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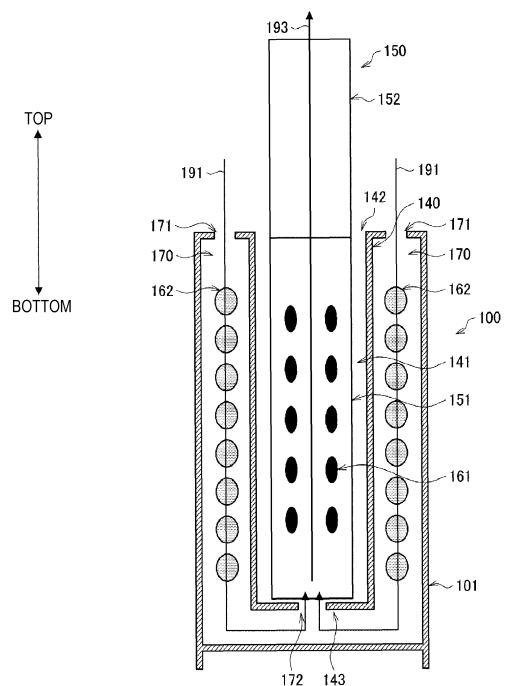
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(54) **SUCTION DEVICE, PROGRAM, AND SYSTEM**

(57) [Problem] To provide a structure that can improve the feeling of use of an induction heating-type suction device. [Solution] A suction device comprising: a power source part that supplies power; an electromagnetic induction source that uses the power supplied from the power source part to produce a variable magnetic field; a retention part that has an interior space, and an opening communicating the interior space to the exterior, and retains a substrate including an aerosol source, said substrate having been inserted into the interior space via the opening; and a first air flow passage that supplies air to the interior space of the retention part, wherein the electromagnetic induction source is positioned in a location where the variable magnetic field produced from the electromagnetic induction source penetrates a susceptor, which is positioned thermally neighboring the aerosol source included in the substrate retained by the retention part, at least one section of the electromagnetic induction source is positioned in the interior of the first air flow passage, and the susceptor produces heat when penetrated by the variable magnetic field.

FIG. 2



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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]** It is not long since the technique disclosed in Patent literature 1 or the like was developed, and there is still room for technical improvement from various viewpoints.

[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 can improve the feel of use of an inhaler device of induction heating type.

35 Solution to Problem

[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 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 first airflow path configured to supply air to the internal space of the holder, in which the electromagnetic induction source is disposed at a position where the varying magnetic field generated from 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, at least a portion of the electromagnetic induction source is disposed inside the first airflow path, and the susceptor is configured to produce heat upon being penetrated by the varying magnetic field.

[0008] The inhaler device may further include a detector configured to detect a current value or an electrical resistance value in a closed circuit including the power source and the electromagnetic induction source.

40 **[0009]** The inhaler device may further include a controller configured to control the electric power to be supplied from the power source to the electromagnetic induction source, based on the current value or the electrical resistance value detected by the detector.

[0010] The controller may be configured to control the electric power to be supplied from the power source to the electromagnetic induction source, based on a change in the current value or the resistance value detected by the detector.

55 **[0011]** The controller may be configured to control the electric power to be supplied from the power source to the electromagnetic induction source, based on a result of comparison of an amount of change in the current value or the electrical resistance value detected by the detector with a threshold.

[0012] The first airflow path may have a first air intake hole near the opening of the holder and may be configured to supply air taken in through the first air intake hole, to the internal space of the holder.

[0013] The inhaler device may further include a second airflow path configured to supply air to the internal space of the holder, in which the second airflow path may have a less pressure loss than the first airflow path.

[0014] The electromagnetic induction source may not be disposed inside the second airflow path.

[0015] The inhaler device may further include a magnetic shield configured to shield a magnetic field, in which the magnetic shield may be disposed between the electromagnetic induction source and a housing that is a re-outer shell of the inhaler device.

[0016] The magnetic shield may be disposed inside the first airflow path.

[0017] A distance between the magnetic shield and the electromagnetic induction source may be smaller than a distance between the magnetic shield and the housing.

[0018] The magnetic shield may be disposed on an inner surface of the first airflow path.

[0019] An end of the magnetic shield adjacent to the opening may be located closer to the opening than an end of the electromagnetic induction source adjacent to the opening is in a direction in which the substrate is inserted and removed.

[0020] An end of the magnetic shield adjacent to a bottom that is opposite the opening may be located closer to the bottom than an end of the electromagnetic induction source adjacent to the bottom is in a direction in which the substrate is inserted and removed.

[0021] An end of the magnetic shield adjacent to the opening may be located closer to the opening than an end of the susceptor adjacent to the opening is in a direction in which the substrate is inserted and removed.

[0022] An end of the magnetic shield adjacent to a bottom that is opposite the opening may be located closer to the bottom than an end of the susceptor adjacent to the bottom is in a direction in which the substrate is inserted and removed.

[0023] The housing and the holder may be an integrated body made of a material not to be heated by induction heating.

[0024] The susceptor may be included in the substrate.

[0025] To overcome the issue described above, another aspect of the present invention provides a program causing a computer that controls an inhaler device to perform control, 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 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; a first airflow path configured to supply air to the internal space of the holder; and a detector configured to detect a current value or an electrical resistance value in a closed circuit including the power source and the electromagnetic induction source, the electromagnetic induction source being disposed at a position where the varying magnetic field generated from 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, at least a portion of the electromagnetic induction source being disposed inside the first airflow path, the susceptor being configured to produce heat upon being penetrated by the varying magnetic field, the control being controlling the electric power to be supplied from the power source to the electromagnetic induction source, based on the current value or the electrical resistance value detected by the detector.

[0026] 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 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 first airflow path configured to supply air to the internal space of the holder, in which the electromagnetic induction source is disposed at a position where the varying magnetic field generated from 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, at least a portion of the electromagnetic induction source is disposed inside the first airflow path, and the susceptor is configured to produce heat upon being penetrated by the varying magnetic field.

Advantageous Effects of Invention

[0027] As described above, the present invention provides a mechanism that can improve the feel of use of an inhaler device of induction heating type.

Brief Description of Drawings

[0028]

[Fig. 1] Fig. 1 is a schematic diagram of an inhaler device according to a configuration example.

[Fig. 2] Fig. 2 is a diagram illustrating a detailed configuration of a portion of the inhaler device according to the present embodiment.

[Fig. 3] Fig. 3 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. 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.

[Fig. 5] Fig. 5 is a diagram illustrating a detailed configuration of a portion of an inhaler device according to a first modification.

[Fig. 6] Fig. 6 is a diagram illustrating a detailed configuration of a portion of an inhaler device according to a second modification.

[Fig. 7] Fig. 7 is a diagram illustrating a detailed configuration of a portion of an inhaler device according to a third modification.

[Fig. 8] Fig. 8 is a diagram illustrating a configuration of a substrate of a stick substrate according to a fourth modification.

[Fig. 9] Fig. 9 is a diagram illustrating a configuration of a substrate of a stick substrate according to a fifth modification.

[Fig. 10] Fig. 10 is a diagram illustrating a configuration of a substrate of a stick substrate according to a sixth modification.

Description of Embodiments

[0029] 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>

[0030] 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.

[0031] 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.

[0032] 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.

[0033] 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.

[0034] 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.

[0035] 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.

[0036] 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.

[0037] 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.

[0038] 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.

[0039] The stick substrate 150 is a stick-shaped member. The stick substrate 150 includes a substrate 151 and an inhalation port 152.

[0040] 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.

[0041] 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.

[0042] 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.

[0043] 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.

[0044] 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.

[0045] 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

[0046] 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.

[0047] 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>

[0048] Induction heating will be described in detail below.

[0049] 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.

[0050] 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.

[0051] 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.

[0052] 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.

[0053] 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.

[0054] 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

[0055] 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.

<3. Technical features>

(1) Arrangement of electromagnetic induction source 162

[0056] Fig. 2 is a diagram illustrating a detailed configuration of a portion of the inhaler device 100 according to the present embodiment. Fig. 2 is a sectional view of a region around the holder 140 when the inhaler device 100 and the stick substrate 150 held by the holder 140 are sectioned in a longitudinal direction of the holder 140. The stick substrate 150 is inserted and removed in the longitudinal direction of the holder 140. The direction in which the stick substrate 150 is removed, that is, a direction toward the opening 142 in the longitudinal direction of the holder 140 is also referred to as top. On the other hand, a direction in which the stick substrate 150 is inserted, that is, a direction opposite the opening 142 in the longitudinal direction of the holder 140 (that is, toward the bottom 143) is also referred to as bottom.

[0057] As illustrated in Fig. 2, the inhaler device 100 has a first airflow path 170. The first airflow path 170 supplies air to the internal space 141 of the holder 140. The first airflow path 170 has a first air intake hole 171 through which air is taken into the first airflow path 170, and an air supply hole 172 through which the air in the first airflow path 170 is ejected to the internal space 141 of the holder 140. The first air intake hole 171 is disposed in the vicinity of the opening 142 of the holder 140. In an example, a housing 101 that is the re-outer shell of the inhaler device 100 may have a cylindrical shape, and the first air intake hole 171 may be disposed on the same plane as the opening 142 of the holder 140 as illustrated in Fig. 2. On the other hand, the air supply hole 172 is disposed at the bottom 143 of the holder 140. Thus, the first airflow path 170 surrounds the holder 140. Therefore, the first airflow path 170 can function as a heat insulating layer for preventing heat from the susceptor 161 from reaching a user who is holding the housing 101.

