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(54) DEVICE AND METHOD FOR COOKING AT CONSTANT TEMPERATURE IN OVEN BY USING CONVECTION HEAT

(57) An apparatus and method for cooking at a constant temperature in an oven including performing a temperature raising operation of operating at least one of at least one heater and at least one circulation fan until a temperature of a preset ratio of a set temperature is reached, continuing the operating at the set temperature for a preset period, and setting an operation level by considering a temperature of the oven at an end of a current period and a temperature of the oven at a start of the current period. The method includes performing a temperature maintaining operation of operating at least one of the at least one heater and the at least one circulation fan for one period according to the set operation level, and repeating the setting of the operation level and the temperature maintaining operation until cooking is completed.

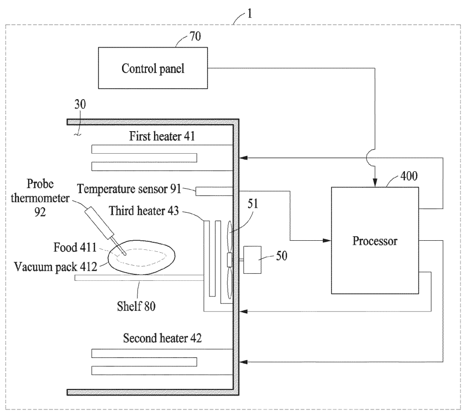

FIG. 4

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Description

BACKGROUND

1. Field

[0001] The disclosure relates to a technology for controlling a heater in an oven.

2. Description of Related Art

[0002] Sous vide recipes, which have recently become popular, involve vacuum sealing a plastic bag containing ingredients, and putting the plastic bag in water heated to an appropriate temperature (50 to 70 degrees) for enough time to cook the ingredients.

[0003] However, sous vide recipes use water, and putting water into a container and throwing the water away each time sous vide cooking is performed may be inconvenient, and it may be necessary to use a separate sous vide machine only for sous vide cooking.

[0004] In the case of an oven, an operating period of a heater corresponding to a heat source may be variable, and the temperature in a cooking chamber may fluctuate greatly. Therefore, it may be difficult to perform sous vide cooking in a conventional oven.

SUMMARY

[0005] According to one embodiment, a method of cooking at a constant temperature in an oven includes: performing a temperature raising operation of operating at least one of at least one heater and at least one circulation fan until a temperature of a preset ratio of a set temperature is reached; continuing the operating of the at least one of the at least one heater and the at least one circulation fan at the set temperature for a preset period; setting an operation level of the at least one of the at least one heater and the at least one circulation fan by considering a temperature of the oven at an end of the current period, and a temperature of the oven at a start of the current period; performing a temperature maintaining operation of operating at least one of the at least one heater and the at least one circulation fan for one period according to the operation level set in the setting; and repeating the setting of the operation level and the temperature maintaining operation until cooking is completed.

[0006] According to one embodiment, a method of cooking at a constant temperature in an oven includes: setting a first set temperature determined by multiplying a set temperature by a preset first ratio, and a second set temperature determined by multiplying the set temperature by a preset second ratio; operating, at least one heater and at least one circulation fan by units of time of a preset first period until the first set temperature is reached, in a preset first combination and in a preset first order for a preset time allocated for each preset first combination. The method includes operating, the at least one heater and the at least one circulation fan by units of time of a preset second period until the second set temperature is reached, in a preset second combination and in a preset second order for a preset time allocated for each preset second combination; continuing the operating at least one of the at least one heater and the at least one circulation fan at the set temperature for a preset third period; setting an operation level of the at least one of the at least one heater and the at least one circulation fan by considering a temperature of the oven at an end of a current third period, and a temperature of the oven at a start of the current third period; performing a temperature maintaining operation of operating at least one of the at least one heater and the at least one circulation fan for one third period according to the set operation level set in the setting; and repeating the setting of the operation level and the temperature maintaining operation until cooking is completed.

[0007] According to one embodiment, an oven for cooking at a constant temperature using convection heat includes: a temperature sensor configured to measure a temperature in a cooking chamber; a first heater on an upper surface of the cooking chamber and configured to generate heat; a second heater on a lower surface of the cooking chamber and configured to generate heat; a third heater on a rear wall side of the cooking chamber and configured to generate heat; a circulation fan disposed around the third heater and configured to spread the heat generated by the at least one heater among the first heater, the second heater and the third heater to the cooking chamber to generate convective heat. The oven includes a control panel configured to receive a set temperature selected by a user; and a processor configured to perform a temperature raising operation of operating at least one of at least one heater and at least one circulation fan until a temperature of a preset ratio of a set temperature is reached, continue the operating of at least one of the at least one heater and the at least one circulation fan at the set temperature for a preset period, set an operation level of the at least one of the at least one heater and the at least one circulation fan by considering a temperature of the oven at an end of a current period, and a temperature of the oven at a start of the current period, until cooking is completed, and perform a temperature maintaining operation of operating at least one of the at least one heater and the at least one circulation fan for one period according to the operation level set in the setting.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The above and other aspects, features, and advantages of certain embodiments of the present disclosure will be more apparent from the following detailed description, taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a perspective view of an oven according to one embodiment;
FIG. 2 is a diagram illustrating a state in which a door of an oven is open according to one embodiment;
FIG. 3 is a cross-sectional side view of an oven according to one embodiment;
FIG. 4 is a diagram illustrating a schematic configuration of an oven for cooking at a constant temperature using convection heat according to one embodiment;
FIG. 5A is a diagram illustrating an example in which an oven includes three heaters and one circulation fan according to one embodiment;
FIG. 5B is a diagram illustrating an example in which an oven includes two heaters and one circulation fan according to one embodiment;
FIG. 5C is a diagram illustrating an example in which an oven includes one heater and one circulation fan according to one embodiment;
FIG. 6 is a flowchart illustrating an example of cooking at a constant temperature using convection heat in an oven according to one embodiment;
FIG. 7 is a flowchart illustrating another example of cooking at a constant temperature using convection heat in an oven according to one embodiment;
FIG. 8 is a flowchart illustrating a process of setting an operation level in an oven according to one embodiment; and
FIG. 9 is a flowchart illustrating a process of operating a heater in an oven by units of time of 1 second when an operation time of the heater according to an operation level exceeds a heating reference value according to one embodiment.

DETAILED DESCRIPTION

[0009] Hereinafter, embodiments will be described in detail with reference to the accompanying drawings. However, various alterations and modifications may be made to the embodiments. Here, the embodiments are not meant to be limited by the descriptions of the present disclosure. The embodiments should be understood to include all changes, equivalents, and replacements within the idea and the technical scope of the disclosure.

[0010] The terminology used herein is for the purpose of describing particular embodiments only and is not to be limiting of the embodiments. The singular forms "a", "an", and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises/comprising" and/or "includes/including" when used herein, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components and/or groups thereof.

[0011] Unless otherwise defined, all terms including technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which examples belong. It will be further understood that terms, such as those defined in commonly-used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

[0012] When describing the examples with reference to the accompanying drawings, like reference numerals refer to like constituent elements and a repeated description related thereto will be omitted. In the description of the embodiments, a detailed description of well-known related structures or functions will be omitted when it is deemed that such description will cause ambiguous interpretation of the present disclosure.

[0013] Also, in the description of the components, terms such as first, second, A, B, (a), (b) or the like may be used herein when describing components of the present disclosure. These terms are used only for the purpose of discriminating one constituent element from another constituent element, and the nature, the sequences, or the orders of the constituent elements are not limited by the terms. When one constituent element is described as being "connected", "coupled", or "attached" to another constituent element, it should be understood that one constituent element can be connected or attached directly to another constituent element, and an intervening constituent element can also be "connected", "coupled", or "attached" to the constituent elements.

[0014] The same name may be used to describe an element included in the examples described above and an element having a common function. Unless otherwise mentioned, the descriptions of the embodiments may be applicable to the following embodiments and thus, duplicated descriptions will be omitted for conciseness.

[0015] Embodiments of the disclosure may provide an oven with a water tank able to perform traditional sous vide cooking having at least one heater that may be controlled to keep the temperature in the cooking chamber constant.

[0016] Hereinafter, an apparatus and method for cooking at a constant temperature using convection heat in an oven according to one embodiment will be described in detail with reference to FIGS. 1 to 9.

[0017] FIG. 1 is a perspective view of an oven according to one embodiment. FIG. 2 is a diagram illustrating a state in which a door of an oven is open according to one embodiment. FIG. 3 is a cross-sectional side view of an oven according to one embodiment.

[0018] Referring to FIGS. 1 to 3, an oven 1 may include a main body 10 forming the overall exterior of the oven 1, a cooking chamber 30 provided inside the main body 10 and opened to one side of the main body 10, and a door 20 forming the overall exterior of the oven 1 together with the main body 10 and that opens and closes the cooking chamber 30 on one side of the main body 10.

[0019] The main body 10 may have a hexahedral shape. The main body 10 may include a front panel 11 disposed toward a first direction (e.g., a +x direction in FIGS. 1 to 3) of the main body 10, and an upper panel 13 disposed toward a second direction (e.g., a +z direction in FIGS. 1 to 3) of the main body 10, a side panel 12 disposed toward a third direction (e.g., a +y direction in FIGS. 1 to 3) of the main body 10), and a rear panel disposed on an opposite side of the front panel 11.

[0020] For example, the oven 1 may be a built-in or a closet-type, and installed such that the side panel 12 and the rear panel may not be exposed to a user in a normal use environment. In this example, the side panel 12 and the rear panel may be designed to be thermally efficient, and external accessories (not shown) or garnish (not shown) for preventing the side panel 12 and the rear panel from being exposed to the user may not be placed on the side panel 12 or the rear panel.

[0021] A suction hole 14 through which air may pass may be formed in the front panel 11 and the side panel 12. The suction hole 14 allows an electric chamber 60, which may be disposed between the cooking chamber 30 and the upper panel 13, to be in gas communication with the outside. This configuration is for cooling electrical equipment that may be disposed in the electric chamber 60. The electric chamber 60 will be described later.

