operating environment of the inhaler device 100. The operating environment of the inhaler device 100 is a concept that includes a surrounding environment of the inhaler device 100 such as temperature, humidity, and pressure, a state of the inhaler device 100 such as an operation history of the inhaler device 100, and a state of the stick substrate 150 subjected to induction heating. The standard environment is defined by a set of parameters including a plurality of parameters that indicate the operating environment of the inhaler device 100 and each have a tolerance. The plurality of parameters are the temperature, the humidity, the pressure, the state of the inhaler device 100, the state of the stick substrate 150 subjected to induction heating, and the like.

[0070] In the standard environment, by controlling electric power supply to the electromagnetic induction source 162 in accordance with the electric power supply profile, the actual temperature of the susceptor 161 can be changed in the same manner as the time-series change in the target temperature defined in the heating profile. However, the operating environment of the inhaler device 100 may deviate from the standard environment because of the presence of a disturbance factor. When electric power supply to the electromagnetic induction source 162 is controlled in accordance with the electric power supply profile in the operating environment that deviates from the standard environment, the change in the actual temperature of the susceptor 161 deviates from the time-series change in the target temperature defined in the heating profile. This consequently makes it difficult to appropriately generate an aerosol.

[0071] Accordingly, the inhaler device 100 according to the present embodiment controls electric power supply to the electromagnetic induction source 162 in accordance with a disturbance factor. Specifically, the inhaler device 100 adjusts the electric power supply profile in accordance with the disturbance factor, and controls electric power supply to the electromagnetic induction source 162 in accordance with the adjusted electric power supply profile. With such a configuration, appropriate generation of an aerosol can be implemented even when a disturbance factor is present.

[0072] Controlling the electric power supply to the electromagnetic induction source 162 in accordance with the dis-

turbance factor includes adjusting an amount of electric power to be supplied to the electromagnetic induction source 162. With such a configuration, an amount of heat produced by the susceptor 161 can be adjusted in accordance with the disturbance factor. Controlling the electric power supply to the electromagnetic induction source 162 in accordance with the disturbance factor may further include stopping the electric power supply to the electromagnetic induction source 162. With such a configuration, overheating caused by the disturbance factor can be prevented and the user safety can be ensured.

[0073] The disturbance factor and adjustment of the electric power supply profile in accordance with the disturbance factor will be described below.

- Temperature of operating environment

[0074] An example of the disturbance factor is a temperature of the operating environment of the inhaler device 100. An example of the temperature of the operating environment of the inhaler device 100 is an ambient temperature. Another example of the temperature of the operating environment of the inhaler device 100 is a temperature inside the inhaler device 100. The inhaler device 100 includes, as the sensor 112, a temperature sensor that detects the temperature of the operating environment of the inhaler device 100. An example of the temperature sensor may be a thermistor. The controller 116 controls electric power supply to the electromagnetic induction source 162, based on the temperature detected by the temperature sensor. In an example, when the temperature detected by the temperature sensor is higher than the temperature of the standard environment, the controller 116 reduces the amount of electric power to be supplied to the electromagnetic induction source 162. On the other hand, when the temperature detected by the temperature sensor is lower than the temperature of the standard environment, the controller 116 increases the amount of electric power to be supplied to the electromagnetic induction source 162.

[0075] Specifically, the controller 116 adjusts the electric power supply profile, based on the temperature detected by the temperature sensor, and controls electric power supply to the electromagnetic induction source 162 in accordance with the adjusted electric power supply profile. In an example, when the temperature detected by the temperature sensor is higher than the temperature of the standard environment, the actual temperature of the susceptor 161 is predicted to be higher than the target temperature. Accordingly, the controller 116 adjusts the amount of electric power supplied corresponding to the target temperature to decrease from the amount before the adjustment. On the other hand, when the temperature detected by the temperature sensor is lower than the temperature of the standard environment, the actual temperature of the susceptor 161 is predicted to be lower than the target temperature. Accordingly, the controller 116 adjusts the amount of electric power supplied corresponding to the target temperature to increase from the amount before the adjustment.

[0076] With such a configuration, the deviation of the actual temperature of the susceptor 161 from the target temperature due to the deviation between the temperature of the standard environment and the temperature of the operating environment of the inhaler device 100 can be reduced. Consequently, appropriate generation of an aerosol can be implemented.

[0077] An arrangement example of the temperature sensor will be described with reference to Fig. 3. Fig. 3 is a diagram schematically illustrating an example of a physical configuration inside the inhaler device 100 according to the present embodiment. In the example illustrated in Fig. 3, the power supply 111 is a battery, the controller 116 is a circuit substrate, the electromagnetic induction source 162 is a solenoid coil, and the holder 140 is a cylindrical chamber. An airflow path 170 is coupled to the holder 140. The outermost shell of the inhaler device 100 is a housing 101, which has the opening 142 of the holder 140 and an air intake hole 171 of the airflow path 170. Air is taken in and ejected through the opening 142 and the air intake hole 171. The airflow path 170 has a function of supplying air taken in through the air intake hole 171 to the internal space 141 of the holder 140 through a hole (not illustrated) provided at the bottom 143 of the holder 140. When the user performs inhalation while holding, in their mouth, the inhalation port 152 of the stick substrate 150 held by the holder 140, the air supplied from the airflow path 170 to the internal space 141 reaches the inside of the mouth of the user together with the aerosol generated from the stick substrate 150.

[0078] As illustrated in Fig. 3, the inhaler device 100 includes a plurality of temperature sensors 118 (118A to 118D). The inhaler device 100 includes the plurality of temperature sensors 118 and thus can accurately grasp the temperature of the operating environment.

[0079] The temperature sensor 118A is disposed in proximity to the power supply 111. The temperature sensor 118B is disposed in proximity to the controller 116. The temperature sensor 118C is disposed in proximity to the holder 140. As described above, the plurality of temperature sensors 118 are disposed at different positions in the inhaler device 100. This makes it possible to evaluate the temperature of the operating environment of the inhaler device 100 from various viewpoints.

[0080] The temperature sensor 118D is disposed in proximity to the airflow path 170. The airflow path 170 is an example of a portion in which the temperature changes in response to inhalation performed by a user. When the stick substrate 150 is heated by induction heating, heat of the stick substrate 150 leaks to the airflow path 170 and increases

the temperature of the airflow path 170. When a puff is performed in this state, air is taken into the airflow path 170 through the air intake hole 171 and cools the airflow path 170. The controller 116 may detect a puff, based on a decrease in the temperature of the airflow path 170 detected by the temperature sensor 118D. As described above, the temperature sensor 118 is disposed in proximity to a portion in which the temperature changes in response to a puff performed by the user, and thus can detect the puff.