[0058] The first airflow path 170 supplies the air taken in through the first air intake hole 171 to the internal space 141 of the holder 140 through the air supply hole 172. More specifically, when the user performs inhalation while holding, in their mouth, the inhalation port 152 protruding from the opening 142, air taken into the first airflow path 170 through the first air intake hole 171 is supplied to the internal space 141 of the holder 140 through the air supply hole 172 as indicated by an airflow 191. The air passes through the substrate 151 and reaches the inside of the mouth of the user together with the aerosol generated from the substrate 151 as indicated by an airflow 193.

[0059] 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.

[0060] 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. 2 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. 2, 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.

[0061] The sensor 112 functions as a detector that detects a current value or a resistance value in a closed circuit including the power supply 111 and the electromagnetic induction source 162. In an example, the sensor 112 may include a micro controller unit (MCU) having a feedback channel from a DC power supply included in the power supply 111. The MCU detects at least one of a current value, a voltage value, and a resistance value of the closed circuit, based

on a feedback from the DC power supply. Patent Literature 1 above discloses details of the detection method.

[0062] The controller 116 controls electric power to be supplied from the power supply 111 to the electromagnetic induction source 162, based on the current value or the electrical resistance value in the closed circuit detected by the sensor 112. Specifically, first, the controller 116 estimates a temperature of the susceptor 161, based on the current value or the electrical resistance value in the closed circuit including the power supply 111 and the electromagnetic induction source 162 detected by the sensor 112. The controller 116 then controls electric power supply to the electromagnetic induction source 162, based on the estimated temperature of the susceptor 161. For example, the controller 116 controls electric power supply to the electromagnetic induction source 162 such that the temperature of the susceptor 161 changes in accordance with a heating profile. The heating profile will be described in detail later.

[0063] Note that there is a very monotonic relationship between the temperature of the susceptor 161 and an apparent ohmic resistance determined from the voltage value and the current value of the DC power supply. This allows the controller 116 to estimate the temperature of the susceptor 161, based on the current value or the electrical resistance value in the closed circuit detected by the sensor 112. Patent Literature 1 above discloses details of the estimation method.

(2) Heating profile

[0064] 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 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.

[0065] 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 controller 116 controls the temperature of the susceptor 161, based on a deviation of the current actual temperature from the target temperature corresponding to the current elapsed time from the start of heating in the heating profile. Control of the temperature of the susceptor 161 can be implemented by known feedback control, for example. In the feedback control, the controller 116 may control electric power to be supplied to the electromagnetic induction source 162, based on a difference between the actual temperature and the target temperature or the like. The feedback control may be, for example, a proportional-integral-differential controller (PID controller). Alternatively, the controller 116 may simply perform ON-OFF control. For example, the controller 116 may supply electric power to the electromagnetic induction source 162 until the actual temperature reaches the target temperature, and may interrupt electric power supply to the electromagnetic induction source 162 upon the actual temperature reaching the target temperature.

[0066] 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.

[0067] Table 1 below presents an example of the heating profile.

[Table 1]

[0068]

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

(continued)

Time section	Elapsed time from start of heating	Target temperature
Temperature re-rise section	180 s	230°C
	260 s	260°C
	355 s	260°C
Heating termination section	Thereafter	-

[0069] 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. 3. Fig. 3 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. 3, 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.

[0070] 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. 3, 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. 3 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.

[0071] 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. 3, 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.

[0072] 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. 3, 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.

[0073] 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. 3, 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. 3, the puffable period, that is, the heating session ends after 365 seconds from the start of heating.

[0074] 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.

(3) Detection of puff

[0075] Referring again to Fig. 2, the electromagnetic induction source 162 according to the present embodiment is disposed inside the first airflow path 170. The electromagnetic induction source 162 has an electrical resistance, and thus produce heat when a current is applied thereto. In this regard, when the user performs inhalation while holding the inhalation port 152 in their mouth, the airflow 191 cools the electromagnetic induction source 162, so that the temperature of the electromagnetic induction source 162 temporarily decreases. The electrical resistance value of the electromagnetic induction source 162 changes in accordance with a change in the temperature of the electromagnetic induction source 162. In an example, when the temperature of the electromagnetic induction source 162 decreases, the electrical resistance value of the electromagnetic induction source 162 decreases. Further, when the electrical resistance value of the electromagnetic induction source 162 decreases, the current value of the electromagnetic induction source 162 increases. By using such characteristics, the controller 116 can estimate the temperature of the electromagnetic induction source 162, based on the current value or the electrical resistance value in the closed circuit including the power supply 111 and the electromagnetic induction source 162.

[0076] The controller 116 also performs control using such characteristics. Specifically, the controller 116 controls electric power to be supplied from the power supply 111 to the electromagnetic induction source 162, based on a change in the current value or the electrical resistance value in the closed circuit including the power supply 111 and the electromagnetic induction source 162 detected by the sensor 112.

[0077] Specifically, first, the controller 116 detects a user operation of inhaling the aerosol, based on the change in the current value or the electrical resistance value detected by the sensor 112. In an example, the controller 116 detects a puff, based on a result of comparison between an amount of change in the current value or the electrical resistance value and a threshold, more specifically, if an increase amount of the current value or a decrease amount of the electrical resistance value exceeds the threshold. Through comparison of the increase amount or the decrease amount with the threshold, erroneous detection of a puff caused by a slowdown of the temperature increase rate due to a magnetic phase transition can be prevented. In another example, the controller 116 may detect a puff by comparing a deviation of the temperature of the susceptor 161 estimated based on the detected current value or electrical resistance value from the target temperature defined in the heating profile with a threshold.

[0078] Subsequently, the controller 116 controls electric power to be supplied from the power supply 111 to the electromagnetic induction source 162, based on the puff detection result. In an example, the controller 116 may increase the temperature of the susceptor 161 stepwise each time a puff is detected in a latter part (for example, the temperature re-rise section) of the heating profile. In the latter part of the heating profile, the aerosol source included in the stick substrate 150 tends to be depleted. However, with the above configuration, deterioration of a flavor tasted by the user due to depletion of the aerosol source can be prevented. In another example, when the number of detected puffs reaches a predetermined value, the controller 116 may stop electric power supply to the electromagnetic induction source 162 and end the heating session. As the number of puffs increases, the aerosol source included in the stick substrate 150 tends to be depleted. However, with the above configuration, deterioration of a flavor tasted by the user due to depletion of the aerosol source can be prevented.

[0079] Since the electromagnetic induction source 162 is disposed inside the first airflow path 170, the electromagnetic induction source 162 is cooled in response to a puff. Thus, the temperature of the electromagnetic induction source 162 can be prevented from excessively increasing. This can consequently prevent the inhaler device 100 from giving a feeling of discomfort caused by an excessive temperature increase of the electromagnetic induction source 162 to the user holding the housing 101.

[0080] The preheating period in the heating profile may be regarded as a period for increasing the temperature of the electromagnetic induction source 162 as well as a period for increasing the temperature of the susceptor 161. That is, the controller 116 may determine to finish preheating when the temperature of the susceptor 161 reaches a predetermined value and/or when the temperature of the electromagnetic induction source 162 reaches a predetermined value. Increasing the temperature of the electromagnetic induction source 162 to be sufficiently high makes can increase a difference between the temperature of air taken into the first airflow path 170 in response to a puff and the temperature of the electromagnetic induction source 162. This can increase a decrease amount of the temperature of the electromagnetic induction source 162 in response to a puff, so that the accuracy of detecting a puff can be improved.

(4) Procedure of Process

[0081] 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.

[0082] 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.

[0083] Subsequently, the controller 116 starts electric power supply from the power supply 111 to the electromagnetic induction source 162 (step S104). At and after this step, the controller 116 controls electric power supply to the electromagnetic induction source 162, based on the heating profile.

[0084] Subsequently, the controller 116 determines whether preheating is finished (step S106). For example, the controller 116 determines that preheating is finished if the temperature of the susceptor 161 and/or the temperature of the electromagnetic induction source 162 estimated based on the current value or the electrical resistance value in the closed circuit including the power supply 111 and the electromagnetic induction source 162 reaches a predetermined value.

[0085] If it is determined that preheating is not finished (step S106: NO), the controller 116 waits until preheating is finished.

[0086] On the other hand, if it is determined that preheating is finished (step S106: YES), the controller 116 determines whether a puff is detected (step S108). For example, the controller 116 detects a puff if an increase amount of the current value or a decrease amount of the electrical resistance value in the closed circuit including the power supply 111 and the electromagnetic induction source 162 exceeds a threshold.

[0087] If a puff is detected (step S108: YES), the controller 116 performs control related to the puff (step S110). In an example, the controller 116 controls electric power supply to the electromagnetic induction source 162 so as to increase the temperature of the susceptor 161 stepwise each time a puff is detected in the temperature re-rise section. The process then proceeds to step S112. If a puff is not detected (step S108: NO), the process also proceeds to step S112.

[0088] In step S112, the controller 116 determines whether to stop heating. In an example, if the elapsed time from the start of heating reaches a predetermined value, the controller 116 determines to stop heating. In another example, the controller 116 determines to stop heating if the number of detected puffs reaches a predetermined value.

[0089] If the controller 116 determines not to stop heating (step S112: NO), the process returns to step S108.

[0090] On the other hand, if the controller 116 determines to stop heating (step S112: YES), the controller 116 stops electric power supply to the electromagnetic induction source 162 (step S114). The process then ends.