[0022] The cooking chamber 30 may be provided inside the main body 10, and may have a hexahedral shape in which a front surface in the first direction (e.g., the +x direction in FIGS. 1 to 3) is open towards an opening 31. Through the opening 31 of the cooking chamber 30, a user may place food in the cooking chamber 30 and take out food from the cooking chamber 30 before or after cooking is finished.

[0023] A first heater 41 for supplying heat to food may be disposed in the second direction (e.g., the +z direction in FIGS. 1 to 3) of the cooking chamber 30.

[0024] A second heater 42 for supplying heat to the food may be disposed in a direction opposite (e.g., a -z direction in FIGS. 1 to 3) to the second direction (e.g., the +z direction in FIGS. 1 to 3) of the cooking chamber 30.

[0025] A third heater 43 for supplying heat to the food in the cooking chamber 30 may be disposed in a direction opposite (e.g., the -x direction in FIGS. 1 to 3) to the first direction (e.g., the +x direction in FIGS. 1 to 3) of the cooking chamber 30, and a circulation fan 51 for forcibly flowing heat supplied by heaters 41, 42, and 43 and a circulation motor 50 for operating the circulation fan 51 may be disposed around the third heater 43.

[0026] The first heater 41 may be a broil heater for grilling food over a fire or on a grill, and the second heater 42 may be a bake heater for baking bread or meat, or the like, without directly putting the bread or meat on fire, and the third heater 43 may be a convection heater for transferring heat by convection. The first heater 41, the second heater 42, and the third heater 43, in this order, may consume a lot of power and emit a lot of heat.

[0027] A temperature sensor 91 for measuring a temperature of the cooking chamber 30 may be disposed in a direction opposite (e.g., the -x direction in FIGS. 1 to 3) to the first direction (e.g., the +x direction in FIGS. 1 to 3) of the cooking chamber 30. The position of the temperature sensor 91 is not limited to a direction opposite (e.g., the -x direction in FIGS. 1 to 3) to the first direction (e.g., the +x direction in FIGS. 1 to 3) of the cooking chamber 30, and may be disposed in any position within the cooking chamber 30 where the temperature of the cooking chamber 30 may be measured.

[0028] As described above, the heaters 41, 42, and 43 may be an electric heater using heat generated when a current flows through an obj ect having resistance, or a gas heater that supplies heat to food by burning gas. The heaters 41, 42, and 43 of the oven 1 are not limited to the above-described electric heater or gas heater and may be various kinds of heaters.

[0029] For example, when the heaters 41, 42, and 43 are electric heaters, a plurality of heating wires may be arranged. In addition, the heating wires that may be included in the heaters 41, 42, and 43 may be disposed in the cooking chamber 30 in a concentric circle shape, or may be disposed in the cooking chamber 30 in a rectangular shape.

[0030] The positions of the heaters 41, 42, and 43 may be in positions other than those illustrated in the drawings depending on the design. For example, the heaters 41, 42, and 43 may be positioned on an inner side surface of the cooking chamber 30 in the third direction (e.g., the +y direction in FIGS. 1 to 3) and/or on an inner side surface of the cooking chamber 30 opposite to the third direction (e.g., the +y direction in FIGS. 1 to 3).

[0031] Each of the heaters 41, 42, and 43 may be individually controlled and may generate heat separately.

[0032] The circulation fan 51 for forcibly flowing the heat supplied to the cooking chamber 30 and the circulation motor 50 for operating the circulation fan 51 may be disposed in a direction opposite (e.g., the -x direction in FIGS. 1 to 3) to the first direction (e.g., the +x direction in FIGS. 1 to 3) of the cooking chamber 30.

[0033] For example, when the circulation fan 51 is not being operated, only a portion close to the heaters 41, 42, and 43 of the food disposed inside the cooking chamber 30 may be intensively heated, but when a circulation device including the circulation fan 51 and the circulation motor 50 are being operated, of the food in its entirety may be heated by the circulation device including the circulation fan 51 and the circulation motor 50 by the heat being forcibly flowed in the cooking chamber 30.

[0034] A fan cover 32 dividing a space where the food is positioned in the cooking chamber 30 and a space where the circulation fan 51 is positioned may be disposed in the first direction (e.g., the +x direction in FIGS. 1 to 3) of the circulation fan 51. The fan cover 32 may prevent food from directly contacting the circulation fan 51 and/or the circulation motor 50.

[0035] For example, the circulation fan 51 and/or the circulation motor 50 may include electrical accessories such as wiring for receiving power. When such electrical accessories are exposed to moisture in the food, the circulation fan 51 and/or the circulation motor 50 may fail due to, for example, a short circuit, so the fan cover 32 may be disposed to prevent moisture or the like from entering.

[0036] Also, for example, when food comes into contact with a rotating blade of the circulation fan 51, the food may be crushed due to a rotational force of the blade and the inside of the cooking chamber 30 may be contaminated, and thus the fan cover 32 may be disposed for maintaining oven 1 and keeping oven 1 clean.

[0037] A through hole 33 may be formed in the fan cover 32 so that air impelled by the circulation fan 51 may be introduced into the cooking chamber 30. The through hole 33 may include, for example, a plurality of holes, and each hole may be a curved slit.

[0038] A slider for dividing upper and lower spaces of the cooking chamber 30 may be inserted into the cooking chamber 30 so that the space of the cooking chamber 30 may be used more efficiently. A structure (e.g., a slit or a groove) into which a slider may be inserted may be formed on a sidewall of the cooking chamber 30 in the third direction (e.g., the +y direction in FIGS. 1 to 3) and on a sidewall of the cooking chamber 30 in an opposite direction of the third direction (e.g., the +y direction in FIGS. 1 to 3). There may be a plurality of such sliders. Accordingly, the cooking chamber 30 may be divided into two or more spaces. The slider may be made of a heat insulating material to make the temperatures between the divided cooking chambers 30 different. A through hole or a through portion may be formed in the slider so that the spaces divided by the slider may be in fluid communication with each other. For example, a length of the slider in the first direction may be shorter than a length of an inner space of the cooking chamber 30 in the first direction. In this case, an open area may be formed so that the spaces divided when the slider is completely inserted into the inside of the cooking chamber 30 may be in fluid communication with each other.

[0039] In addition to the above-mentioned slider, a divider that may divide a space of the cooking chamber 30 into left and right may be disposed in the cooking chamber 30. For example, the space divided into left and right by the divider may be individually heated by a plurality of sub-heaters (not shown).

[0040] A shelf 80 on which food to be cooked is to be placed may be provided in the cooking chamber 30, and guide rails 81 for detachably supporting the shelf 80 may be provided on both side walls of the cooking chamber 30. The shelf 80 may be in a form of a grill that may evenly transfer heat to a bottom surface of a food 411.

[0041] The door 20 may be hinged to a lower portion of the main body 10 to rotate with respect to the main body 10. The opening 31 of the cooking chamber 30 may be opened and closed by the door 20 by rotating the door 20 around the hinge axis. A door handle 21 formed in a direction away from the cooking chamber 30 may be disposed at an end portion of the door 20 in the second direction (e.g., the +z direction in FIGS. 1 to 3). The door handle 21 may be formed to be elongated in the third direction (e.g., the +y direction in FIGS. 1 to 3), and a user may hold a prismatic gripper or a cylindrical gripper of the door handle 21 to open and close the door 20.

[0042] The door 20 may be hinged to an end portion of the opening 31 of the cooking chamber 30 in the third direction (e.g., the +y direction in FIGS. 1 to 3) or the opposite end thereof. In this case, the door 20 may be opened and closed by rotating the door 20, the rotation based on the z-axis with respect to the main body 10.

[0043] A door duct 22 may be provided at an upper portion of the door 20, and the door duct 22 may include a discharge hole 23 for discharging high-temperature air inside the door 20 to the outside of the door 20.

[0044] An air inlet 25 for sucking external air into the door 20 may be provided at a lower portion of the door 20.

[0045] The door 20 may include a transparent member (e.g., plastic, tempered glass, and the like) (not shown) and a support frame (not shown) for supporting the transparent member. For example, the door 20 may include a support frame having a through portion formed in the center of a surface of the support frame, and tempered glass attached to the support frame, and a user may visually observe a cooking state of the food inside the cooking chamber 30 through the transparent tempered glass and the through portion of the support frame. Also, the door 20 may be designed without, for example, a transparent member through which the inside may be observed in order to reduce the heat of the cooking chamber 30 from being emitted to the outside. In this case, the oven 1 may display the cooking state of the food inside the cooking chamber 30 to the user on a display, and may include an observation medium (e.g., a camera, and the like) inside the cooking chamber to collect information for display.

[0046] As described above, the electric chamber 60 may be disposed between the cooking chamber 30 and the upper panel 13. The electric chamber 60 may accommodate electrical equipment capable of controlling various parts that may be provided in the oven. For example, the electrical equipment may include a printed circuit board (PCB), a microprocessor, and the like.

[0047] Since the electrical equipment disposed in the electric chamber 60 may be sensitive to temperature change, it may be preferable that the electric chamber 60 is not heated, unlike the cooking chamber 30. For example, the temperature of the cooking chamber 30 of the oven may be increased to 150 to 450 degrees Celsius, and due to a temperature difference between the high temperature of the cooking chamber 30 and the temperature of the electric chamber 60 that is not directly heated, heat transfer may occur. To prevent this, the oven 1 may be provided with a heat insulating medium for reducing an amount of heat transferred from the heater 40 and/or a cooling medium for cooling the electrical equipment.

[0048] For example, an insulator (not shown) for preventing heat generated from the heater 40 may be provided between the electric chamber 60 and the cooking chamber 30. The insulator (not shown) may completely cover the outside of the cooking chamber 30 to prevent heat supplied to the cooking chamber 30 from being transferred to the outside of the cooking chamber 30.

[0049] Also, for example, a cooling fan 61 may be provided in the electric chamber 60 as a cooling medium. The rotation of the cooling fan 61 may circulate the air inside the electric chamber 60, thereby cooling the electrical equipment. In this case, as described above, air may be sucked through the suction hole 14 formed in the side panel 12, and the sucked air being a flow generated by the rotation of the cooling fan 61 may cool the electrical equipment.