[0081] Note that the plurality of temperature sensors 118 may include at least two or more of a temperature sensor disposed in proximity to the power supply 111, the controller 116, or the holder 140, and a temperature sensor disposed at a position where the temperature changes in response to inhalation performed by the user. That is, the arrangement of the temperature sensors 118 illustrated in Fig. 3 is merely an example, and the temperature sensors 118 may be disposed at other positions.

- Operation history

[0082] Another example of the disturbance factor is an operation history of the inhaler device 100. The controller 116 controls electric power supply to the electromagnetic induction source 162, based on the operation history of the inhaler device 100. In an example, the controller 116 reduces the amount of electric power to be supplied to the electromagnetic induction source 162 when the actual temperature of the susceptor 161 is predicted to be higher than the expected temperature from the deviation between the actual operation history of the inhaler device 100 and the operation history in the standard environment. On the other hand, the controller 116 increases the amount of electric power to be supplied to the electromagnetic induction source 162 when the actual temperature of the susceptor 161 is predicted to be lower than the expected temperature from the deviation between the actual operation history of the inhaler device 100 and the operation history in the standard environment.

[0083] Specifically, the controller 116 adjusts the electric power supply profile, based on the operation history of the inhaler device 100, and controls electric power supply to the electromagnetic induction source 162 in accordance with the adjusted electric power supply profile. In an example, the controller 116 adjusts the amount of electric power corresponding to the target temperature to be smaller than the amount before the adjustment when the actual temperature of the susceptor 161 is predicted to be higher than the target temperature from the deviation between the actual operation history of the inhaler device 100 and the operation history in the standard environment. On the other hand, the controller 116 adjusts the amount of electric power corresponding to the target temperature to be larger than the amount before the adjustment when the actual temperature of the susceptor 161 is predicted to be lower than the target temperature from the deviation between the actual operation history of the inhaler device 100 and the operation history in the standard environment.

[0084] With such a configuration, the deviation of the actual temperature of the susceptor 161 from the target temperature due to the operation history of the inhaler device 100 can be reduced. Consequently, appropriate generation of an aerosol can be implemented.

[0085] The operation history of the inhaler device 100 may be stored in the memory 114. The controller 116 updates the operation history stored in the memory 114 each time induction heating based on the heating profile is performed on the stick substrate 150.

[0086] An example of the operation history of the inhaler device 100 is the number of times of electric power supply to the electromagnetic induction source 162. The number of times of electric power supply to the electromagnetic induction source 162 is the number of times induction heating based on the heating profile is performed. The controller 116 controls electric power supply to the electromagnetic induction source 162, based on the number of times of electric power supply to the electromagnetic induction source 162. Specifically, the controller 116 adjusts the electric power supply profile, based on the number of times of electric power supply to the electromagnetic induction source 162, and controls electric power supply to the electromagnetic induction source 162 in accordance with the adjusted electric power supply profile. It is considered that as the number of times of electric power supply to the electromagnetic induction source 162 increases, the electromagnetic induction source 162 deteriorates and thus the actual temperature of the susceptor 161 decreases for the same amount of supplied electric power. That is, when the actual number of times of electric power supply is less than the number of times of electric power supply in the standard environment, the actual temperature of the susceptor 161 is predicted to be higher than the target temperature. In this case, the controller 116 adjusts the amount of electric power supplied corresponding to the target temperature to be smaller than the amount before the adjustment. On the other hand, when the actual number of times of electric power supply is greater than the number of times of electric power supply in the standard environment, the actual temperature of the susceptor 161 is predicted to be lower than the target temperature. In this case, the controller 116 adjusts the amount of electric power supplied corresponding to the target temperature to be larger than the amount before the adjustment. With such a configuration, the deviation of the actual temperature of the susceptor 161 from the target temperature due to the number of times of electric power supply to the electromagnetic induction source 162 can be reduced. Consequently, appropriate generation of an aerosol can be implemented.

[0087] Another example of the operation history of the inhaler device 100 is an interval of electric power supply to the electromagnetic induction source 162. The interval of electric power supply to the electromagnetic induction source 162 is a time length from when previous induction heating based on the heating profile is performed to when current induction based on the heating profile heating is performed. The controller 116 controls electric power supply to the electromagnetic induction source 162, based on the interval of electric power supply to the electromagnetic induction source 162. Specifically, the controller 116 adjusts the electric power supply profile, based on the interval of electric power supply to the electromagnetic induction source 162, and controls electric power supply to the electromagnetic induction source 162 in accordance with the adjusted electric power supply profile. It is considered that as the interval of electric power supply to the electromagnetic induction source 162 becomes shorter, more heat from the previous induction heating is left and thus the actual temperature of the susceptor 161 increases for the same amount of supplied electric power. That is, when the actual interval of electric power supply is shorter than the interval of electric power supply in the standard environment, the actual temperature of the susceptor 161 is predicted to be higher than the target temperature. In this case, the controller 116 adjusts the amount of electric power supplied corresponding to the target temperature to be smaller than the amount before the adjustment. On the other hand, when the interval of electric power supply is longer than the interval of electric power supply in the standard environment, the actual temperature of the susceptor 161 is predicted to be lower than the target temperature. In this case, the controller 116 adjusts the amount of electric power supplied corresponding to the target temperature to be larger than the amount before the adjustment. With such a configuration, the deviation of the actual temperature of the susceptor 161 from the target temperature due to the interval of electric power supply to the electromagnetic induction source 162 can be reduced. Consequently, appropriate generation of an aerosol can be implemented.

- Type of substrate

[0088] An example of the disturbance factor is the type of the stick substrate 150. Depending on the type of the stick substrate 150, the material, shape, content, and distribution of the susceptor 161 and the type of the aerosol source may change. Accordingly, the controller 116 controls electric power supply to the electromagnetic induction source 162, based on the type of the stick substrate 150 held by the holder 140. In an example, the actual temperature of the susceptor 161 is sometimes predicted to be higher than the expected temperature from a difference between the type of the stick substrate 150 held by the holder 140 and the type of the stick substrate 150 in the standard environment. In this case, the controller 116 reduces the amount of electric power to be supplied to the electromagnetic induction source 162. On the other hand, the actual temperature of the susceptor 161 is sometimes predicted to be lower than the expected temperature from a difference between the type of the stick substrate 150 held by the holder 140 and the type of the stick substrate 150 in the standard environment. In this case, the controller 116 increases the amount of electric power to be supplied to the electromagnetic induction source 162.