<4. Modifications>

(1) First modification

[0091] A first modification is an example in which two types of airflow paths for supplying air to the internal space 141 of the holder 140 are provided. This modification will be described in detail with reference to Fig. 5.

[0092] Fig. 5 is a diagram illustrating a detailed configuration of a portion of the inhaler device 100 according to the first modification. Fig. 5 is a sectional view of a region around the holder 140 when the inhaler device 100 and the stick substrate 150 held by the holder 140 are sectioned in a longitudinal direction of the holder 140.

[0093] As illustrated in Fig. 5, the inhaler device 100 according to the first modification includes a second airflow path 173, which differs from the configuration illustrated in Fig. 2. The second airflow path 173 has a second air intake hole 174 through which air is taken into the second airflow path 173, and the air supply hole 172 through which the air in the second airflow path 173 is ejected to the internal space 141 of the holder 140. The second airflow path 173 supplies the air taken in through the second air intake hole 174 to the internal space 141 of the holder 140 through the air supply hole 172. More specifically, when the user performs inhalation while holding, in their mouth, the inhalation port 152 protruding from the opening 142, air taken into the second airflow path 173 through the second air intake hole 174 is supplied to the internal space 141 of the holder 140 through the air supply hole 172 as indicated by an airflow 192. The air passes through the substrate 151 and reaches the inside of the mouth of the user together with the aerosol generated from the substrate 151 as indicated by the airflow 193. The first airflow path 170 and the second airflow path 173 partially overlap with each other in Fig. 5 but may be provided independently of each other.

[0094] A pressure loss in the second airflow path 173 is smaller than that in the first airflow path 170. In an example, a diameter of the second air intake hole 174 may be larger than a diameter of the first air intake hole 171. In another example, a distance between the second air intake hole 174 and the air supply hole 172 may be shorter than a distance between the first air intake hole 171 and the air supply hole 172. With such a configuration, the airflow 192 passing through the second airflow path 173 can be made larger than the airflow 191 passing through the first airflow path 170.

[0095] In particular, as illustrated in Fig. 5, it is desirable that the electromagnetic induction source 162 is not disposed inside the second airflow path 173. As described above, the airflow 192 passing through the second airflow path 173 is

larger than the airflow 191 passing through the first airflow path 170. Thus, a larger amount of dust may enter the second airflow path 173 than in the first airflow path 170. Conversely, an amount of dust entering the first airflow path 170 can be reduced. Thus, the occurrence of a failure in the electromagnetic induction source 162 due to entry of dust into the first airflow path 170 can be suppressed. In addition, since the electromagnetic induction source 162 is not disposed inside the second airflow path 173, a load of cleaning the dust that has entered the second airflow path 173 can be reduced.

(2) Second modification

[0096] A second modification is an example in which a magnetic shield that shields a magnetic field generated from the electromagnetic induction source 162 is provided. This modification will be described in detail with reference to Fig. 6.

[0097] Fig. 6 is a diagram illustrating a detailed configuration of a portion of the inhaler device 100 according to the second modification. Fig. 6 is a sectional view of a region around the holder 140 when the inhaler device 100 and the stick substrate 150 held by the holder 140 are sectioned in a longitudinal direction of the holder 140.

[0098] As illustrated in Fig. 6, the inhaler device 100 according to the second modification includes a magnetic shield 175, which differs from the configuration illustrated in Fig. 2. The magnetic shield 175 has a function of restricting passage of the magnetic field from the inside (that is, the side adjacent to the electromagnetic induction source 162) to the outside (that is, that side adjacent to the housing 101) of the magnetic shield 175. The magnetic shield 175 is made of any material having a function of shielding a magnetic field. Furthermore, the magnetic shield 175 is preferably made of a material having a high magnetic permeability. Examples of such a material include new metal and permalloy.

[0099] As illustrated in Fig. 6, the magnetic shield 175 is disposed between the electromagnetic induction source 162 and the housing 101. With such a configuration, the magnetic field generated from the electromagnetic induction source 162 is not prevented from penetrating the susceptor 161 while being prevented from reaching the housing 101 and other devices located in the vicinity of the inhaler device 100. When electronic components such as the power supply 111 and the controller 116 are disposed between the housing 101 and the electromagnetic induction source 162, the magnetic shield 175 is desirably disposed between the electromagnetic induction source 162 and the electronic components. This is to prevent an adverse effect of the varying magnetic field on the electronic component.

[0100] As illustrated in Fig. 6, the magnetic shield 175 is disposed inside the first airflow path 170. That is, the magnetic shield 175 is disposed in the same space as the electromagnetic induction source 162. With such a configuration, diffusion of the magnetic field generated from the electromagnetic induction source 162 can be efficiently prevented.

[0101] Further, as illustrated in Fig. 6, a distance between the magnetic shield 175 and the electromagnetic induction source 162 may be smaller than a distance between the magnetic shield 175 and the housing 101. For example, the magnetic shield 175 may be a film wound around the electromagnetic induction source 162 from the outside. With such a configuration, the magnetic field generated from the electromagnetic induction source 162 can be shielded before the magnetic field diffuses. Further, with such a configuration, a space through which the airflow 191 can easily pass can be provided between the magnetic shield 175 and the inner surface of the first airflow path 170.

[0102] The housing 101 is desirably made of a material that is not to be heated by induction heating. That is, the housing 101 is desirably made of a non-conductive material. Further, the housing 101 is desirably made of a material other than a magnetic body. Examples of such a material include glass, ceramic, and a resin material such as polyether ether ketone (PEEK), polycarbonate (PC), or polyimide (PI). With such a configuration, even if the magnetic field leaks to the outside from the magnetic shield 175, heat production by the housing 101 can be prevented and thus the user safety can be ensured.

[0103] The holder 140 is also desirably made of a material that is not to be heated by induction heating. The housing 101 and the holder 140 may be integrated together. For example, the housing 101 and the holder 140 may be injection molded. Such a configuration can reduce a manufacturing load, compared with a case where the housing 101 and the holder 140 are molded separately and then are joined together.

[0104] As illustrated in Fig. 6, an upper end of the magnetic shield 175 is located above an upper end of the electromagnetic induction source 162 in the direction in which the stick substrate 150 is inserted and removed. In addition, a lower end of the magnetic shield 175 is located below a lower end of the electromagnetic induction source 162 in the direction in which the stick substrate 150 is inserted and removed. In other words, the electromagnetic induction source 162 is disposed on the inner side relative to both ends of the magnetic shield 175 in the longitudinal direction of the holder 140. With such a configuration, diffusion of the magnetic field generated from the electromagnetic induction source 162 can be prevented more firmly.

[0105] As illustrated in Fig. 6, the upper end of the magnetic shield 175 is located above an upper end of the susceptor 161 in the direction in which the stick substrate 150 is inserted and removed. In addition, the lower end of the magnetic shield 175 is located below a lower end of the susceptor 161 in the direction in which the stick substrate 150 is inserted and removed. In other words, the susceptor 161 is disposed on the inner side relative to both ends of the magnetic shield 175 in the longitudinal direction of the holder 140. When the susceptor 161 is a magnetic body, a magnetic field may also be generated from the susceptor 161 due to induction heating. However, with the above configuration, diffusion of

the magnetic field generated from the susceptor 161 can be prevented.

(3) Third modification

[0106] A third modification is an example in which a magnetic shield that shields a magnetic field generated from the electromagnetic induction source 162 is provided at a position different from that in the second modification. This modification will be described in detail with reference to Fig. 7.

[0107] Fig. 7 is a diagram illustrating a detailed configuration of a portion of the inhaler device 100 according to the third modification. Fig. 7 is a sectional view of a region around the holder 140 when the inhaler device 100 and the stick substrate 150 held by the holder 140 are sectioned in a longitudinal direction of the holder 140.

[0108] As illustrated in Fig. 7, in the inhaler device 100 according to the third modification, the position of the magnetic shield 175 differs from that in the configuration illustrated in Fig. 6. Specifically, the magnetic shield 175 is disposed on an inner surface of the first airflow path 170. With such a configuration, a wider space can be provided between the magnetic shield 175 and the electromagnetic induction source 162 than in the second modification. Thus, an adverse effect, on the magnetic shield 175, of heat produced from the electromagnetic induction source 162 when a current is applied to the electromagnetic induction source 162 can be reduced.

(4) Fourth modification

[0109] A fourth modification is an example in which the susceptor 161 extends in a longitudinal direction of the stick substrate 150. This modification will be described in detail with reference to Fig. 8.

[0110] Fig. 8 is a diagram illustrating a configuration of the substrate 151 of the stick substrate 150 according to the fourth modification. Fig. 8 is a sectional view of a portion of the substrate 151 when the stick substrate 150 is sectioned in the longitudinal direction. As illustrated in Fig. 8, the substrate 151 includes a filler 153, a wrapping paper 154, and the susceptor 161.

[0111] The filler 153 includes an aerosol source that generates an aerosol when reaching a predetermined temperature. The aerosol source is not limited to a particular type and may be selected from substances extracted from various natural products and/or constituents forming such substances in accordance with the purpose of use. Examples of the aerosol source are glycerine, propylene glycol, triacetin, 1,3-butanediol, and a mixture thereof.

[0112] The filler 153 may further include a flavor source. The flavor source is not limited to a particular type and may be selected from substances extracted from various natural products and/or constituents forming such substances in accordance with the purpose of use. An example of the flavor source is shredded tobacco. The flavor source may also include a flavoring agent such as menthol.