[0050] A control panel 70 may be disposed in the first direction (e.g., the +x direction in FIGS. 1 to 3) of the electric chamber 60 or may be disposed in the second direction (e.g., the +z direction in FIGS. 1 to 3) of the door 20.

[0051] For example, the control panel 70 may include a display module capable of displaying operation information of the oven 1 and receiving operation commands through user interaction via a touch screen, and the like. For example, the display module may display a power state of the oven, an opening and closing state of the door 20, an operation state of the heater 40, the circulation fan 51 and/or the cooling fan 61, a temperature of the cooking chamber 30, and/or a temperature of each compartment of the cooking chamber 30, and a user may input an operation command related to, for example, a target temperature and a heating time inside the cooking chamber 30, via the display module.

[0052] In one embodiment, a manipulatable portion provided separately from the touch screen may be positioned on one side of the display module. For example, the manipulatable portion may be provided in various forms known in the art, such as a rotatable dial knob, a click switch, or a slider.

[0053] FIG. 4 is a diagram illustrating a schematic configuration of an oven for cooking at a constant temperature using convection heat according to one embodiment.

[0054] Referring to FIG. 4, the main components of the oven 1 may include the first heater 41, the second heater 42, the third heater 43, the temperature sensor 91, the circulation fan 51, the control panel 70, and a processor 400.

[0055] The control panel 70 may be a device that provides an interface with a user, and may receive information input by a user such as a mode (e.g., a sous vide mode, and the like) selected by the user, a set temperature selected by the user, and a cooking time selected by the user. That is, the control panel 70 may receive the set temperature and the cooking time information selected by the user in the sous vide mode.

[0056] The temperature sensor 91 may measure and provide a temperature of the cooking chamber 30 to the processor 400.

[0057] The processor 400 may perform a temperature raising operation of operating at least one of at least one heater 41, 42, and 43 and the circulation fan 51 until a temperature of a preset ratio of a set temperature is reached, operating at least one of the at least one heater 41, 42, and 43 and the circulation fan 51 at an operation level corresponding to the set temperature for a preset period, setting an operation level by considering a current period temperature, which is a temperature of the oven 1 at an end of a current period, and a previous period temperature, which is a temperature of the oven 1 at a start of the current period, until cooking is finished, and a temperature maintaining operation of operating at least one of the at least one heater 41, 42, and 43 and the circulation fan 51 for one period according to the set operation level. Here, the preset period may be, for example, 60 seconds.

[0058] The operation level may correspond to and be the same as the set temperature. For example, when the set temperature is 100 degrees Fahrenheit, the operation level corresponding to the set temperature, which may be the initial operation level, may be level 100, and when the set temperature is 150 degrees Fahrenheit, the operation level corresponding to the set temperature may be level 150.

[0059] In addition, an operation of the operation level may be confirmed through a reference operation level.

[0060] Operating at the reference operation level may comprise operating the at least one heater 41, 42, and 43 and the circulation fan 51 in a preset combination and in a preset order for a preset time allocated for each preset combination, in one period.

[0061] The operation level is the same as the reference operation level in that the at least one heater 41, 42, and 43 and the circulation fan 51 are operated in a preset combination and in a preset order, and only differs from the reference operation level in terms of the preset time allocated for each preset combination.

[0062] The preset time allocated for each preset combination of the operation level may be determined by multiplying the preset time allocated for each preset combination of the reference operation level by a ratio determined by dividing the operation level by the reference operation level. That is, the preset time allocated for each preset combination of the operation level may be determined by, the time allocated for each combination of the reference operation level * (operation level/reference operation level).

[0063] For example, when the oven 1 comprises three heaters 41, 42, and 43 and one circulation fan 51, an example of the reference operation level may be 100 corresponding to 100 degrees Fahrenheit, and an example of operating in a preset combination and in a preset order for a preset time allocated for each preset combination may be "Combination B (3.0 seconds) -> Combination A (0.4 seconds) -> Combination C (1.2 seconds) -> Combination E (remaining time of period)". Combination A, Combination B, Combination C, and Combination E may be as shown in Table 1 below.

[Table 1]

Combination number	Combination of heater and circulation fan
A	first heater 41 + circulation fan 51
B	second heater 42 + circulation fan 51
C	third heater 43 + circulation fan 51
D	second heater 42 + third heater 43 + circulation fan 51
E	circulation fan 51

[0064] When the set temperature is 50 degrees Fahrenheit at reference operation level 100 as described above, operation level 50 may be "Combination B (1.5 sec) -> Combination A (0.2 seconds) -> Combination C (0.6 seconds) -> Combination E (remaining times of period)", and operation level 200 may be "Combination B (6.0 seconds) -> Combination A (0.8 seconds) -> Combination C (2.4 seconds) -> Combination E (remaining time of period)".

[0065] When the operation level is set, the processor 400 may calculate the operation level via Equation 1 below.

[Equation 1]

$$\text{Next Level} = \text{Current Level} - K1*P - K2*D$$

[0066] Here, Next Level may be the operation level of the next period, Current Level may be the operation level of the current period, K1 may be a preset proportional coefficient, K2 may be a preset differential coefficient, P may be a value determined by subtracting a set temperature from a current period temperature, and D may be a value determined by subtracting a previous period temperature from a current period temperature. Here, K1 may be preset to 1.5 and K2 may be preset to 15.

[0067] In Equation 1, K1*P may correspond to a proportional control of a proportional integral derivative (PID) control, a component to check how far out of the set temperature the current temperature is and to compensate for this, and K2*D may correspond to a derivative control in a PID control, a component to reduce a rate of change of temperature.

[0068] When the operation level is set, the processor 400 may set the operation level to an off level for turning off all of the at least one heater 41, 42, and 43 when the current period temperature exceeds an upper limit reference value of the set temperature. In this case, the upper limit reference value may be 15. And, the upper limit reference value of the set temperature may be determined by adding the upper limit reference value to the set temperature. When the set temperature is 100 degrees Fahrenheit and the upper limit reference value is 15, the upper limit reference value of the set temperature may be 115 degrees Fahrenheit. In the off level, the processor 400 may turn off all of the heaters 41, 42, and 43 and operate only the circulation fan 51.

[0069] When the operation level is set, the processor 400 may set the operation level to a highest operation level when the current period temperature is less than a lower limit reference value of the set temperature. In this case, the highest operation level may be, for example, level 400.

[0070] When the operation level is set, the processor 400 may set the operation level to the highest operation level in response to calculating the operation level and the calculated operation level exceeding a preset highest operation level.

[0071] When the operation level is set, the processor 400 may set the operation level to a lowest operation level in response to calculating the operation level and the calculated operation level being less than a preset lowest operation level. In this case, the lowest operation level may be, for example, level 25.

[0072] When the temperature maintaining operation is performed, the processor 400 may calculate an operation time value by adding a time allocated to the at least one heater 41, 42, and 43 according to the operation level and a time stored in a buffer corresponding to the at least one heater. And, when the operation time value is less than a preset heating reference value, the corresponding heater may not be operated in the current period, and the operation time value may be stored in the buffer corresponding to the corresponding heater, and when the operation time value is greater than or equal to a preset heating reference value, the corresponding heater may be operated by units of seconds of the operation time value in the current period, and the remaining time may be stored in the buffer corresponding to the corresponding heater. In this case, the heating reference value may be, for example, 2 seconds. In addition, when the time allocated to the heater does not exceed the heating reference value, collecting and processing until the heating reference value is exceeded may correspond to integral control in the PID control.

[0073] When the temperature raising operation is performed as one operation, the processor 400 may set a first set temperature determined by multiplying the set temperature by a preset first ratio, and operate at least one heater 41, 42, and 43 and the circulation fan 51, by units of time of a preset first period, in a preset first combination and in a preset first order for a preset time allocated for each preset first combination until the first set temperature is reached. In this case, the preset first ratio may be 90%. In addition, the set temperature may be a temperature between 100 degrees Fahrenheit and 205 degrees Fahrenheit.

[0074] In this case, the preset time allocated for each preset first combination in the first order preset by the preset first combination may be, for example, Combination A (15 seconds) -> Combination D (8 seconds) -> Combination E (47 seconds), and the first period may be 70 seconds. Combination A, Combination D, and Combination E may be as shown in the above-mentioned Table 1.

[0075] On the other hand, when the temperature raising operation is performed as two operations, the processor 400 may set the first set temperature determined by multiplying the set temperature by the first preset ratio and a second set temperature determined by multiplying the set temperature by a preset second ratio, and operate at least one heater 41, 42, and 43 and the circulation fan 51, by units of time of the preset first period, in the preset first combination and in the preset first order for the preset time allocated for each preset first combination until the first set temperature is reached, and operate the at least one heater 41, 42, and 43 and the circulation fan 51, by units of time of a preset second period, in a preset second combination and in a preset second order for a preset time allocated for each preset second combination until the second set temperature is reached. In this case, the preset first ratio may be 70%, and the preset second ratio may be 95%.

[0076] In this case, the preset time allocated for each preset first combination in the first order preset by the preset first combination may be, for example, Combination A (15 seconds) -> Combination D (8 seconds) -> Combination E (47 seconds), and the first period may be 70 seconds. Combination A, Combination D, and Combination E may be as shown in the above-mentioned Table 1.

[0077] And, the preset time allocated for each preset second combination in the second order preset by the preset second combination may be, for example, Combination B (14 seconds) -> Combination A (4 seconds) -> Combination E (52 seconds), and the second period may be 70 seconds. Combination A, Combination B, and Combination E may be as shown in the above-mentioned Table 1.

[0078] In the above-described example, when Combination A (15 seconds) -> Combination D (8 seconds) -> Combination E (47 seconds) used until the first set temperature is reached and Combination B (14 seconds) -> Combination A (4 seconds) -> Combination E (52 seconds) used until the second set temperature is reached are compared, it may be confirmed that the temperature is raised faster by generating higher heat until the first set temperature is reached, and the second set temperature is set not to be exceeded by generating relatively low heat compared to when the temperature is raised to the first set temperature until the second set temperature is reached.