[0089] Specifically, the controller 116 adjusts the electric power supply profile, based on the type of the stick substrate 150 held by the holder 140, and controls electric power supply to the electromagnetic induction source 162 in accordance with the adjusted electric power supply profile. In an example, the actual temperature of the susceptor 161 is sometimes predicted to be higher than the target temperature from a difference between the type of the stick substrate 150 held by the holder 140 and the type of the stick substrate 150 in the standard environment. In this case, the controller 116 adjusts the amount of electric power supplied corresponding to the target temperature to be smaller than the amount before the adjustment. On the other hand, the actual temperature of the susceptor 161 is sometimes predicted to be lower than the target temperature from a difference between the type of the stick substrate 150 held by the holder 140 and the type of the stick substrate 150 in the standard environment. In this case, the controller 116 adjusts the amount of electric power supplied corresponding to the target temperature to be larger than the amount before the adjustment.

[0090] With such a configuration, the deviation of the actual temperature of the susceptor 161 from the target temperature due to the type of the stick substrate 150 held by the holder 140 can be reduced. Consequently, appropriate generation of an aerosol can be implemented.

[0091] The type of the stick substrate 150 held by the holder 140 is identifiable by various methods. In an example, identification information such as a two-dimensional code indicating the type of the stick substrate 150 may be given to the stick substrate 150. In this case, the type of the stick substrate 150 can be identified by performing image recognition or the like on the identification information given to the stick substrate 150 held by the holder 140. In another example, different types of the stick substrate 150 may include different types of the susceptor 161. The electrical resistance value of a closed circuit including the power supply 111 and the electromagnetic induction source 162 when electric power is supplied to the electromagnetic induction source 162 may vary depending on the type of the susceptor 161 included in the stick substrate 150 held by the holder 140. In this case, the type of the stick substrate 150 can be identified based on the electrical resistance value of the closed circuit including the power supply 111 and the electromagnetic induction source 162.

- Supplementary description

[0092] The controller 116 may change the heating profile to be used. The memory 114 may store a plurality of heating profiles and a plurality of electric power supply profiles corresponding the respective heating profiles. Upon changing the heating profile, the controller 116 adjusts the electric power supply profile corresponding to the heating profile after the change, based on the disturbance factor, and controls electric power supply to the electromagnetic induction source 162 in accordance with the adjusted electric power supply profile. The amount by which the electric power supply profile is adjusted may be different for each heating profile to be used. That is, the amount by which the electric power supply profile is adjusted based on the temperature detected by the temperature sensor 118, the operation history of the inhaler device 100, and/or the type of the stick substrate 150 held by the holder 140 may be different for each heating profile to be used. This is because the target temperatures are different for different heating profiles, and the amount of adjustment to be performed accordingly may differ. With such a configuration, appropriate generation of an aerosol can be implemented even when the heating profile is changed.

(3) Procedure of Process

[0093] Fig. 4 is a flowchart illustrating an example of a procedure of a process performed by the inhaler device 100 according to the present embodiment.

[0094] As illustrated in Fig. 4, first, the sensor 112 receives a user operation for a heating start instruction (step S102). An example of the operation for instructing the start of heating is pressing of a button of the inhaler device 100.

[0095] Then, the controller 116 acquires information indicating a disturbance factor (step S104). In an example, the controller 116 acquires the temperature of the operating environment of the inhaler device 100 detected by the temperature sensor 118. In another example, the controller 116 acquires the number of times of electric power supply to the electromagnetic induction source 162 and/or the interval of electric power supply to the electromagnetic induction source 162, which is the operation history of the inhaler device 100 stored in the memory 114. In another example, the controller 116 acquires the identification result of the type of the stick substrate 150 held by the holder 140.

[0096] Then, based on the disturbance factor, the controller 116 adjusts the electric power supply profile that is determined in advance in accordance with the heating profile (step S106). For example, the controller 116 adjusts the amount of electric power defined in the electric power supply profile, based on the temperature detected by the temperature sensor 118, the operation history of the inhaler device 100, and/or the type of the stick substrate 150 held by the holder 140.

[0097] Then, the controller 116 controls electric power supply to the electromagnetic induction source 162, based on the adjusted electric power supply profile (step S108). Specifically, the controller 116 controls electric power supply to the electromagnetic induction source 162 such that the actual amount of electric power supplied to the electromagnetic induction source 162 changes in the same manner as the time-series change in the amount of electric power to be supplied to the electromagnetic induction source 162 defined in the adjusted electric power supply profile.

<4. Supplementary description>

[0098] While the preferred embodiment of the present invention has been described in detail above with reference to the accompanying drawings, the present invention is not limited to such examples. Obviously, a person with an ordinary knowledge in the technical field to which the present invention pertains can conceive various modifications and corrections within the scope of the technical spirit described in the claims. It should be understood that these modifications and corrections naturally pertain to the technical scope of the present invention.

[0099] For example, in the embodiment described above, an example has been described in which the inhaler device 100 includes a single electromagnetic induction source 162. However, the present invention is not limited to such an example. The inhaler device 100 may include a plurality of electromagnetic induction sources 162. For example, the inhaler device 100 may include a first electromagnetic induction source 162 wound around the outer circumference of the holder 140 adjacent to the opening 142, and a second electromagnetic induction source 162 wound around the outer circumference of the holder 140 adjacent to the bottom 143. In this case, the controller 116 may control electric power supply to each of the plurality of electromagnetic induction sources 162, based on different heating profiles for the respective electromagnetic induction source 162. That is, the controller 116 may control electric power supply to each of the plurality of electromagnetic induction sources 162 in accordance with a corresponding one of the different electric power supply profiles for the respective electromagnetic induction sources 162. With such a configuration, the operation can be optimized for each of the electromagnetic induction sources 162 and appropriate generation of an aerosol can be implemented. It is conceivable that the operation history differs for each of the electromagnetic induction sources 162. That is, the number of times of electric power supply or the interval of electric power supply may be different for each of the electromagnetic induction sources 162. Thus, the controller 116 may adjust the electric power supply profile

for use in controlling each of the plurality of electromagnetic induction sources 162, based on the operation history of the electromagnetic induction source 162. The amount by which the electric power supply profile is adjusted based on the operation history may be different for each of the electromagnetic induction sources 162. With such a configuration, appropriate generation of an aerosol can be implemented even when the operation history is different for each of the electromagnetic induction sources 162.