[0113] The wrapping paper 154 is a member that is an outermost circumference of the stick substrate 150. The wrapping paper 154 wraps the filler 153 and the susceptor 161 from the outside and fixes the shape of the stick substrate 150 to, for example, a cylindrical shape. By wrapping the substrate 151 and the inhalation port 152, the wrapping paper 154 may couple the substrate 151 and the inhalation port 152 to each other.

[0114] As illustrated in Fig. 8, the susceptor 161 according to the present modification extends in the longitudinal direction of the stick substrate 150. For example, the susceptor 161 may have an elongated shape such as a rod shape, a cylindrical shape, or a plate shape. The susceptor 161 is disposed at the center of the substrate 151 in the longitudinal direction. With such a configuration, an aerosol can be generated in a short time from the start of heating since the susceptor 161 that produces a large amount of heat by induction heating is disposed at the center of the substrate 151.

[0115] As illustrated in Fig. 2 and so on, when the susceptor 161 is formed to be granular or a small piece and is distributed to be mixed with the filler 153, the filler 153 is uniformly heated. Thus, an aerosol can be efficiently generated.

(5) Fifth modification

[0116] A fifth modification is an example in which the stick substrate 150 includes two types of susceptors 161 having different shapes. This modification will be described in detail with reference to Fig. 9.

[0117] Fig. 9 is a diagram illustrating a configuration of the substrate 151 of the stick substrate 150 according to the fifth modification. Fig. 9 is a sectional view of a portion of the substrate 151 when the stick substrate 150 is sectioned in the longitudinal direction. As illustrated in Fig. 9, the substrate 151 includes the filler 153, the wrapping paper 154, a susceptor 161A, and a susceptor 161B.

[0118] The susceptor 161A has an elongated shape and is disposed at the center of the substrate 151 in the longitudinal direction. By contrast, the susceptor 161B is formed to be granular or a small piece and is distributed to be mixed with the filler 153. Thus, both quick heating provided by the susceptor 161A and uniform heating provided by the susceptor 161B can be implemented.

[0119] Note that the substrate 151 may include regions where the susceptor 161B is distributed at different densities.

Specifically, the density at which the susceptor 161B is distributed may be different between a region Z1 farther from the sensor and a region Z2 closer to the center

[0120] In an example, the density in the region Z1 may be lower than the density in the region Z2. With such a configuration, the region Z2 can be heated in a more concentrated manner by the susceptors 161A and 161B. The density in the region Z1 may be 0.

[0121] In another example, the density in the region Z2 may be lower than the density in the region Z1. With such a configuration, a difference in the amount of heat between the region Z1 closer to the susceptor 161A and the region Z2 farther from the susceptor 161A can be reduced, and thus the regions Z1 and Z2 can be heated more uniformly. The density in the region Z2 may be 0.

[0122] The susceptors 161A and 161B may be made of the same material or different materials. The Curie points of the susceptors 161A and 161B may be the same or different.

(6) Sixth modification

[0123] A sixth modification is an example in which two types of susceptors 161 are disposed adjacently to each other in the stick substrate 150. This modification will be described in detail with reference to Fig. 10.

[0124] Fig. 10 is a diagram illustrating a configuration of the substrate 151 of the stick substrate 150 according to the sixth modification. Fig. 10 is a sectional view of a portion of the substrate 151 when the stick substrate 150 is sectioned in the longitudinal direction. As illustrated in Fig. 10, the substrate 151 includes the filler 153, the wrapping paper 154, the susceptor 161A, and the susceptor 161B.

[0125] Each of the susceptors 161A and 161B has an elongated shape. The susceptors 161A and 161B are disposed adjacently to each other at the center of the substrate 151 in the longitudinal direction. Typically, the susceptors 161A and 161B are made of different materials and have different Curie points. With such a configuration, a slowdown of the temperature increase rate due to a magnetic phase transition occurs at different timings between the susceptor 161A and the susceptor 161B. Thus, a rapid decrease in the temperature increase rate in the entire stick substrate 150 due to the magnetic phase transition may be reduced.

<5. Supplementary description>

[0126] 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.

[0127] For example, in the embodiment described above, an example has been described in which the whole electromagnetic induction source 162 is disposed inside the first airflow path 170. However, the present invention is not limited to such an example. That is, at least a portion of the electromagnetic induction source 162 may be disposed inside the first airflow path 170. If at least a portion of the electromagnetic induction source 162 is disposed inside the first airflow path 170, a puff can be detected based on a decrease in the temperature of the electromagnetic induction source 162 due to the puff.

[0128] 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 location 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.

[0129] 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.

[0130] 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.

[0131] Configurations below also pertain to the technical scope of the present invention.

(1) An inhaler device including:

5 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 holder having an internal space and an opening that allows the internal space to communicate with outside
 10 and configured to hold a substrate inserted into the internal space through the opening, the substrate including an aerosol source; and
 a first airflow path configured to supply air to the internal space of the holder, in which
 the electromagnetic induction source is disposed at a position where the varying magnetic field generated from 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,
 15 at least a portion of the electromagnetic induction source is disposed inside the first airflow path, and
 the susceptor is configured to produce heat upon being penetrated by the varying magnetic field.

(2) The inhaler device according to (1), further including:

20 a detector configured to detect a current value or an electrical resistance value in a closed circuit including the power source and the electromagnetic induction source.

(3) The inhaler device according to (2), further including:

a controller configured to control the electric power to be supplied from the power source to the electromagnetic induction source, based on the current value or the electrical resistance value detected by the detector.

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

25 the controller is configured to control the electric power to be supplied from the power source to the electromagnetic induction source, based on a change in the current value or the resistance value detected by the detector.

(5) The inhaler device according to (4), in which

30 the controller is configured to control the electric power to be supplied from the power source to the electromagnetic induction source, based on a result of comparison of an amount of change in the current value or the electrical resistance value detected by the detector with a threshold.

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

the first airflow path has a first air intake hole near the opening of the holder and is configured to supply air taken in through the first air intake hole, to the internal space of the holder.

(7) The inhaler device according to any one of (1) to (6), further including:

35 a second airflow path configured to supply air to the internal space of the holder, in which
 the second airflow path has a less pressure loss than the first airflow path.

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

40 the electromagnetic induction source is not disposed inside the second airflow path.

(9) The inhaler device according to any one of (1) to (8), further including:

45 a magnetic shield configured to shield a magnetic field, in which
 the magnetic shield is disposed between the electromagnetic induction source and a housing that is a re-outer shell of the inhaler device.

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

the magnetic shield is disposed inside the first airflow path.

(11) The inhaler device according to (10), in which

50 a distance between the magnetic shield and the electromagnetic induction source is smaller than a distance between the magnetic shield and the housing.

(12) The inhaler device according to (10), in which

the magnetic shield is disposed on an inner surface of the first airflow path.

(13) The inhaler device according to any one of (9) to (12), in which

55 an end of the magnetic shield adjacent to the opening is located closer to the opening than an end of the electromagnetic induction source adjacent to the opening is in a direction in which the substrate is inserted and removed.

(14) The inhaler device according to any one of (9) to (13), in which

an end of the magnetic shield adjacent to a bottom that is opposite the opening is located closer to the bottom than

an end of the electromagnetic induction source adjacent to the bottom is in a direction in which the substrate is inserted and removed.

(15) The inhaler device according to any one of (9) to (14), in which an end of the magnetic shield adjacent to the opening is located closer to the opening than an end of the susceptor adjacent to the opening is in a direction in which the substrate is inserted and removed.

(16) The inhaler device according to any one of (9) to (15), in which an end of the magnetic shield adjacent to a bottom that is opposite the opening is located closer to the bottom than an end of the susceptor adjacent to the bottom is in a direction in which the substrate is inserted and removed.

(17) The inhaler device according to any one of (9) to (16), in which the housing and the holder are an integrated body made of a material not to be heated by induction heating.

(18) The inhaler device according to any one of (1) to (17), in which the susceptor is included in the substrate.

(19) A program causing a computer that controls an inhaler device to perform control, 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 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;
 a first airflow path configured to supply air to the internal space of the holder; and
 a detector configured to detect a current value or an electrical resistance value in a closed circuit including the power source and the electromagnetic induction source,
 the electromagnetic induction source being disposed at a position where the varying magnetic field generated from 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,
 at least a portion of the electromagnetic induction source being disposed inside the first airflow path,
 the susceptor being configured to produce heat upon being penetrated by the varying magnetic field,
 the control being
 controlling the electric power to be supplied from the power source to the electromagnetic induction source, based on the current value or the electrical resistance value detected by the detector.

(20) 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 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 first airflow path configured to supply air to the internal space of the holder, in which
 the electromagnetic induction source is disposed at a position where the varying magnetic field generated from 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,
 at least a portion of the electromagnetic induction source is disposed inside the first airflow path, and
 the susceptor is configured to produce heat upon being penetrated by the varying magnetic field.

(21) The inhaler device according to (20), in which the susceptor is included in the substrate.

Reference Signs List

[0132]

- 100 inhaler device
- 101 housing

111	power supply
112	sensor
113	notifier
114	memory
5 115	communicator
116	controller
140	holder
141	internal space
142	opening
10 143	bottom
150	stick substrate
151	substrate
152	inhalation port
153	filler
15 154	wrapping paper
161	susceptor
162	electromagnetic induction source
170	first airflow path
171	first air intake hole
20 172	air supply hole
173	second airflow path
174	second air intake hole
175	magnetic shield

25

Claims

1. An inhaler device comprising:

30 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 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
35 an aerosol source; and
a first airflow path configured to supply air to the internal space of the holder, wherein
the electromagnetic induction source is disposed at a position where the varying magnetic field generated from
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,
40 at least a portion of the electromagnetic induction source is disposed inside the first airflow path, and
the susceptor is configured to produce heat upon being penetrated by the varying magnetic field.