[0079] The processor 400 may sense a core temperature of the food 411, and may stop an operation of the at least one heater 41, 42, and 43 when the sensed core temperature of the food 411 reaches the set temperature, and notify that cooking is completed. The processor 400 may receive and sense the core temperature of the food 411 from a probe thermometer 92 inserted into the food 411.

[0080] The probe thermometer 92 may be connected to the oven 1 by wire or wirelessly and may provide a sensed temperature to the processor 400.

[0081] The food 411 cooked in the oven 1 may be preferably packaged in a vacuum pack 412. In addition, the shelf 80 supporting the food 411 may be provided with a structure (e.g., a mesh-net shape, a perforated plate shape, a net shape, a grill, and the like) that may easily receive heat generated from the second heater 42 without losing much heat.

[0082] Although the oven 1 is illustrated as including three heaters 41, 42, and 43 and one circulation fan 51 in FIGS. 1 to 4, the oven 1 is not limited to including three heaters 41, 42, and 43 and one circulation fan 51. The oven 1 may include a variable number of heaters as shown in FIGS. 5A, 5B, and 5C below.

[0083] FIG. 5A is a diagram illustrating an example in which an oven includes three heaters and one circulation fan according to one embodiment.

[0084] Referring to FIG. 5A, the oven 1 may include three heaters 41, 42, and 43 and one circulation fan 51 as shown in the examples of FIGS. 1 and 2. The first heater 41 may be installed on an upper surface of the cooking chamber 30, the second heater 42 may be installed on a lower surface of the cooking chamber 30, and the third heater 43 and the circulation fan 51, configured to heat a cooking space in the cooking chamber 30, may be installed on a rear wall side of the cooking chamber 30.

[0085] FIG. 5B is a diagram illustrating an example in which an oven includes two heaters and one circulation fan according to one embodiment.

[0086] Referring to FIG. 5B, the oven 1 may include two heaters 41 and 43 and one circulation fan 51. The first heater 41 may be installed on an upper surface of the cooking chamber 30, and the third heater 43 and the circulation fan 51, configured to heat a cooking space in the cooking chamber 30, may be installed on a rear wall side of the cooking chamber 30.

[0087] FIG. 5C is a diagram illustrating an example in which an oven includes one heater and one circulation fan according to one embodiment.

[0088] Referring to FIG. 5C, the oven 1 may include one heater 43 and one circulation fan 51. The third heater 43 and the circulation fan 51, configured to heat a cooking space in the cooking chamber 30, may be installed on a rear wall side of the cooking chamber 30.

[0089] The disclosure is not limited to the number of heaters and circulation fans of FIGS. 5A, 5B, and 5C, and may also include a greater number of heaters and circulation fans.

[0090] Hereinafter, a method according to the disclosure configured as described above will be described with reference to the drawings.

[0091] FIG. 6 is a flowchart illustrating an example of cooking at a constant temperature using convection heat in an oven according to one embodiment.

[0092] Referring to FIG. 6, in operation 610, when the oven 1 receives a set temperature selected by a user, in operation 612, the oven 1 may set a first set temperature by multiplying the set temperature by a preset first ratio. Here, the preset first ratio may be 90%. In addition, the set temperature may be a temperature between 100 degrees Fahrenheit and 205 degrees Fahrenheit.

[0093] In operation 610, the oven 1 may receive the set temperature and also receive a cooking end condition by an input. The cooking end condition may include a cooking time or a temperature (e.g., a core temperature of food or an external temperature of food) of food.

[0094] To increase the temperature to the first set temperature, in operation 614, the oven 1 may operate, at least one heater and at least one circulation fan by units of time of a preset first period until the first set temperature is reached, in a preset first combination and in a preset first order for a preset time allocated for each preset first combination.

[0095] In this case, there may be up to four heaters, and when there are three heaters a first heater may be disposed at the top of the cooking chamber of the oven, a second heater may be disposed at the bottom of the cooking chamber, and a third heater may be disposed at an inner surface of the cooking chamber of the oven. In addition, there may be up to two circulation fans, and at least one circulation fan may be disposed around the third heater performing a convection function.

[0096] For the oven 1 including three heaters and one circulation fan, the preset time allocated for each preset first combination in the first order preset by the preset first combination may be, for example, Combination A (15 seconds) -> Combination D (8 seconds) -> Combination E (47 seconds), and the first period may be 70 seconds. Combination A, Combination D, and Combination E may be as shown in the above-mentioned Table 1.

[0097] In operation 616, the oven 1 may check whether the temperature of the cooking chamber has reached the first set temperature.

[0098] Based on a result of the checking in operation 616, when the temperature of the cooking chamber has not reached the first set temperature, the oven 1 may return to operation 614.

[0099] Based on a result of the checking in operation 616, when the temperature of the cooking chamber has reached the first set temperature, in operation 630, the oven 1 may operate at least one of at least one heater and at least one circulation fan at an operation level corresponding to the set temperature for one period. The one period of operation 630 may be a period having a size different from that of the first period of operation 614, and the one period of operation 630 may be, for example, 60 seconds.

[0100] In operation 630, the operation level may correspond to and be the same as the set temperature. For example, when the set temperature is 100 degrees Fahrenheit, the operation level corresponding to the set temperature, which may be the initial operation level, may be level 100, and when the set temperature is 150 degrees Fahrenheit, the operation level corresponding to the set temperature may be level 150.

[0101] An operation of the operation level may be confirmed through the reference operation level.

[0102] Operating at the reference operation level may comprise operating at least one heater and at least one circulation fan in a preset combination and in a preset order for a preset time allocated for each preset combination, in one period.

[0103] The operation level is the same as the reference operation level in that the at least one heater and the at least one circulation fan are operated in a preset combination and in a preset order, and only differs from the reference operation level in terms of the preset time allocated for each preset combination.

[0104] The preset time allocated for each preset combination of the operation level may be determined by multiplying the preset time allocated for each preset combination of the reference operation level by a ratio determined by dividing the operation level by the reference operation level. That is, the preset time allocated for each preset combination of the operation level may be determined by, the time allocated for each combination of the reference operation level * (operation level/reference operation level).

[0105] For example, when the oven 1 comprises three heaters and one circulation fan, an example of the reference operation level may be 100, corresponding to 100 degrees Fahrenheit, and an example of an operation performed in a preset combination and in a preset order for a preset time allocated for each preset combination may be "Combination B (3.0 seconds) -> Combination A (0.4 seconds) -> Combination C (1.2 seconds) -> Combination E (remaining time of period)". In this example, Combination A, Combination B, Combination C, and Combination E may be as shown in the above-described Table 1.

[0106] When the set temperature is 50 degrees Fahrenheit at reference operation level 100 as described above, operation level 50 may be "Combination B (1.5 sec) -> Combination A (0.2 seconds) -> Combination C (0.6 seconds) -> Combination E (remaining times of period)", and operation level 200 may be "Combination B (6.0 seconds) -> Combination A (0.8 seconds) -> Combination C (2.4 seconds) -> Combination E (remaining time of period)".

[0107] In operation 632, the oven 1 may set an operation level by considering a current period temperature, which is a temperature of the oven 1 at an end of the current period, and a previous period temperature, which is a temperature of the oven 1 at a start of the current period. Since the previous period temperature is the temperature of the oven 1 at the end of the previous period, and the current period starts immediately after the previous period ends, the temperature of the previous period may be the same as the temperature of the oven 1 when the current period starts.

[0108] In operation 632, the oven 1 may calculate the operation level via Equation 1 below.

[Equation 1]

$$\text{Next Level} = \text{Current Level} - K1*P - K2*D$$

[0109] Here, Next Level may be the operation level of the next period, Current Level may be the operation level of the current period, K1 may be a preset proportional coefficient, K2 may be a preset differential coefficient, P may be a value determined by subtracting a set temperature from a current period temperature, and D may be a value determined by subtracting a previous period temperature from a current period temperature. Here, K1 may be preset to 1.5 and K2 may be preset to 15.

[0110] In Equation 1, K1*P may correspond to a proportional control of a proportional integral derivative (PID) control, a component to check how far out of the set temperature the current temperature is and to compensate for this, and K2*D may correspond to a derivative control in a PID control, a component to reduce a rate of change of temperature.

[0111] An example of setting the operation level in operation 632 will be further described below with reference to FIG. 8.

[0112] In operation 634, the temperature of the cooking chamber of the oven 1 may be maintained by the operation of at least one heater and at least one circulation fan for one period according to the set operation level.

[0113] In the process of operating at least one heater and at least one circulation fan according to the set operation level of operations 630 and 634, the at least one heater and the at least one circulation fan may be operated for a preset time allocated for a preset combination for each operation level, but it may not be easy to turn the at least one heater on and off when the at least one heater is being operated by units of time of less than 1 second, for example, 0.4 seconds.

[0114] Therefore, rather than configuring the oven to operate the at least one heater by units of time of 0.1 second, configuring the oven to operate the at least one heater by units of time of 1 second when the total number of times the at least one heater is operated exceeds the heating reference value may reduce the cost of product implementation. In addition, a method of operating the at least one heater by units of time of 1 second when the total number of times the at least one heater is operated exceeds the heating reference value may be effective because there is not much difference in maintaining the temperature compared to an oven that operates the at least one heater by units of time of 0.1 second for sous vide cooking which involves a long cooking process.

[0115] A method of operating the at least one heater by units of time of 1 second when the total number of times the at least one heater is operated exceeds the heating reference value will be further described below with reference to FIG. 9.

[0116] In operation 636, the oven 1 may check whether cooking is finished. It may be determined that cooking is finished when a set cooking time has elapsed, when the core temperature of food has reached the set temperature, when the user inputs an end command via a button, or when the user opens the door of the oven 1.

[0117] Based on a result of the checking in operation 636, when it is determined that cooking is not finished, the oven

1 may return to operation 632 and repeat the subsequent process.

[0118] FIG. 7 is a flowchart illustrating another example of cooking at a constant temperature using convection heat in an oven according to one embodiment.

[0119] Referring to FIG. 7, in operation 710, when the oven 1 receives a set temperature selected by a user, in operation 712, the oven 1 may set a first set temperature by multiplying the set temperature by a preset first ratio, and set a second set temperature by multiplying the set temperature by a preset second ratio. In this case, the preset first ratio may be 70%, and the preset second ratio may be 95%. In addition, the set temperature may be a temperature between 100 degrees Fahrenheit and 205 degrees Fahrenheit.