[0100] For example, in the embodiment described above, an example has been described in which the substrate 151 includes the susceptor 161. However, the present invention is not limited to such an example. That is, the susceptor 161 may be disposed at any position where the susceptor 161 is in thermal proximity to the aerosol source. In an example, the susceptor 161 may have a blade-like shape, and may be disposed so that the susceptor 161 protrudes from the bottom 143 of the holder 140 toward the internal space 141. When the stick substrate 150 is inserted into the holder 140, the susceptor 161 having the blade-like shape may be inserted so as to pierce the substrate 151 from the end portion of the stick substrate 150 in the insertion direction. In another example, the susceptor 161 may be disposed on an inner wall of the holder 140 that forms the internal space 141.

[0101] The series of steps performed by the individual devices described in this specification may be implemented by using any of software, hardware, and a combination of software and hardware. Programs constituting software are, for example, stored in advance in recording media (non-transitory media) provided inside or outside the individual devices. Each program is, for example, at the time of being executed by a computer that controls each of the devices described in this specification, loaded into a RAM and executed by a processor such as a CPU. The recording media are, for example, a magnetic disk, an optical disc, a magneto-optical disk, a flash memory, and the like. The computer programs may be distributed, for example, via a network without using recording media.

[0102] The steps described using a flowchart and a sequence diagram in this specification need not necessarily be executed in the order illustrated. Some of the process steps may be executed in parallel. An additional process step may be adopted, or one or some of the process steps may be omitted.

[0103] Configurations below also pertain to the technical scope of the present invention.

(1) An inhaler device including:

- a power supply configured to supply electric power;
- an electromagnetic induction source configured to generate a varying magnetic field by using the electric power supplied from the power supply;
- a controller configured to control electric power supply to the electromagnetic induction source;
- a holder having an internal space and an opening that allows the internal space to communicate with outside and configured to hold a substrate inserted into the internal space through the opening, the substrate including an aerosol source; and
- a temperature sensor configured to detect a temperature of an operating environment of the inhaler device, in which
 - the electromagnetic induction source is disposed at a position where the varying magnetic field generated by the electromagnetic induction source penetrates a susceptor that is disposed in thermal proximity to the aerosol source included in the substrate held by the holder,
 - the susceptor is configured to produce heat upon being penetrated by the varying magnetic field, and
 - the controller is configured to control the electric power supply to the electromagnetic induction source, based on the temperature detected by the temperature sensor.

(2) The inhaler device according to (1), in which

the controller is configured to control the electric power supply to the electromagnetic induction source, based on an operation history of the inhaler device.

(3) The inhaler device according to (2), in which

the controller is configured to control the electric power supply to the electromagnetic induction source, based on a number of times of electric power supply to the electromagnetic induction source.

(4) The inhaler device according to (2) or (3), in which

the controller is configured to control the electric power supply to the electromagnetic induction source, based on an interval of electric power supply to the electromagnetic induction source.

(5) The inhaler device according to any one of (1) to (4), in which

the controller is configured to control the electric power supply to the electromagnetic induction source, based on a type of the substrate held by the holder.

(6) The inhaler device according to any one of (1) to (5), in which

the controller is configured to control, based on a heating profile, the electric power supply to the electromagnetic induction source, the heating profile being information that defines a time-series change in a target temperature that

is a target value of a temperature of the susceptor.

(7) The inhaler device according to (6), in which

the controller is configured to adjust, based on the temperature detected by the temperature sensor, a time-series change, in an amount of electric power to be supplied to the electromagnetic induction source, determined in advance in accordance with the time-series change in the target temperature defined in the heating profile, and control the electric power supply to the electromagnetic induction source in accordance with the adjusted time-series change in the amount of electric power to be supplied to the electromagnetic induction source.

(8) The inhaler device according to (6) or (7), in which

the controller is configured to adjust, based on an operation history of the inhaler device, a time-series change, in an amount of electric power to be supplied to the electromagnetic induction source, determined in advance in accordance with the time-series change in the target temperature defined in the heating profile, and control the electric power supply to the electromagnetic induction source in accordance with the adjusted time-series change in the amount of electric power to be supplied to the electromagnetic induction source.

(9) The inhaler device according to (8), in which

the controller is configured to adjust, based on a number of times of electric power supply to the electromagnetic induction source, the time-series change, in the amount of electric power to be supplied to the electromagnetic induction source, determined in advance in accordance with the time-series change in the target temperature defined in the heating profile, and control the electric power supply to the electromagnetic induction source in accordance with the adjusted time-series change in the amount of electric power to be supplied to the electromagnetic induction source.

(10) The inhaler device according to (8) or (9), in which

the controller is configured to adjust, based on an interval of electric power supply to the electromagnetic induction source, the time-series change, in the amount of electric power to be supplied to the electromagnetic induction source, determined in advance in accordance with the time-series change in the target temperature defined in the heating profile, and control the electric power supply to the electromagnetic induction source in accordance with the adjusted time-series change in the amount of electric power to be supplied to the electromagnetic induction source.

(11) The inhaler device according to any one of (6) to (10), in which

the controller is configured to adjust, based on a type of the substrate, a time-series change, in an amount of electric power to be supplied to the electromagnetic induction source, determined in advance in accordance with the time-series change in the target temperature defined in the heating profile, and control the electric power supply to the electromagnetic induction source in accordance with the adjusted time-series change in the amount of electric power to be supplied to the electromagnetic induction source.

(12) The inhaler device according to any one of (7) to (11), in which

the controller is configured to change the heating profile to be used, and

an amount by which the time-series change, in the amount of electric power to be supplied to the electromagnetic induction source, determined in advance in accordance with the time-series change in the target temperature defined in the heating profile, is adjusted is different for each heating profile to be used.

(13) The inhaler device according to any one of (6) to (12), in which

the inhaler device comprises a plurality of the electromagnetic induction sources, and

the controller is configured to control electric power supply to each of the plurality of electromagnetic induction sources, based on the heating profile that is different for each of the electromagnetic induction sources.

(14) The inhaler device according to any one of (1) to (13), in which

controlling the electric power supply to the electromagnetic induction source includes stopping the electric power supply to the electromagnetic induction source.

(15) The inhaler device according to any one of (1) to (14), in which

the inhaler device comprises a plurality of the temperature sensors.

(16) The inhaler device according to (15), in which

the plurality of temperature sensors include at least two or more of the temperature sensor disposed in proximity to the power supply, the controller, or the holder, and the temperature sensor disposed in proximity to a region in which a temperature changes in response to inhalation performed by a user.