2. The inhaler device according to claim 1, further comprising:

45 a detector configured to detect a current value or an electrical resistance value in a closed circuit including the power source and the electromagnetic induction source.

3. The inhaler device according to claim 2, further comprising:

50 a controller configured to control the electric power to be supplied from the power source to the electromagnetic induction source, based on the current value or the electrical resistance value detected by the detector.

4. The inhaler device according to claim 3, wherein

the controller is configured to control the electric power to be supplied from the power source to the electromagnetic induction source, based on a change in the current value or the resistance value detected by the detector.

5. The inhaler device according to claim 4, wherein

the controller is configured to control the electric power to be supplied from the power source to the electromagnetic induction source, based on a result of comparison of an amount of change in the current value or the electrical resistance value detected by the detector with a threshold.

6. The inhaler device according to any one of claims 1 to 5, wherein the first airflow path has a first air intake hole near the opening of the holder and is configured to supply air taken in through the first air intake hole, to the internal space of the holder.
- 5 7. The inhaler device according to any one of claims 1 to 6, further comprising:

a second airflow path configured to supply air to the internal space of the holder, wherein the second airflow path has a less pressure loss than the first airflow path.
- 10 8. The inhaler device according to claim 7, wherein the electromagnetic induction source is not disposed inside the second airflow path.
9. The inhaler device according to any one of claims 1 to 8, further comprising:

15 a magnetic shield configured to shield a magnetic field, wherein the magnetic shield is disposed between the electromagnetic induction source and a housing that is a re-outer shell of the inhaler device.
10. The inhaler device according to claim 9, wherein
20 the magnetic shield is disposed inside the first airflow path.
11. The inhaler device according to claim 10, wherein a distance between the magnetic shield and the electromagnetic induction source is smaller than a distance between the magnetic shield and the housing.
- 25 12. The inhaler device according to claim 10, wherein the magnetic shield is disposed on an inner surface of the first airflow path.
13. The inhaler device according to any one of claims 9 to 12, wherein
30 an end of the magnetic shield adjacent to the opening is located closer to the opening than an end of the electromagnetic induction source adjacent to the opening is in a direction in which the substrate is inserted and removed.
14. The inhaler device according to any one of claims 9 to 13, wherein
35 an end of the magnetic shield adjacent to a bottom that is opposite the opening is located closer to the bottom than an end of the electromagnetic induction source adjacent to the bottom is in a direction in which the substrate is inserted and removed.
15. The inhaler device according to any one of claims 9 to 14, wherein
40 an end of the magnetic shield adjacent to the opening is located closer to the opening than an end of the susceptor adjacent to the opening is in a direction in which the substrate is inserted and removed.
16. The inhaler device according to any one of claims 9 to 15, wherein
45 an end of the magnetic shield adjacent to a bottom that is opposite the opening is located closer to the bottom than an end of the susceptor adjacent to the bottom is in a direction in which the substrate is inserted and removed.
17. The inhaler device according to any one of claims 9 to 16, wherein the housing and the holder are an integrated body made of a material not to be heated by induction heating.
18. The inhaler device according to any one of claims 1 to 17, wherein
50 the susceptor is included in the substrate.
19. A program causing a computer that controls an inhaler device to perform control, the inhaler device including:

55 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 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;
 a first airflow path configured to supply air to the internal space of the holder; and
 a detector configured to detect a current value or an electrical resistance value in a closed circuit including the
 power source and the electromagnetic induction source,
 5 the electromagnetic induction source being disposed at a position where the varying magnetic field generated
 from 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,
 at least a portion of the electromagnetic induction source being disposed inside the first airflow path,
 10 the susceptor being configured to produce heat upon being penetrated by the varying magnetic field,
 the control being
 controlling the electric power to be supplied from the power source to the electromagnetic induction source,
 based on the current value or the electrical resistance value detected by the detector.

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

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

20 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 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
 25 a first airflow path configured to supply air to the internal space of the holder, wherein
 the electromagnetic induction source is disposed at a position where the varying magnetic field generated
 from 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,
 at least a portion of the electromagnetic induction source is disposed inside the first airflow path, and
 30 the susceptor is configured to produce heat upon being penetrated by the varying magnetic field.