[0120] In operation 710, the oven 1 may receive the set temperature and also receive a cooking end condition by an input. The cooking end condition may include a cooking time or a temperature (e.g., a core temperature of food or an external temperature of food) of food.

[0121] To increase the temperature to the first set temperature, in operation 714, the oven 1 may operate, at least one heater and at least one circulation fan by units of time of a preset first period until the first set temperature is reached, in a preset first combination and in a preset first order for a preset time allocated for each preset first combination.

[0122] In this case, there may be up to four heaters, and when there are three heaters, a first heater may be disposed at the top of the cooking chamber of the oven, a second heater may be disposed at the bottom of the cooking chamber, and a third heater may be disposed at an inner surface of the cooking chamber of the oven. In addition, there may be up to two circulation fans and at least one circulation fan may be disposed around the third heater performing a convection function.

[0123] For the oven 1 including three heaters and one circulation fan, the preset time allocated for each preset first combination in the first order preset by the preset first combination may be, for example, Combination A (15 seconds) -> Combination D (8 seconds) -> Combination E (47 seconds), and the first period may be 70 seconds. Combination A, Combination D, and Combination E may be as shown in the above-mentioned Table 1.

[0124] In operation 716, the oven 1 may check whether the temperature of the cooking chamber has reached the first set temperature.

[0125] Based on a result of the checking in operation 716, when it is determined that the temperature of the cooking chamber has not reached the first set temperature, the oven 1 may return to operation 714.

[0126] Based on a result of the checking in operation 716, when it is determined that the temperature of the cooking chamber has reached the first set temperature, to increase the temperature to the second set temperature, in operation 720, the oven 1 may operate, at least one heater and at least one circulation fan by units of time of a preset second period until the second set temperature is reached, in a preset second combination and in a preset second order for a preset time allocated for each preset second combination.

[0127] In this case, there may be up to four heaters and when there are three heaters a first heater may be disposed at the top of the cooking chamber of the oven, a second heater may be disposed at the bottom of the cooking chamber, and a third heater may be disposed at an inner surface of the cooking chamber of the oven. In addition, there may be up to two circulation fans and at least one circulation fan may be disposed around the third heater performing a convection function.

[0128] For the oven 1 including three heaters and one circulation fan, the preset time allocated for each preset second combination in the second order preset by the preset second combination may be, for example, Combination B (14 seconds) -> Combination A (4 seconds) -> Combination E (52 seconds), and the second period may be 70 seconds. Combination A, Combination B, and Combination E may be as shown in the above-mentioned Table 1.

[0129] In operation 722, the oven 1 may check whether the temperature of the cooking chamber has reached the second set temperature.

[0130] Based on a result of the checking in operation 722, when it is determined that the temperature of the cooking chamber has not reached the second set temperature, the oven 1 may return to operation 720.

[0131] Based on a result of the checking in operation 722, when it is determined that the temperature of the cooking chamber has reached the second set temperature, in operation 730, the oven 1 may operate at least one heater and at least one circulation fan at an operation level corresponding to the set temperature for one period. The one period of operation 730 may be a period having a size different from that of the first period of operation 714 or the second period of operation 720, and the one period of operation 730 may be, for example, 60 seconds. That is, the period of operation 730, the first period of operation 714 or the second period of operation 720 may be different periods of the same size or different sizes respectively.

[0132] Meanwhile, in operation 730, the operation level may correspond to and be the same as the set temperature. For example, when the set temperature is 100 degrees Fahrenheit, the operation level corresponding to the set temperature, which may be the initial operation level, may be level 100, and when the set temperature is 150 degrees Fahrenheit, the operation level corresponding to the set temperature may be level 150.

[0133] An operation of the operation level may be confirmed through the reference operation level.

[0134] Operating at the reference operation level may comprise operating at least one heater and at least one circulation fan in a preset combination and in a preset order for a preset time allocated for each preset combination, in one period.

[0135] The operation level is the same as the reference operation level in that the at least one heater and the at least one circulation fan are operated in a preset combination and in a preset order, and only differs from the reference operation level in terms of the preset time allocated for each preset combination.

[0136] The preset time allocated for each preset combination of the operation level may be determined by multiplying the preset time allocated for each preset combination of the reference operation level by a ratio determined by dividing the operation level by the reference operation level. That is, the preset time allocated for each preset combination of the operation level may be determined by, the time allocated for each combination of the reference operation level * (operation level/reference operation level).

[0137] For example, when the oven 1 comprises three heaters and one circulation fan, an example of the reference operation level may be 100, corresponding to 100 degrees Fahrenheit, and an example of an operation in a preset combination and in a preset order for a preset time allocated for each preset combination may be "Combination B (3.0 seconds) -> Combination A (0.4 seconds) -> Combination C (1.2 seconds) -> Combination E (remaining time of period)". In this example, Combination A, Combination B, Combination C, and Combination E may be as shown in the above-described Table 1.

[0138] When the set temperature is 50 degrees Fahrenheit at reference operation level 100 as described above, operation level 50 may be "Combination B (1.5 sec) -> Combination A (0.2 seconds) -> Combination C (0.6 seconds) -> Combination E (remaining times of period)", and operation level 200 may be "Combination B (6.0 seconds) -> Combination A (0.8 seconds) -> Combination C (2.4 seconds) -> Combination E (remaining time of period)".

[0139] In operation 732, the oven 1 may set an operation level of a next period by considering a current period temperature, which is a temperature of the oven 1 at an end of the current period, and a previous period temperature, which is a temperature of the oven 1 at a start of the current period. Since the previous period temperature is the temperature of the oven 1 at the end of the previous period, and the current period starts immediately after the previous period ends, the temperature of the previous period may be the same as the temperature of the oven 1 when the current period starts.

[0140] In operation 732, the oven 1 may calculate the operation level via Equation 1 below.

[Equation 1]

$$\text{Next Level} = \text{Current Level} - K1*P - K2*D$$

[0141] Here, Next Level may be the operation level of the next period, Current Level may be the operation level of the current period, K1 may be a preset proportional coefficient, K2 may be a preset differential coefficient, P may be a value determined by subtracting a set temperature from a current period temperature, and D may be a value determined by subtracting a previous period temperature from a current period temperature. Here, K1 may be preset to 1.5 and K2 may be preset to 15.

[0142] In Equation 1, K1*P may correspond to a proportional control of a proportional integral derivative (PID) control, a component to check how far out of the set temperature the current temperature is and to compensate for this, and K2*D may correspond to a derivative control in a PID control, a component to reduce a rate of change of temperature.

[0143] An example of setting the operation level in operation 732 will be further described below with reference to FIG. 8.

[0144] In operation 734, the temperature of the cooking chamber of the oven 1 may be maintained by the operation of at least one heater and at least one circulation fan for one period according to the set operation level.

[0145] In the process of operating at least one heater and at least one circulation fan according to the set operation level of operations 730 and 734, the at least one heater and the circulation fan may be operated for a preset time allocated for a preset combination for each operation level, but it may not be easy to turn the at least one heater on and off when the at least one heater is being operated by units of time of less than 1 second, for example, 0.4 seconds.

[0146] Therefore, rather than configuring the oven to operate the at least one heater by units of time of 0.1 second, configuring the oven to operate the at least one heater by units of time of 1 second when the total number of times the at least one heater is operated exceeds the heating reference value may reduce the cost of product implementation. In addition, a method of operating the at least one heater by collecting the operation times of the at least one heater may be effective because there is not much difference in maintaining the temperature compared to an oven that operates the at least one heater by units of time of 0.1 second for sous vide cooking which involves a long cooking process.

[0147] A method of operating the at least heater by units of time of 1 second when the total number of times the at least one heater is operated exceeds the heating reference value will be further described below with reference to FIG. 9.

[0148] In operation 736, the oven 1 may check whether cooking is finished. It may be determined that cooking is finished when a set cooking time has elapsed, when the core temperature of food has reached the set temperature, when the user inputs an end button, or when the user opens the door of the oven 1.

[0149] Based on a result of the checking in operation 736, when it is determined that cooking is not finished, the oven 1 may return to operation 732 and repeat the subsequent process.

[0150] The difference between FIG. 6 and FIG. 7 is in the number of operations the temperature raising operation has. In the case of FIG. 6, the temperature raising operation may be performed as one operation, and in the case of FIG. 7, the temperature raising operation may be performed as two operations.

[0151] In the disclosure, although the examples only describe a temperature raising operation including one operation or two operations, the examples are not limited thereto, and the temperature raising operation may be omitted, or may be configured to include more operations.

[0152] An example of setting the operation level in operation 632 of FIG. 6 and in operation 732 of FIG. 7 will be further described below with reference to FIG. 8.

[0153] FIG. 8 is a flowchart illustrating a process of setting an operation level in an oven according to one embodiment.

[0154] Referring to FIG. 8, in operation 810, when the operation level is set, the oven 1 may check whether a current period temperature exceeds an upper limit reference value of a set temperature. In this case, the upper limit reference value may be 15. And, the upper limit reference value of the set temperature may be determined by adding the upper limit reference value to the set temperature. When the set temperature is 100 degrees Fahrenheit and the upper limit reference value is 15, the upper limit reference value of the set temperature may be 115 degrees Fahrenheit.

[0155] Based on a result of the checking in operation 810, when it is determined that the current period temperature has risen above the upper limit reference value of the set temperature, in operation 812, the oven 1 may set the operation level to an off level that turns off each of at least one heater. That is, when the temperature is above the set temperature, the oven 1 may set an off level at which each of the at least one heater is turned off and only the circulation fan operates, to prevent overcooking of food.

[0156] Based on a result of the checking in operation 810, when it is determined that the current period temperature does not exceed the upper limit reference value of the set temperature, in operation 820, the oven 1 may check whether the current period temperature is less than the lower limit reference value of the set temperature.

[0157] Based on a result of the checking in operation 820, when it is determined that the current period temperature is less than the lower limit reference value of the set temperature, the oven 1 may set the operation level to a highest operation level. In this case, the highest operation level may be, for example, level 400.