(17) A program to be executed by a computer that controls an inhaler device,

the inhaler device including:

a power supply configured to supply electric power;
 an electromagnetic induction source configured to generate a varying magnetic field by using the electric power supplied from the power supply;
 a controller configured to control electric power supply to the electromagnetic induction source;
 a holder having an internal space and an opening that allows the internal space to communicate with outside and configured to hold a substrate inserted into the internal space through the opening, the substrate including an aerosol source; and
 a temperature sensor configured to detect a temperature of an operating environment of the inhaler device, the electromagnetic induction source being disposed at a position where the varying magnetic field generated by the electromagnetic induction source penetrates a susceptor that is disposed in thermal proximity to the aerosol source included in the substrate held by the holder,
 the susceptor being configured to produce heat upon being penetrated by the varying magnetic field,

the program causing
 controlling the electric power supply to the electromagnetic induction source, based on the temperature detected by the temperature sensor
 to be performed.

(18) A system including: an inhaler device; and a substrate,

the substrate including an aerosol source,
 the inhaler device including:

a power supply configured to supply electric power;
 an electromagnetic induction source configured to generate a varying magnetic field by using the electric power supplied from the power supply;
 a controller configured to control electric power supply to the electromagnetic induction source;
 a holder having an internal space and an opening that allows the internal space to communicate with outside and configured to hold the substrate inserted into the internal space through the opening; and
 a temperature sensor configured to detect a temperature of an operating environment of the inhaler device, in which
 the electromagnetic induction source is disposed at a position where the varying magnetic field generated by the electromagnetic induction source penetrates a susceptor that is disposed in thermal proximity to the aerosol source included in the substrate held by the holder,
 the susceptor is configured to produce heat upon being penetrated by the varying magnetic field, and
 the controller is configured to control the electric power supply to the electromagnetic induction source, based on the temperature detected by the temperature sensor.

(19) The system according to (18), in which
 the susceptor is included in the substrate.

Reference Signs List

[0104]

100 inhaler device
 101 housing
 111 power supply
 112 sensor
 113 notifier
 114 memory
 115 communicator
 116 controller
 118 temperature sensor
 140 holder
 141 internal space
 142 opening
 143 bottom

150 stick substrate
 151 substrate
 152 inhalation port
 161 susceptor
 5 162 electromagnetic induction source
 170 airflow path
 171 air intake hole

Claims

1. An inhaler device comprising:

a power supply configured to supply electric power;
 15 an electromagnetic induction source configured to generate a varying magnetic field by using the electric power supplied from the power supply;
 a controller configured to control electric power supply to the electromagnetic induction source;
 a holder having an internal space and an opening that allows the internal space to communicate with outside and configured to hold a substrate inserted into the internal space through the opening, the substrate including
 20 an aerosol source; and
 a temperature sensor configured to detect a temperature of an operating environment of the inhaler device, wherein
 the electromagnetic induction source is disposed at a position where the varying magnetic field generated by the electromagnetic induction source penetrates a susceptor that is disposed in thermal proximity to the aerosol
 25 source included in the substrate held by the holder,
 the susceptor is configured to produce heat upon being penetrated by the varying magnetic field, and
 the controller is configured to control the electric power supply to the electromagnetic induction source, based on the temperature detected by the temperature sensor.

2. The inhaler device according to claim 1, wherein

the controller is configured to control the electric power supply to the electromagnetic induction source, based on an operation history of the inhaler device.

3. The inhaler device according to claim 2, wherein

the controller is configured to control the electric power supply to the electromagnetic induction source, based on a number of times of electric power supply to the electromagnetic induction source.

4. The inhaler device according to claim 2 or 3, wherein

the controller is configured to control the electric power supply to the electromagnetic induction source, based on an interval of electric power supply to the electromagnetic induction source.

5. The inhaler device according to any one of claims 1 to 4, wherein

the controller is configured to control the electric power supply to the electromagnetic induction source, based on a type of the substrate held by the holder.

6. The inhaler device according to any one of claims 1 to 5, wherein

the controller is configured to control, based on a heating profile, the electric power supply to the electromagnetic induction source, the heating profile being information that defines a time-series change in a target temperature that is a target value of a temperature of the susceptor.

7. The inhaler device according to claim 6, wherein

the controller is configured to adjust, based on the temperature detected by the temperature sensor, a time-series change, in an amount of electric power to be supplied to the electromagnetic induction source, determined in advance in accordance with the time-series change in the target temperature defined in the heating profile, and control the electric power supply to the electromagnetic induction source in accordance with the adjusted time-series change in the amount of electric power to be supplied to the electromagnetic induction source.

8. The inhaler device according to claim 6 or 7, wherein

the controller is configured to adjust, based on an operation history of the inhaler device, a time-series change, in an amount of electric power to be supplied to the electromagnetic induction source, determined in advance in accordance with the time-series change in the target temperature defined in the heating profile, and control the electric power supply to the electromagnetic induction source in accordance with the adjusted time-series change in the amount of electric power to be supplied to the electromagnetic induction source.

9. The inhaler device according to claim 8, wherein the controller is configured to adjust, based on a number of times of electric power supply to the electromagnetic induction source, the time-series change, in the amount of electric power to be supplied to the electromagnetic induction source, determined in advance in accordance with the time-series change in the target temperature defined in the heating profile, and control the electric power supply to the electromagnetic induction source in accordance with the adjusted time-series change in the amount of electric power to be supplied to the electromagnetic induction source.

10. The inhaler device according to claim 8 or 9, wherein the controller is configured to adjust, based on an interval of electric power supply to the electromagnetic induction source, the time-series change, in the amount of electric power to be supplied to the electromagnetic induction source, determined in advance in accordance with the time-series change in the target temperature defined in the heating profile, and control the electric power supply to the electromagnetic induction source in accordance with the adjusted time-series change in the amount of electric power to be supplied to the electromagnetic induction source.

11. The inhaler device according to any one of claims 6 to 10, wherein the controller is configured to adjust, based on a type of the substrate, a time-series change, in an amount of electric power to be supplied to the electromagnetic induction source, determined in advance in accordance with the time-series change in the target temperature defined in the heating profile, and control the electric power supply to the electromagnetic induction source in accordance with the adjusted time-series change in the amount of electric power to be supplied to the electromagnetic induction source.

12. The inhaler device according to any one of claims 7 to 11, wherein the controller is configured to change the heating profile to be used, and an amount by which the time-series change, in the amount of electric power to be supplied to the electromagnetic induction source, determined in advance in accordance with the time-series change in the target temperature defined in the heating profile, is adjusted is different for each heating profile to be used.