FIG. 1

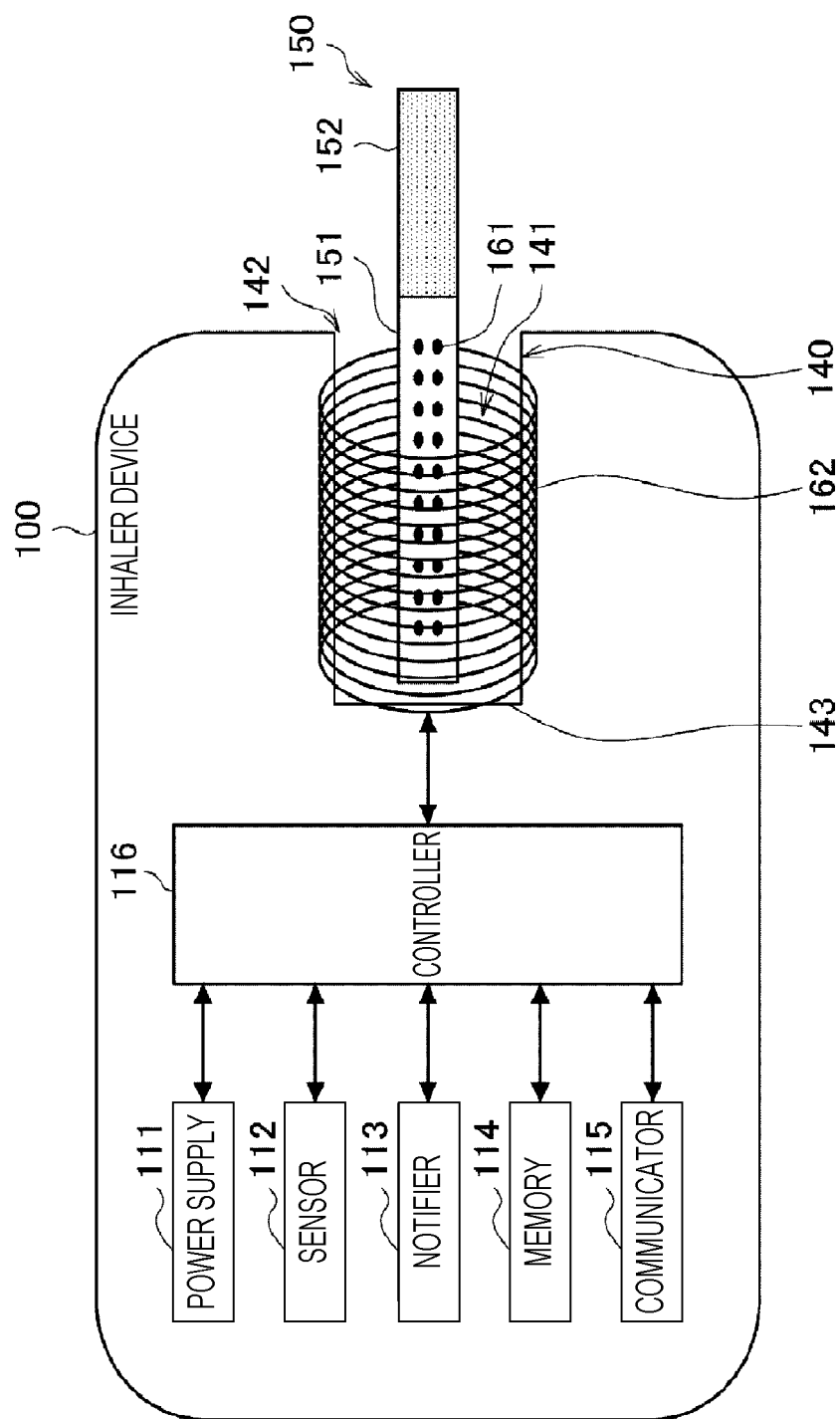


FIG. 2

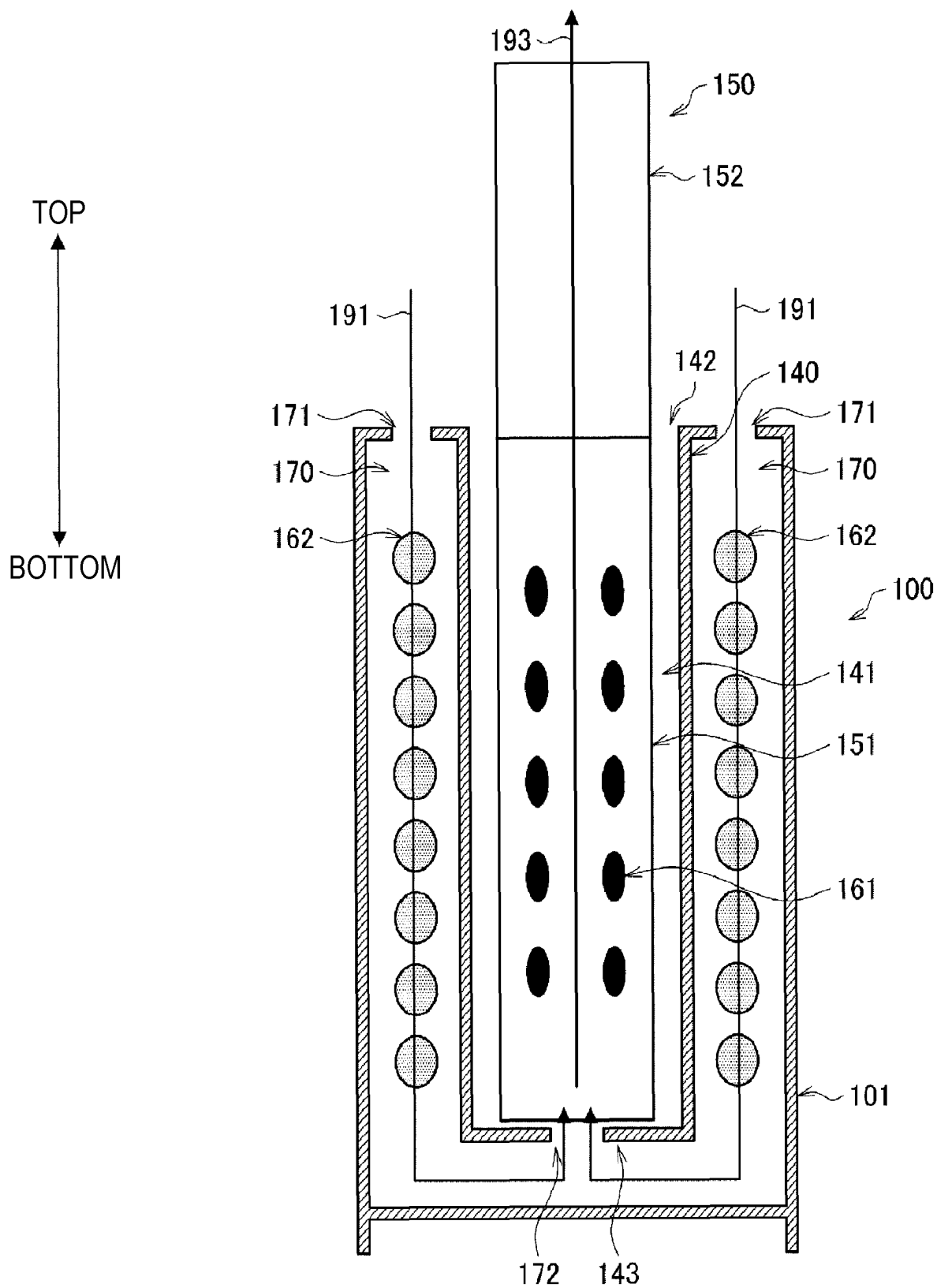


FIG. 3

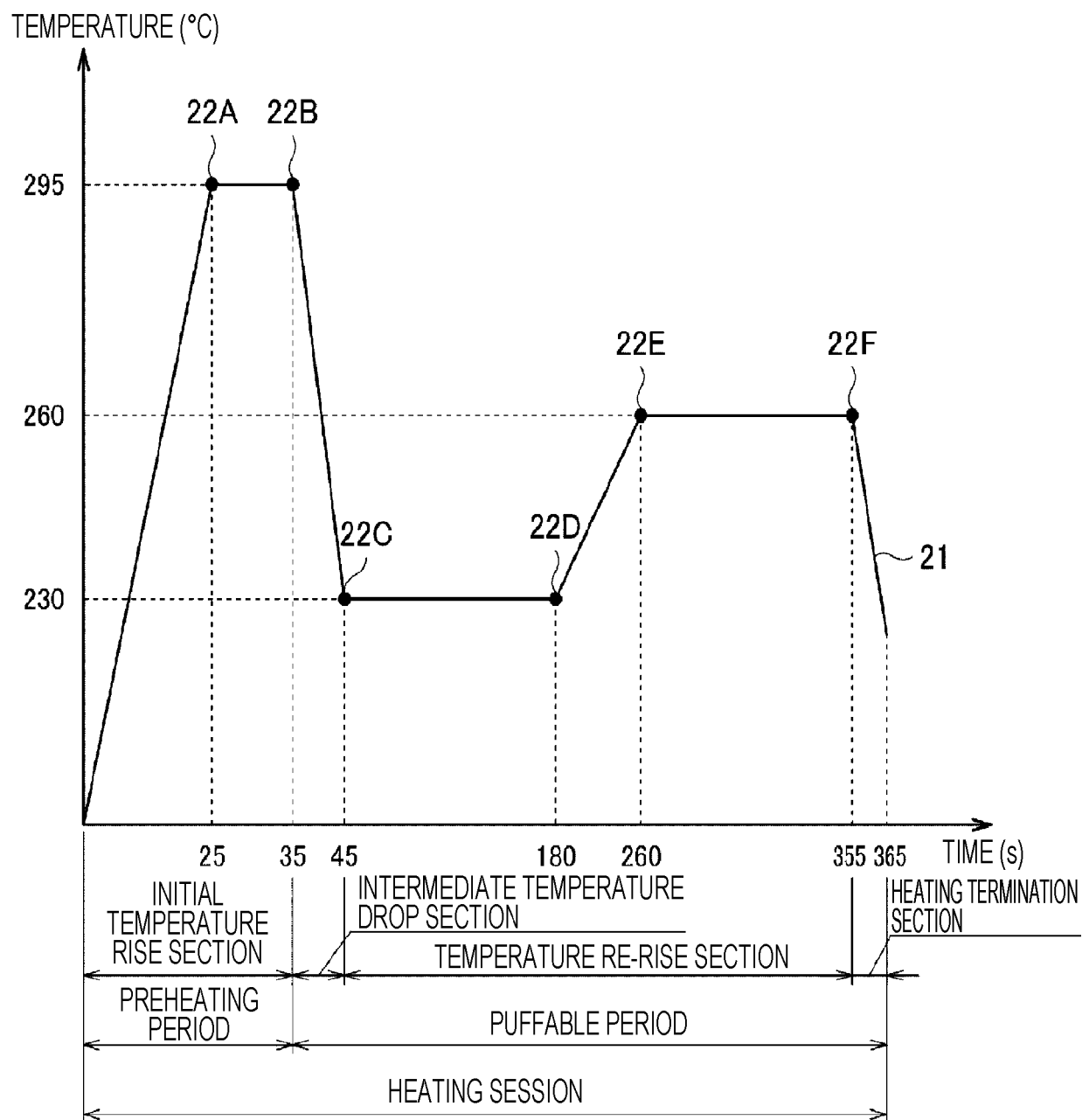


FIG. 4

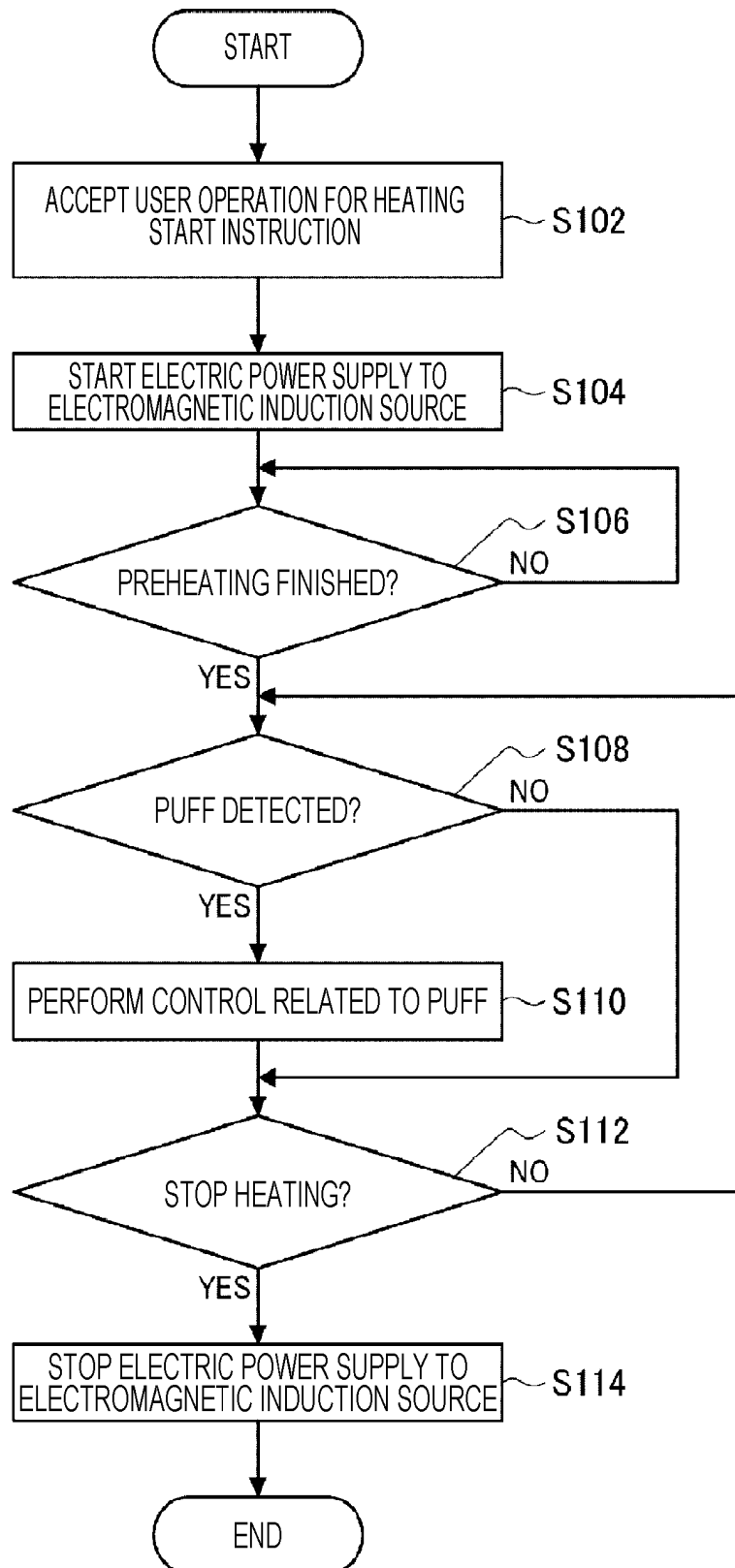


FIG. 5

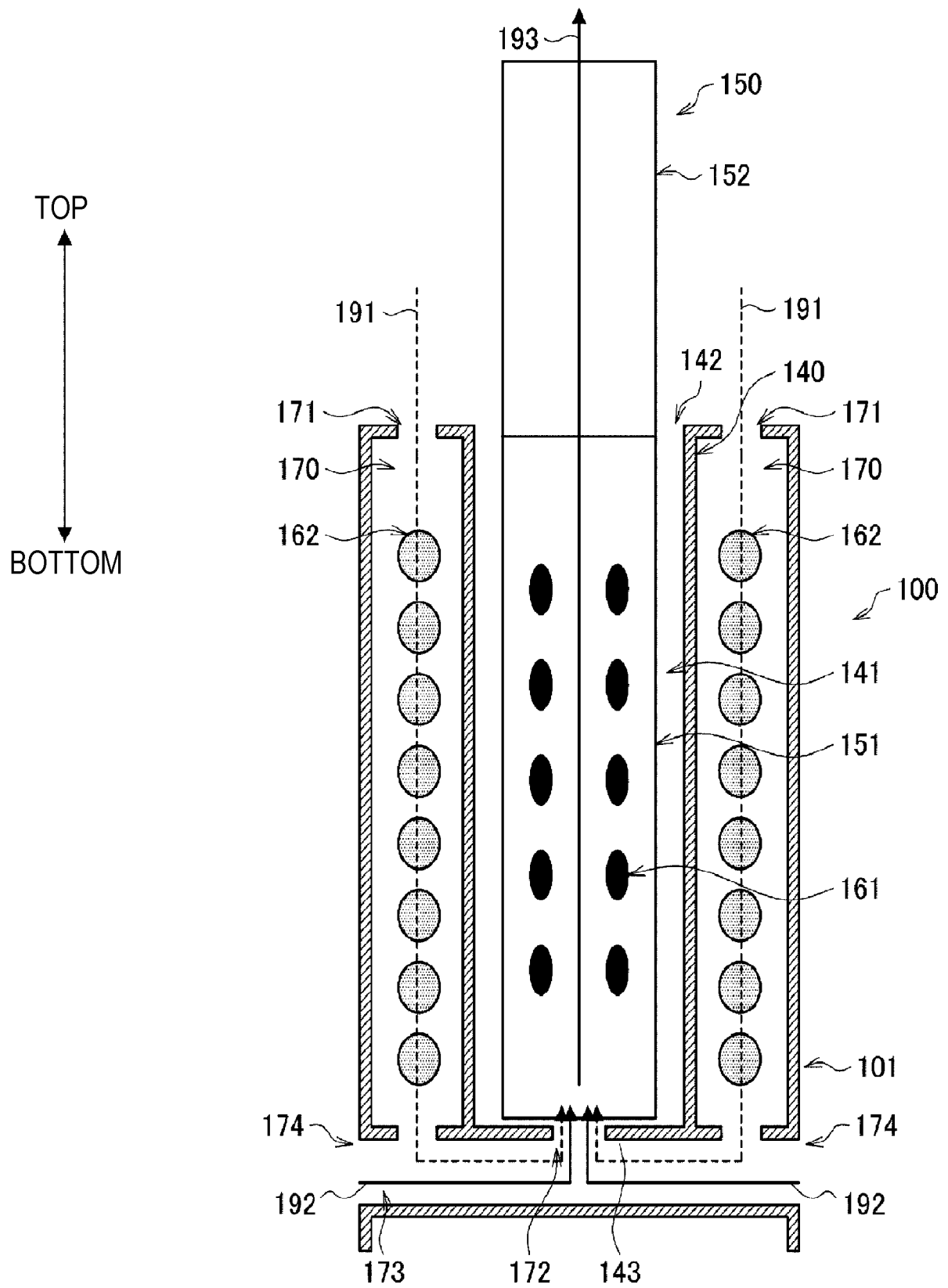


FIG. 6

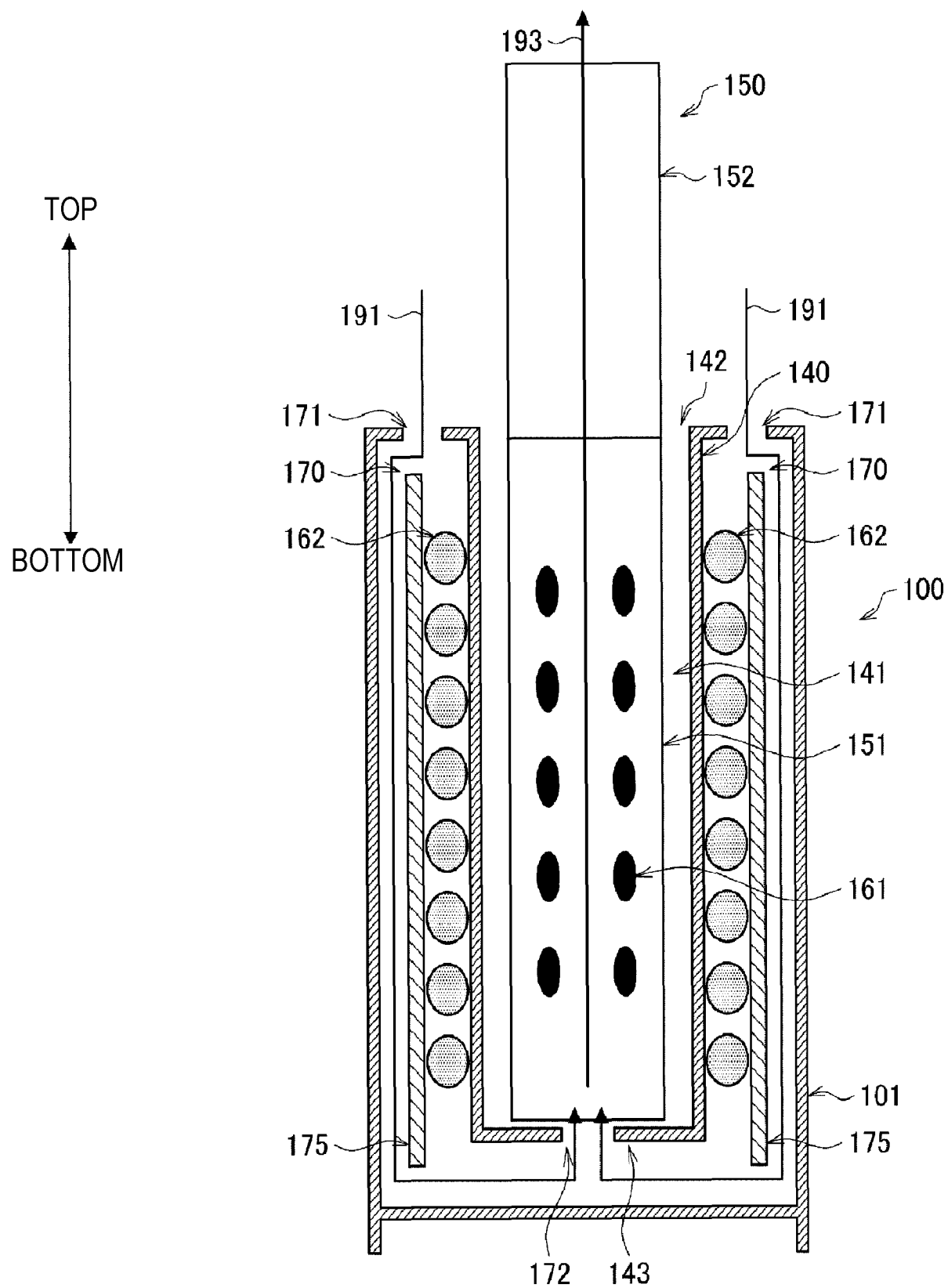


FIG. 7

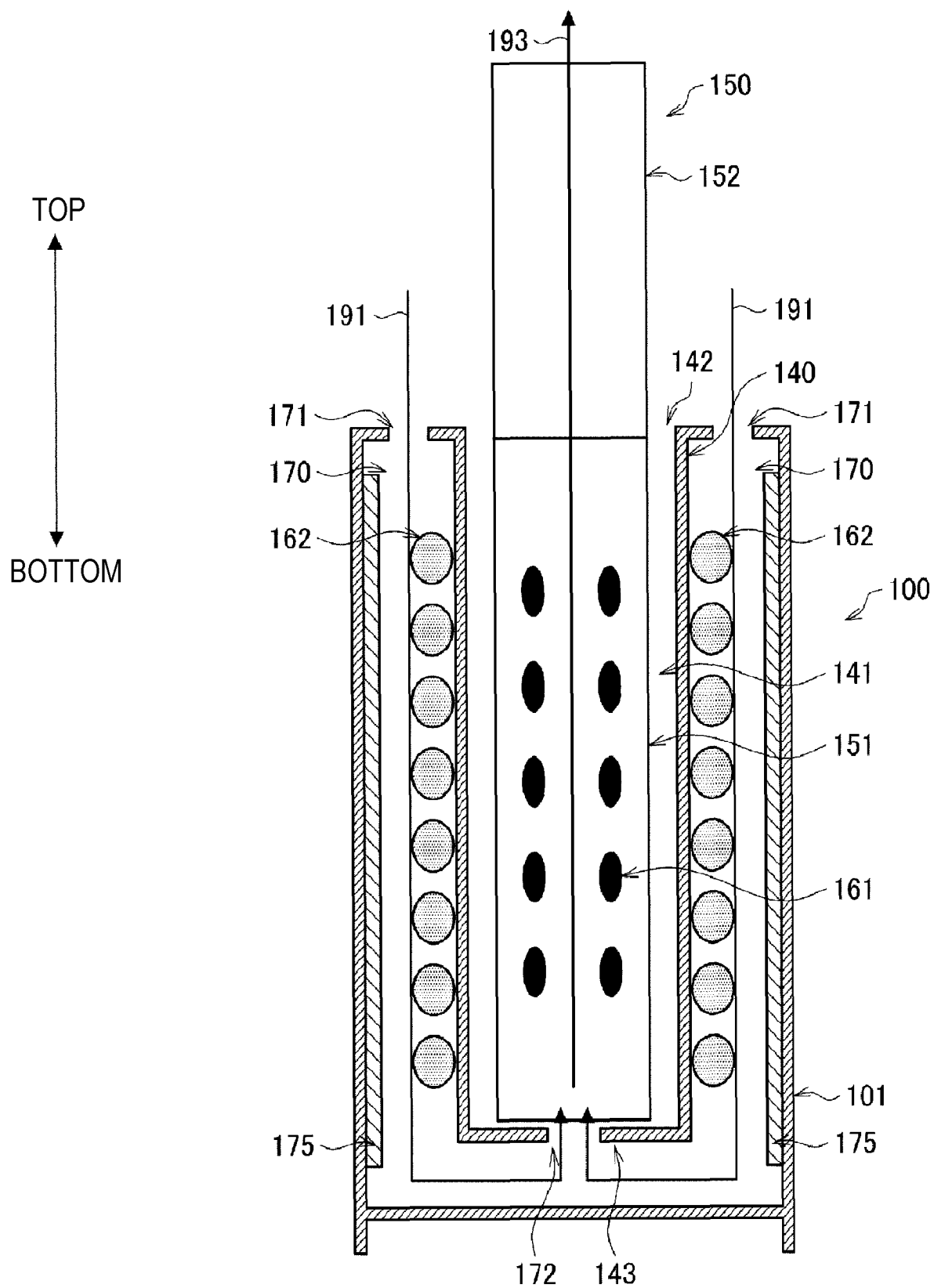


FIG. 8

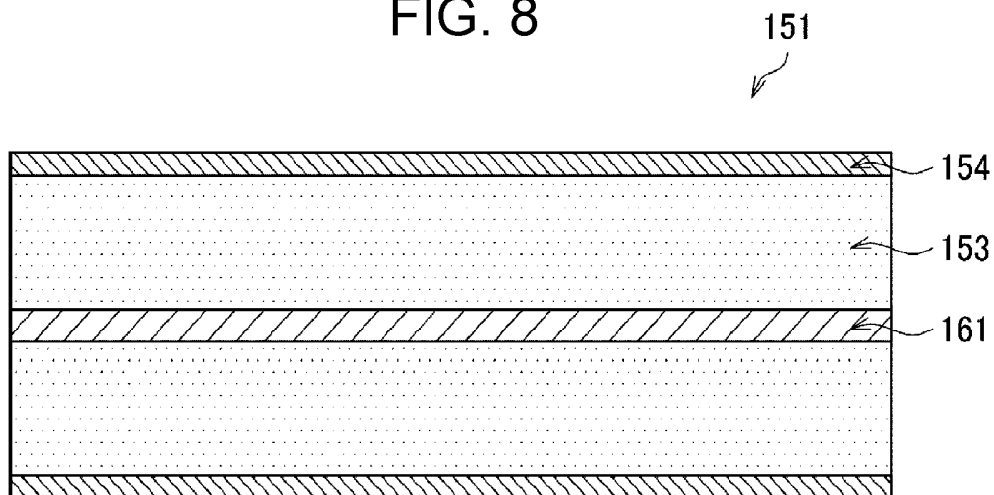


FIG. 9

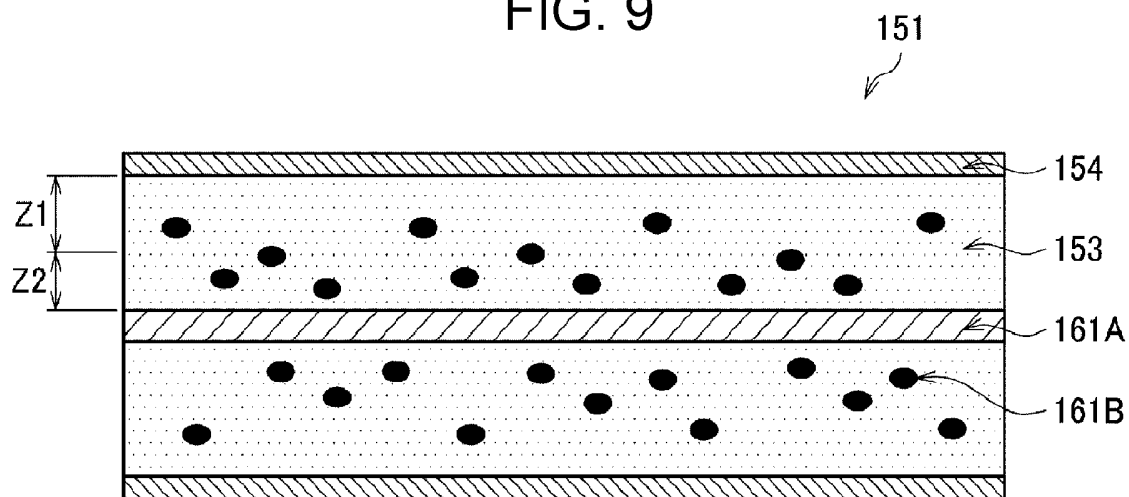
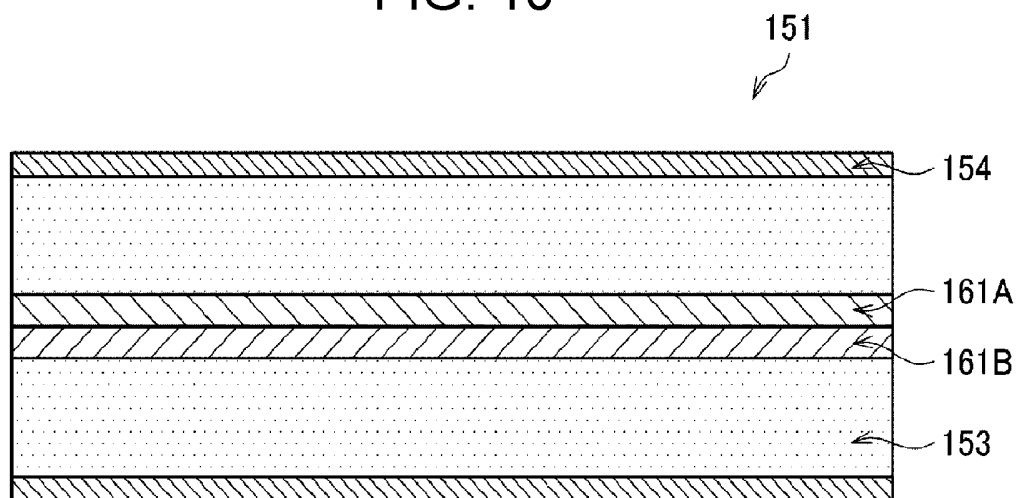


FIG. 10



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2021/006145

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 Y A	CN 104095291 A (CHINA TOBACCO CHUANYU INDUSTRIAL CO., LTD.) 15 October 2014 (2014-10-15) paragraphs [0040]-[0050], fig. 1-3	1, 6, 20 2-5, 9-19 7-8
Y	JP 2020-505011 A (BRITISH AMERICAN TOBACCO (INVESTMENTS) LIMITED) 20 February 2020 (2020-02-20) paragraphs [0081]-[0082], [0094], fig. 7-8	2-5, 9-19
Y	JP 2020-532977 A (BRITISH AMERICAN TOBACCO (INVESTMENTS) LIMITED) 19 November 2020 (2020-11-19) paragraphs [0045], [0058], fig. 1	9-18



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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“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

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“&” document member of the same patent family

Date of the actual completion of the international search

07 April 2021 (07.04.2021)

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

Information on patent family members

International application No.

PCT/JP2021/006145

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CN 104095291 A	15 Oct. 2014	(Family: none)	
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		paragraphs [0083]-[0085], [0108], fig. 7-8	
		WO 2018/138072 A1	
		EP 3574710 A1	
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JP 2020-532977 A	19 Nov. 2020	WO 2019/053268 A1	
		page 10, lines 22-32,	
		page 13, lines 29-33,	
		fig. 1	
		KR 10-2020-0044022 A	
		CN 111093408 A	

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

REFERENCES CITED IN THE DESCRIPTION

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- JP 6623175 B [0004]