[0158] Based on a result of the checking in operation 820, when it is determined that the current period temperature is not less than the lower limit reference value of the set temperature, the oven 1 may calculate the next operation level using the following Equation 1.

[Equation 1]

$$\text{Next Level} = \text{Current Level} - K1*P - K2*D$$

[0159] Here, Next Level may be the operation level of the next period, Current Level may be the operation level of the current period, K1 may be a preset proportional coefficient, K2 may be a preset differential coefficient, P may be a value determined by subtracting a set temperature from a current period temperature, and D may be a value determined by subtracting a previous period temperature from a current period temperature. Here, K1 may be preset to 1.5 and K2 may be preset to 15.

[0160] In Equation 1, K1*P may correspond to a proportional control of a proportional integral derivative (PID) control, a component to check how far out of the set temperature is and to compensate for this, and K2*D may correspond to a derivative control in a PID control, a component to reduce a rate of change of temperature.

[0161] In operation 840, the oven 1 may check whether the calculated operation level is greater than the highest operation level.

[0162] Based on a result of the checking in operation 840, when it is determined that the operation level calculated in operation 830 is greater than the highest operation level, in operation 842, the oven 1 may set the operation level to the highest operation level.

[0163] In operation 850, the oven 1 may check whether the calculated next operation level is smaller than a lowest operation level.

[0164] Based on a result of the checking in operation 850, when it is determined that the operation level calculated in operation 830 is smaller than the lowest operation level, in operation 852, the oven 1 may set the operation level to the lowest operation level. In this case, the lowest operation level may be, for example, level 25.

[0165] An example of operating a heater by units of time of 1 second according to the operation level at which operations 630 and 634 of FIG. 6 are performed and at which operations 730 and 734 of FIG. 7 are performed, will be further described below with reference to FIG. 9.

[0166] FIG. 9 is a flowchart illustrating a process of operating a heater in an oven by units of time of 1 second when an operation time of the heater according to an operation level exceeds a heating reference value, according to one embodiment.

[0167] Referring to FIG. 9, in operation 910, the oven 1 may check a combination of a heater and a circulation fan, an order of the combination, and a time allocated for each combination according to an operation level.

[0168] In operation 920, the oven 1 may calculate an operation time value by adding a time allocated to a heater corresponding to a combination in accordance with an order and a time stored in a buffer corresponding to the heater.

[0169] In operation 930, the oven 1 may check whether the operation time value is smaller than the heating reference value. Here, the heating reference value may be set to, for example, 2 seconds.

[0170] Based on a result of the checking in operation 930, in operation 940, when it is determined that the operation time value is less than the heating reference value, the oven 1 may not operate the heater and store the operation time value in the buffer corresponding to the heater.

[0171] Based on a result of the checking in operation 930, in operation 950, when it is determined that the operation time value is greater than or equal to the heating reference value, the oven 1 may operate the corresponding heater by units of time of seconds of the operation time value in a current period, and may store the remaining time in the buffer corresponding to the corresponding heater.

[0172] For example, when the operation time of the heater is 0.8 seconds and 0.4 seconds is stored in the buffer corresponding to the heater, the sum of the times (1.2 seconds) is less than the heating reference value of 2 seconds, so the oven 1 may not operate the heater, and store 1.2 seconds in the buffer corresponding to the heater.

[0173] As another example, when the operation time of the heater is 3.6 seconds and 1.8 seconds is stored in the buffer corresponding to the heater, the sum of the times (5.4 seconds) is greater than the heating reference value of 2 seconds, so the oven 1 may operate the heater for 5 seconds, and store 0.4 seconds in the buffer corresponding to the heater.

[0174] In FIG. 9, when the time allocated to the heater does not exceed the heating reference value, collecting and processing until the heating reference value is exceeded may correspond to integral control in the PID control.

[0175] The methods according to the above-described embodiments may be recorded in non-transitory computer-readable media including program instructions to implement various operations of the above-described embodiments. The media may also include, alone or in combination with the program instructions, data files, data structures, and the like. The program instructions recorded on the media may be those specially designed and constructed for the purposes of embodiments, or they may be of the kind well-known and available to those having skill in the computer software arts. Examples of non-transitory computer-readable media include magnetic media such as hard disks, floppy disks, and magnetic tape; optical media such as CD-ROM discs or DVDs; magneto-optical media such as optical discs; and hardware devices that are specially configured to store and perform program instructions, such as read-only memory (ROM), random access memory (RAM), flash memory, and the like. Examples of program instructions include both machine code, such as produced by a compiler, and files including higher-level code that may be executed by the computer using an interpreter. The above-described devices may be configured to act as one or more software modules in order to perform the operations of the above-described embodiments, or vice versa.

[0176] The software may include a computer program, a piece of code, an instruction, or some combination thereof, to independently or uniformly instruct or configure the processing device to operate as desired. Software and data may be embodied permanently or temporarily in any type of machine, component, physical or virtual equipment, computer storage medium or device, or in a propagated signal wave capable of providing instructions or data to or being interpreted by the processing device. The software also may be distributed over network-coupled computer systems so that the software is stored and executed in a distributed fashion. The software and data may be stored by one or more non-transitory computer-readable recording mediums.

[0177] While this disclosure includes specific examples, it will be apparent to one of ordinary skill in the art that various changes in form and details may be made in these examples without departing from the spirit and scope of the claims and their equivalents. The examples described herein are to be considered in a descriptive sense only, and not for purposes of limitation. Descriptions of features or aspects in each example are to be considered as being applicable to similar features or aspects in other examples. Suitable results may be achieved if the described techniques are performed in a different order, and/or if components in a described system, architecture, device, or circuit are combined in a different manner, and/or replaced or supplemented by other components or their equivalents.

[0178] Accordingly, other implementations are within the scope of the following claims.

[0179] The disclosure relates to an apparatus and method for cooking at a constant temperature using convection heat in an oven, whereby sous vide cooking without water may be performed by controlling the heater of the oven to maintain a constant temperature in the cooking chamber.

Claims

1. A method of cooking at a constant temperature in an oven, the method comprising:

    performing a temperature raising operation of operating at least one of at least one heater and at least one circulation fan until a temperature of a preset ratio of a set temperature is reached;
    continuing the operating of the at least one of the at least one heater and the at least one circulation fan at the set temperature for a preset period;
    setting an operation level of the at least one of the at least one heater and the at least one circulation fan by considering a temperature of the oven at an end of a current period and a temperature of the oven at a start of the current period;
    performing a temperature maintaining operation of operating the at least one of the at least one heater and the at least one circulation fan for one period according to the operation level set in the setting; and
    repeating the setting of the operation level and the temperature maintaining operation until cooking is completed.

2. The method of claim 1, wherein the temperature raising operation comprises:

    setting a first set temperature determined by multiplying the set temperature by the preset ratio; and
    operating, the at least one heater and the at least one circulation fan by units of time of a preset first period until the first set temperature is reached, in a preset first combination and in a preset first order for a preset time allocated for each preset first combination.

3. The method of claim 1, wherein the temperature raising operation comprises:

    setting a first set temperature determined by multiplying the set temperature by a preset first ratio and setting a second set temperature determined by multiplying the set temperature by a preset second ratio;
    operating, the at least one heater and the at least one circulation fan by units of time of a preset first period until the first set temperature is reached, in a preset first combination and in a preset first order for a preset time allocated for each preset first combination; and
    operating, the at least one heater and the at least one circulation fan by units of time of a preset second period until the second set temperature is reached, in a preset second combination and in a preset second order for a preset time allocated for each preset second combination.

4. The method of claim 3, wherein the preset first ratio is lower than the preset second ratio.

5. The method of claim 1, wherein for the operation level,
the at least one heater and the at least one circulation fan are operated for each operation level in one period, in a preset combination and in a preset order for a preset time allocated for each preset combination.

6. The method of claim 1, wherein the operation level comprises a reference operation level at which the at least one heater and the at least one circulation fan are operated in a preset combination and in a preset order for a preset time allocated for each preset combination, in one period, and
at the operation level,

    the at least one heater and the at least one circulation fan are operated in the preset combination and in the preset order during the one period, and
    the preset time allocated for each preset combination at remaining operation levels other than the reference operation level is determined by multiplying the preset time allocated for each preset combination at the reference operation level by a ratio determined by dividing the operation level by the reference operation level.

7. The method of claim 1, wherein the operation level comprises a lowest operation level and a highest operation level, and
the operation level does not fall below the lowest operation level and does not rise above the highest operation level.

8. The method of claim 1, wherein for the temperature maintaining operation,

    an operation time value is calculated by adding a time allocated to the at least one heater according to the operation level and a time stored in a buffer corresponding to the at least one heater, and

in response to the operation time value being less than a preset heating reference value, the at least one heater is not operated in the current period, and the operation time value is stored in the buffer corresponding to the at least one heater, and
in response to the operation time value being greater than or equal to the preset heating reference value, the at least one heater is operated by units of seconds of the operation time value in the current period, and remaining time is stored in the buffer corresponding to the at least one heater.

9. The method of claim 1, wherein the at least one heater comprises:

a first heater positioned at a top of a cooking chamber of the oven;
a second heater positioned at a bottom of the cooking chamber; and
a third heater positioned on an inner surface of the cooking chamber.

10. The method of claim 1, wherein for the setting of the operation level,
in response to a calculated operation level exceeding a preset highest operation level as a result of calculating the operation level, the operation level is set to a highest operation level considering the set temperature, a current period temperature which is the temperature of the oven at the end of the current period, and a previous period temperature which is the temperature of the oven at the start of the current period.

11. The method of claim 1, wherein for the setting of the operation level,
in response to a calculated operation level being less than a preset highest operation level as a result of calculating the operation level, the operation level is set to a lowest operation level considering the set temperature, a current period temperature which is the temperature of the oven at the end of the current period, and a previous period temperature which is the temperature of the oven at the start of the current period.

12. The method of claim 1, wherein for the setting of the operation level,

the operation level is calculated as follows:

$$\text{Next Level} = \text{Current Level} - K1*P - K2*D$$

where, K1 is a preset proportional coefficient, K2 is a preset differential coefficient, P is a value determined by subtracting the set temperature from a current period temperature which is the temperature of the oven at the end of the current period, and D is a value determined by subtracting a previous period temperature from the current period temperature which is the temperature of the oven at the start of the current period.