13. The inhaler device according to any one of claims 6 to 12, wherein the inhaler device comprises a plurality of the electromagnetic induction sources, and the controller is configured to control electric power supply to each of the plurality of electromagnetic induction sources, based on the heating profile that is different for each of the electromagnetic induction sources.

14. The inhaler device according to any one of claims 1 to 13, wherein controlling the electric power supply to the electromagnetic induction source includes stopping the electric power supply to the electromagnetic induction source.

15. The inhaler device according to any one of claims 1 to 14, wherein the inhaler device comprises a plurality of the temperature sensors.

16. The inhaler device according to claim 15, wherein the plurality of temperature sensors include at least two or more of the temperature sensor disposed in proximity to the power supply, the controller, or the holder, and the temperature sensor disposed in proximity to a region in which a temperature changes in response to inhalation performed by a user.

17. A program to be executed by a computer that controls an inhaler device, the inhaler device including:

a power supply configured to supply electric power;

an electromagnetic induction source configured to generate a varying magnetic field by using the electric power supplied from the power supply;
 a controller configured to control electric power supply to the electromagnetic induction source;
 a holder having an internal space and an opening that allows the internal space to communicate with outside
 and configured to hold a substrate inserted into the internal space through the opening, the substrate
 including an aerosol source; and
 a temperature sensor configured to detect a temperature of an operating environment of the inhaler device,
 the electromagnetic induction source being disposed at a position where the varying magnetic field gener-
 ated by the electromagnetic induction source penetrates a susceptor that is disposed in thermal proximity
 to the aerosol source included in the substrate held by the holder,
 the susceptor being configured to produce heat upon being penetrated by the varying magnetic field,

the program causing
 controlling the electric power supply to the electromagnetic induction source, based on the temperature detected
 by the temperature sensor
 to be performed.

18. A system comprising: an inhaler device; and a substrate,

the substrate including an aerosol source,
 the inhaler device including:

a power supply configured to supply electric power;
 an electromagnetic induction source configured to generate a varying magnetic field by using the electric
 power supplied from the power supply;
 a controller configured to control electric power supply to the electromagnetic induction source;
 a holder having an internal space and an opening that allows the internal space to communicate with outside
 and configured to hold the substrate inserted into the internal space through the opening; and
 a temperature sensor configured to detect a temperature of an operating environment of the inhaler device,
 wherein
 the electromagnetic induction source is disposed at a position where the varying magnetic field generated
 by the electromagnetic induction source penetrates a susceptor that is disposed in thermal proximity to the
 aerosol source included in the substrate held by the holder,
 the susceptor is configured to produce heat upon being penetrated by the varying magnetic field, and
 the controller is configured to control the electric power supply to the electromagnetic induction source,
 based on the temperature detected by the temperature sensor.