13. The method of claim 1, wherein for the setting of the operation level,
in response to a current period temperature, which is the temperature of the oven at the end of the current period, rising above an upper limit reference value than the set temperature, the operation level is set to an off level for turning off each of the at least one heater.

14. The method of claim 1, wherein for the setting of the operation level,
in response to a current period temperature which is the temperature of the oven at the end of the current period, falling below an upper limit reference value than the set temperature, the operation level is set to a highest operation level.

15. An oven for cooking at a constant temperature using convective heat, comprising:

a temperature sensor configured to measure a temperature in a cooking chamber;
a first heater on an upper surface of the cooking chamber and configured to generate heat;
a second heater on a lower surface of the cooking chamber and configured to generate heat;
a third heater on a rear wall side of the cooking chamber and configured to generate heat;
a circulation fan disposed around the third heater and configured to spread the heat generated by at least one heater among the first heater, the second heater and the third heater to the cooking chamber to generate convective heat;
a control panel configured to receive a set temperature selected by a user; and
a processor configured to:

perform a temperature raising operation of operating at least one of the at least one heater and at least one circulation fan until a temperature of a preset ratio of a set temperature is reached,
continue the operating of the at least one of the at least one heater and the at least one circulation fan at the set temperature for a preset period,
set an operation level of the at least one of the at least one heater and the at least one circulation fan by considering a temperature of the oven at an end of a current period and a temperature of the oven at a start of the current period, until cooking is completed, and
perform a temperature maintaining operation of operating the at least one of the at least one heater and the at least one circulation fan for one period according to the operation level set in the setting.