19. The system according to claim 18, wherein
 the susceptor is included in the substrate.

FIG. 1

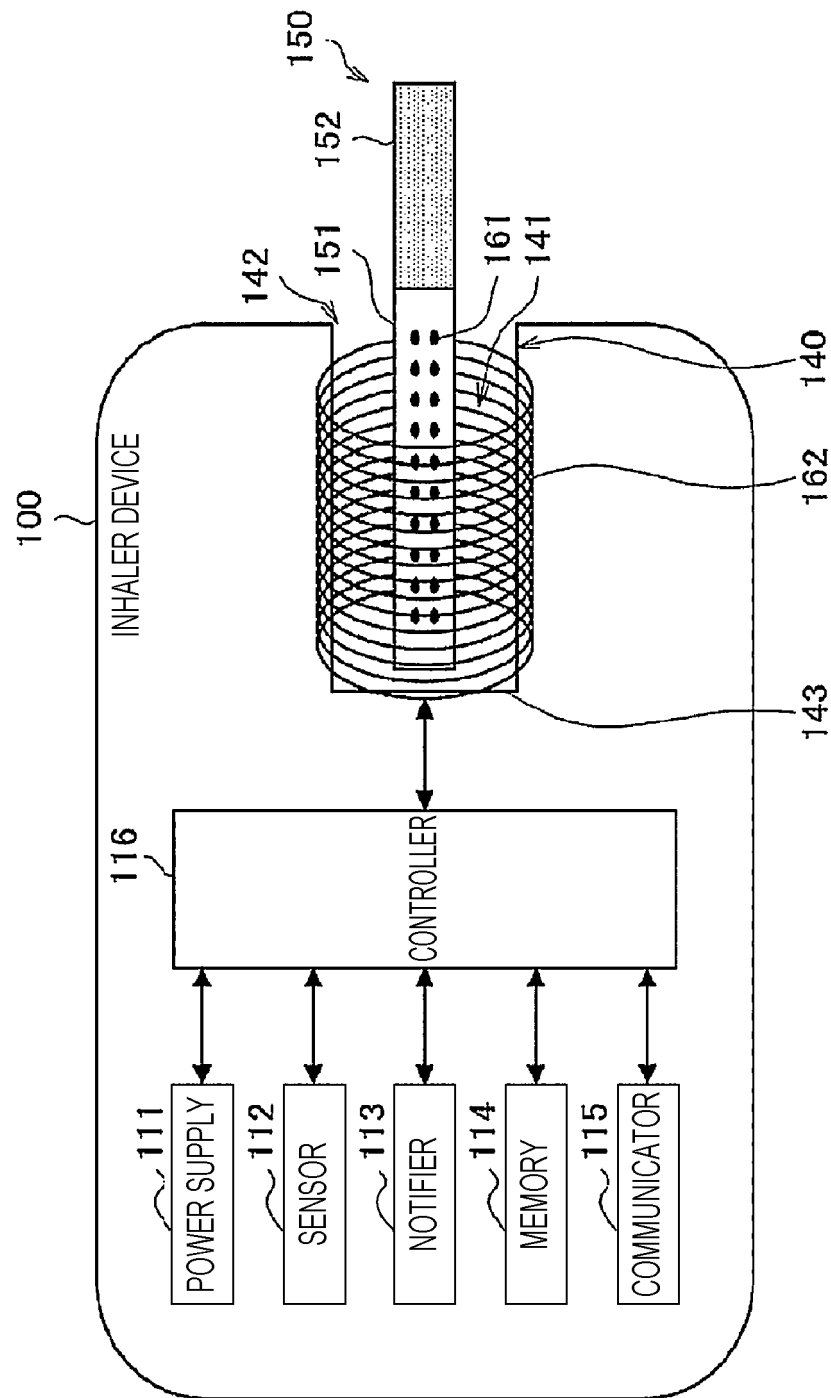


FIG. 2

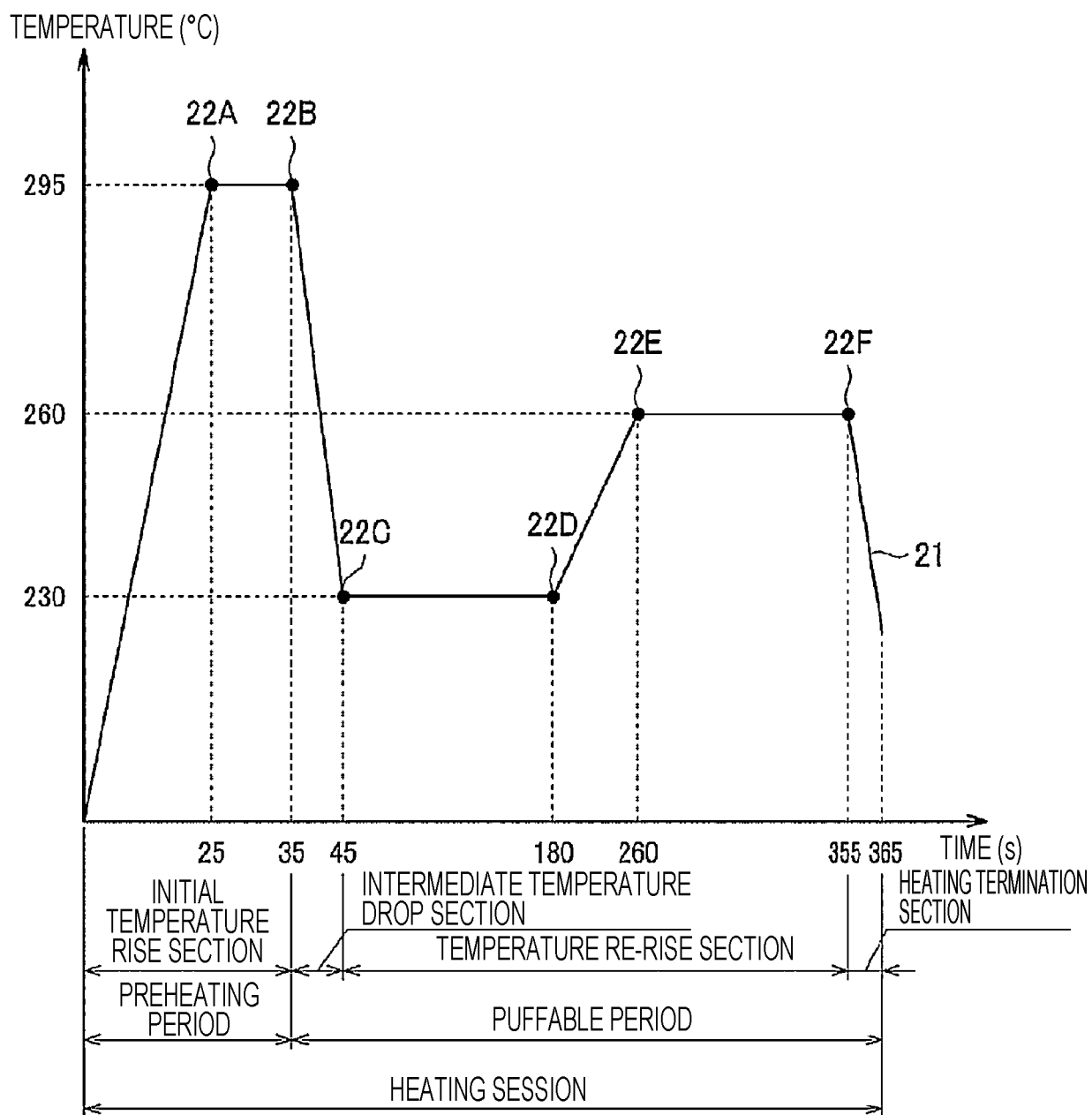


FIG. 3

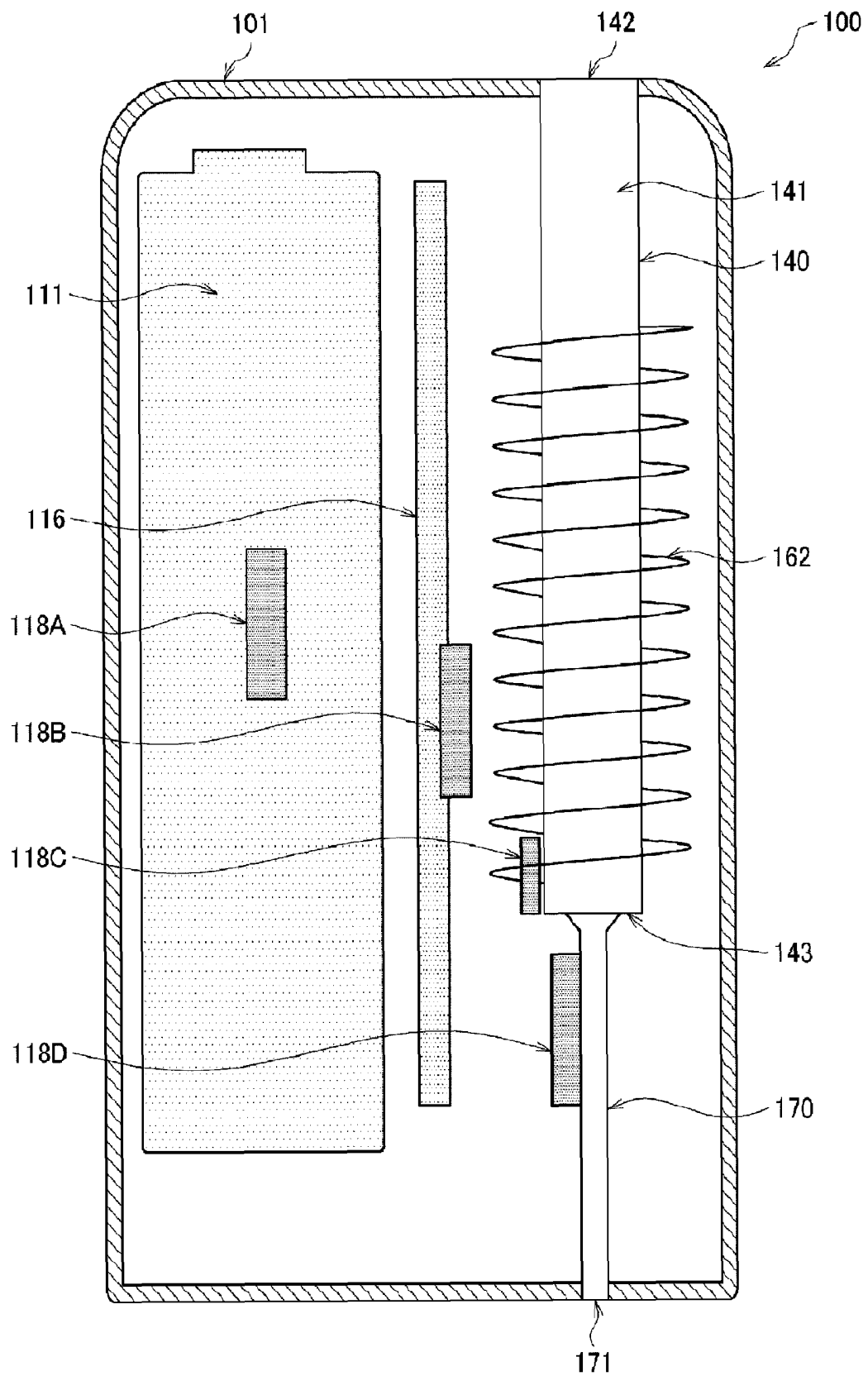
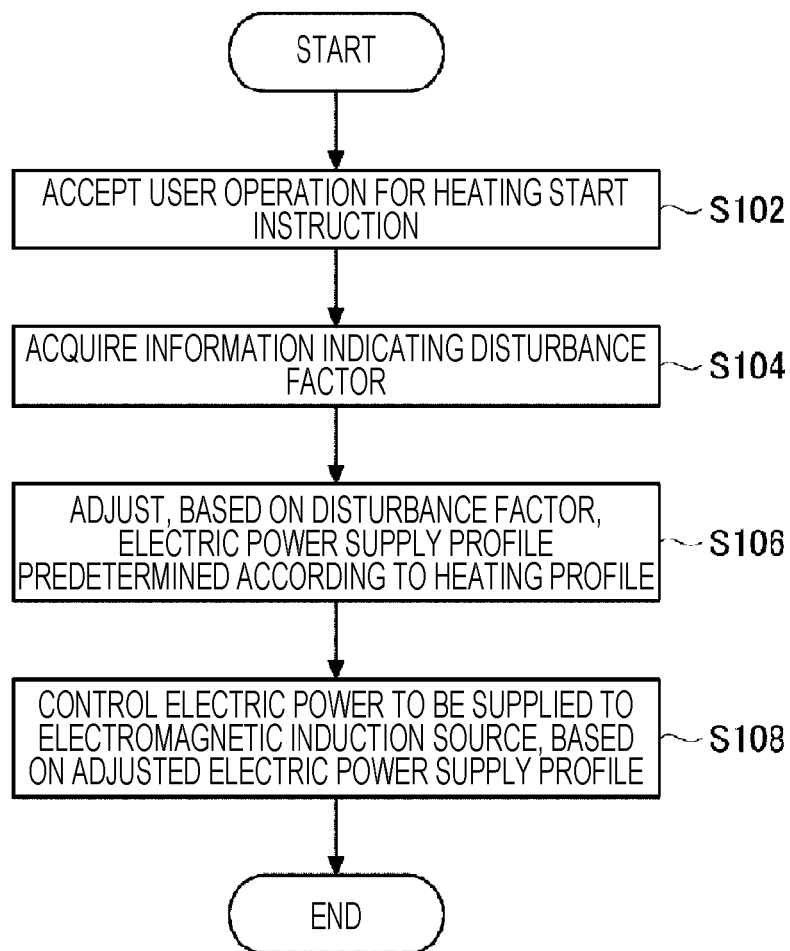


FIG. 4



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2021/006179

A. CLASSIFICATION OF SUBJECT MATTER

A24F 40/465(2020.01)i

FI: A24F40/465

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)

A24F40/465

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 1971-2021

Registered utility model specifications of Japan 1996-2021

Published registered utility model applications of Japan 1994-2021

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	JP 2019-524079 A (BRITISH AMERICAN TOBACCO (INVESTMENTS) LIMITED) 05 September 2019 (2019-09-05) paragraphs [0069]-[0097], fig. 8-9	1, 17-19 2-16
Y	W0 2019/146062 A1 (JAPAN TOBACCO INC) 01 August 2019 (2019-08-01) paragraph [0159]	2-16
Y	US 2020/0329776 A1 (KT&G CORPORATION) 22 October 2020 (2020-10-22) paragraph [0120]	2-16
Y	JP 2020-526865 A (LOTO LABS, INC.) 31 August 2020 (2020-08-31) paragraphs [0118]-[0120]	5-16
Y	JP 2018-534926 A (JT INTERNATIONAL SA) 29 November 2018 (2018-11-29) paragraphs [0017], [0033]	5-16

☒ 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

12 April 2021 (12.04.2021)

Date of mailing of the international search report

20 April 2021 (20.04.2021)

Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2021/006179

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN 104095291 A (CHINA TOBACCO CHUANYU INDUSTRIAL CO., LTD.) 15 October 2014 (2014-10-15) paragraphs [0040]-[0050], fig. 1-3	13-16
Y	JP 6811346 B1 (JAPAN TOBACCO INC.) 13 January 2021 (2021-01-13) paragraphs [0047]-[0055], fig. 6	15-16

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

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/JP2021/006179

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
JP 2019-524079 A	05 Sep. 2019	US 2019/0239555 A1 paragraphs [0078]- [0106], fig. 8-9 WO 2018/002084 A1 EP 3478103 A1 KR 10-2019-0014535 A CN 109414073 A (Family: none)	
WO 2019/146062 A1 US 2020/0329776 A1	01 Aug. 2019 22 Oct. 2020	WO 2020/101204 A1 JP 2021-509276 A CN 111542240 A KR 2020-0057491 A	
JP 2020-526865 A	31 Aug. 2020	WO 2018/195335 A1 paragraphs [0126]- [0128] EP 3613258 A1 CN 110679202 A	
JP 2018-534926 A	29 Nov. 2018	US 2018/0332894 A1 paragraphs [0017], [0036] WO 2017/064487 A1 EP 3361888 A1 KR 10-2018-0069837 A CN 108289515 A (Family: none)	
CN 104095291 A JP 6811346 B1	15 Oct. 2014 13 Jan. 2021	(Family: none) (Family: none)	

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 6623175 B [0004]