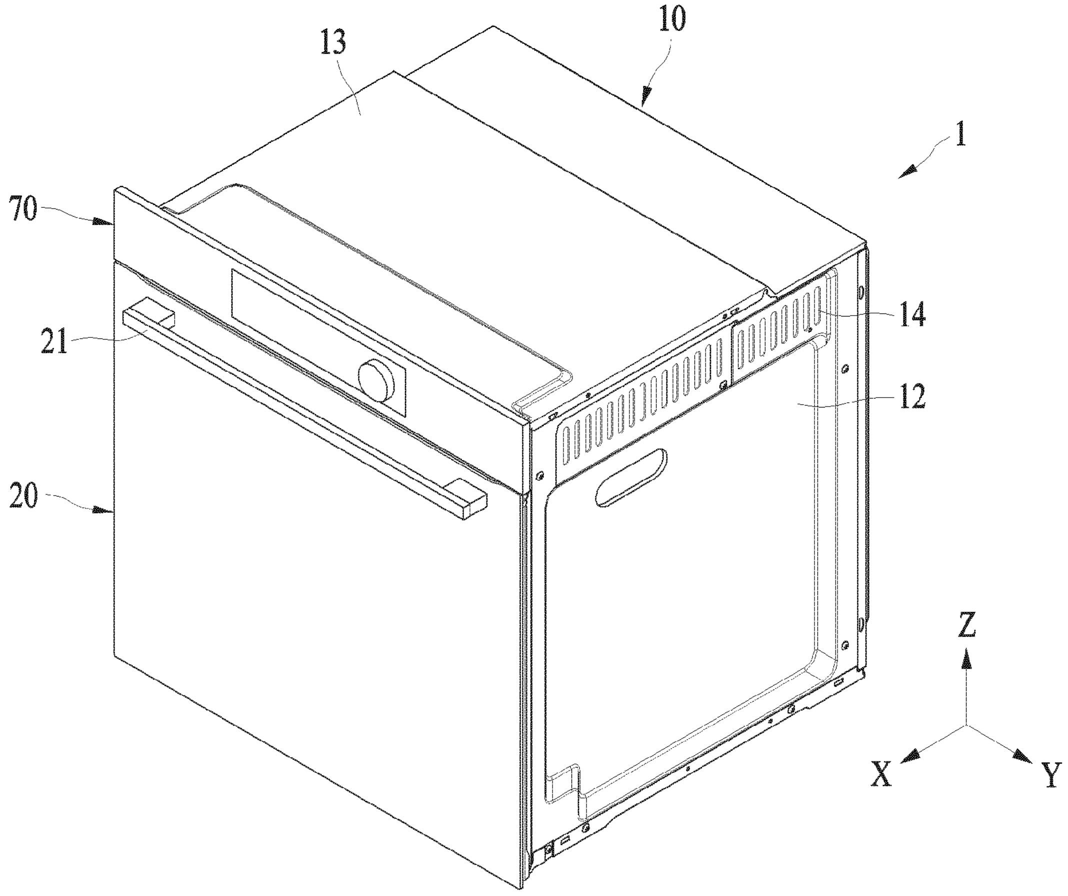

FIG. 1

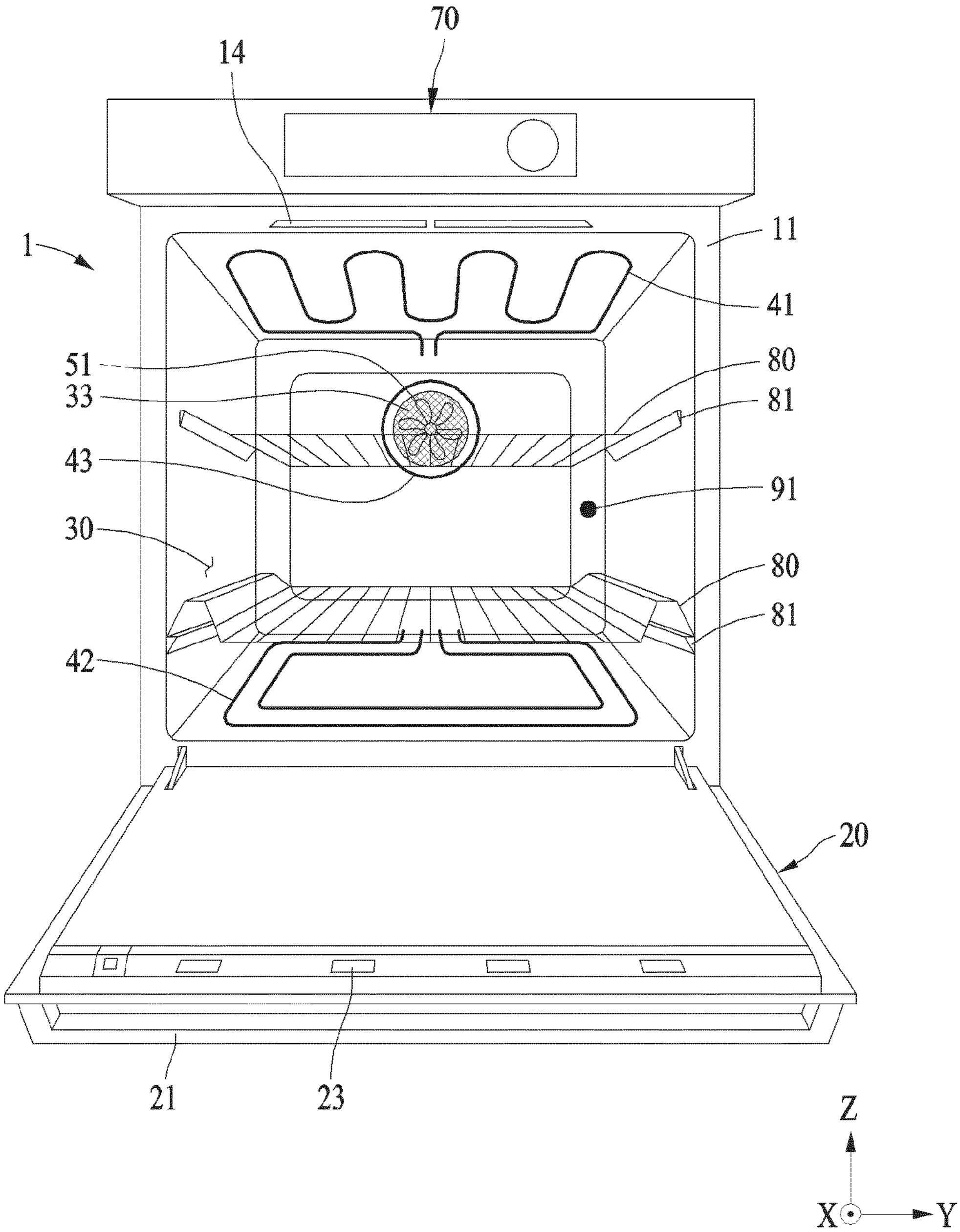

FIG. 2

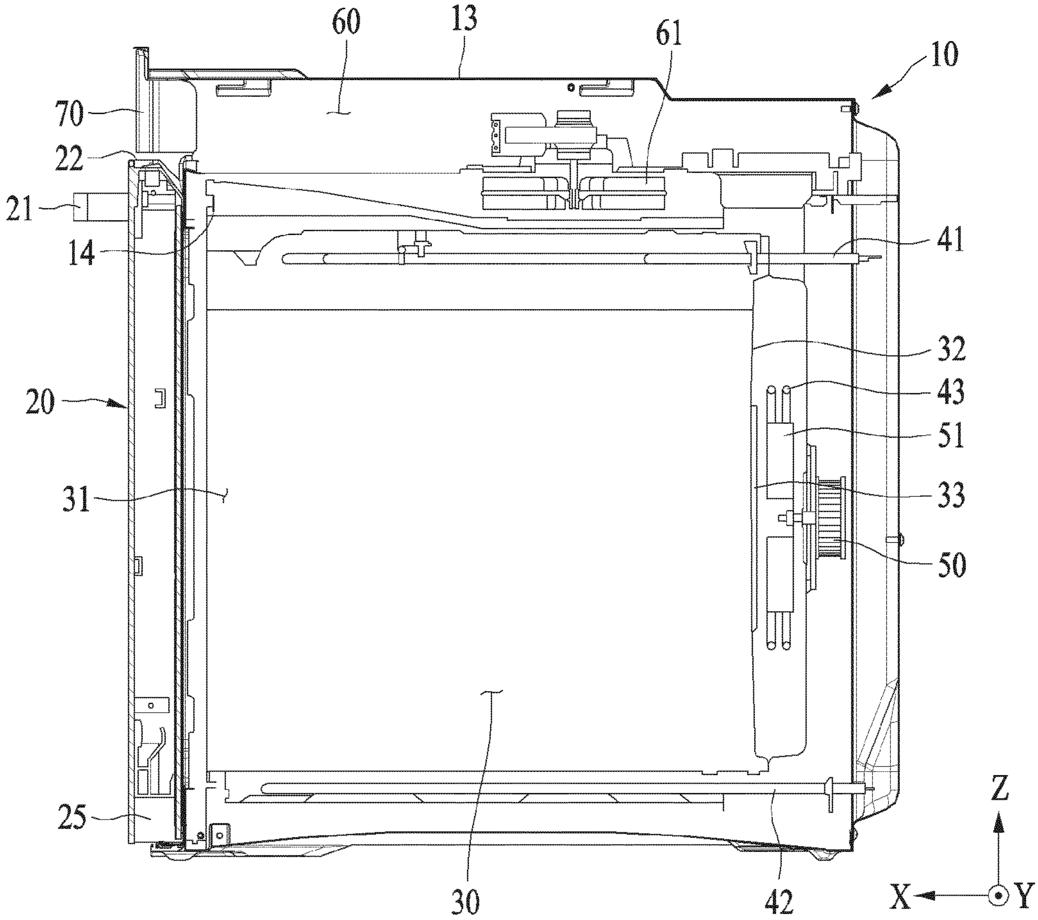

FIG. 3

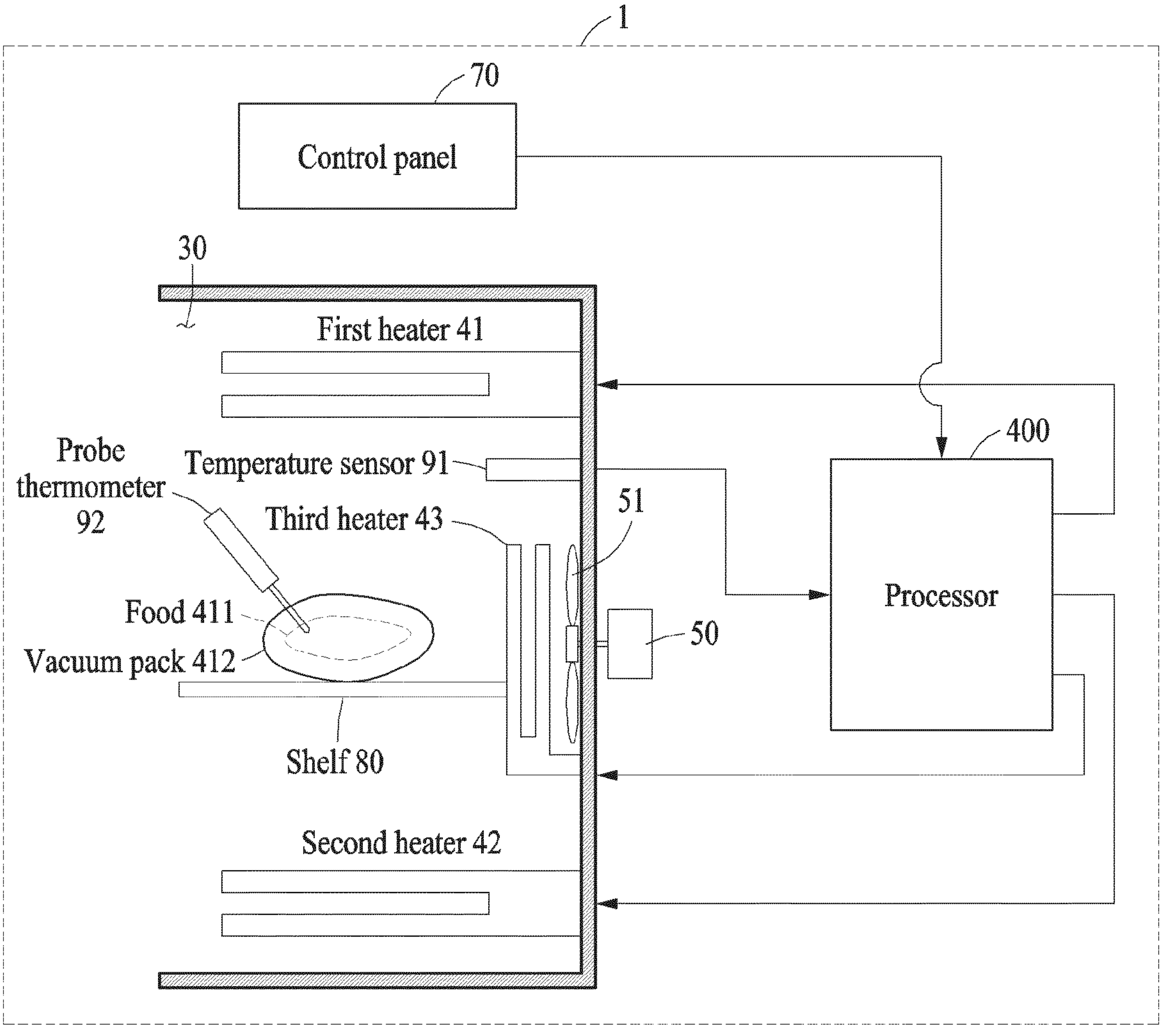
1
70
Control panel
30
First heater 41
Probe
thermometer
92
Temperature sensor 91
400
Third heater 43
51
Processor
Food 411
50
Vacuum pack 412
Shelf 80
Second heater 42

FIG. 4

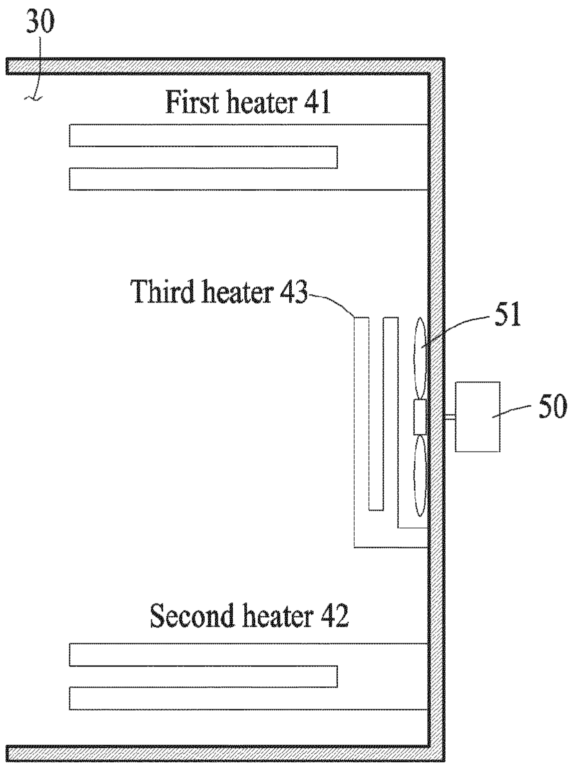

FIG. 5A

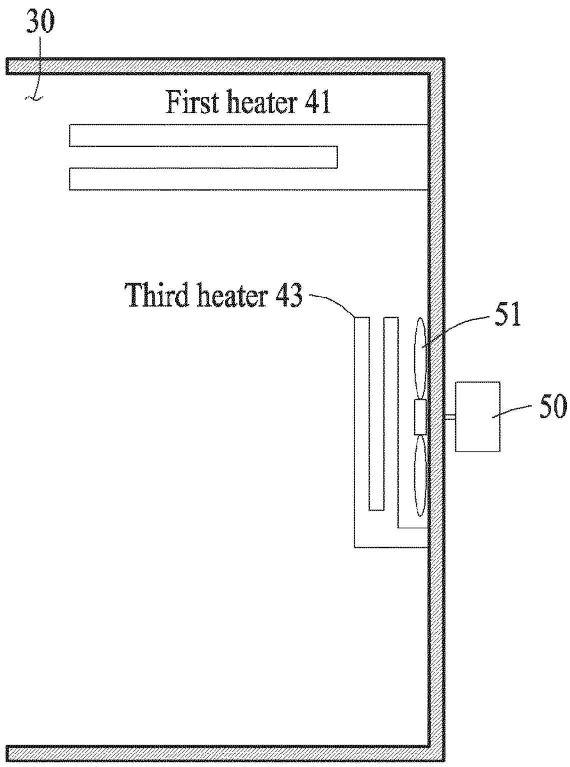

FIG. 5B

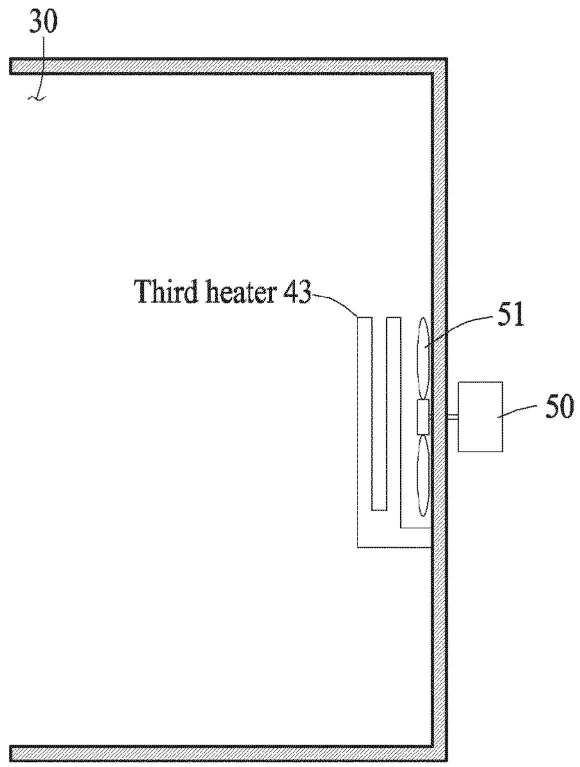

FIG. 5C

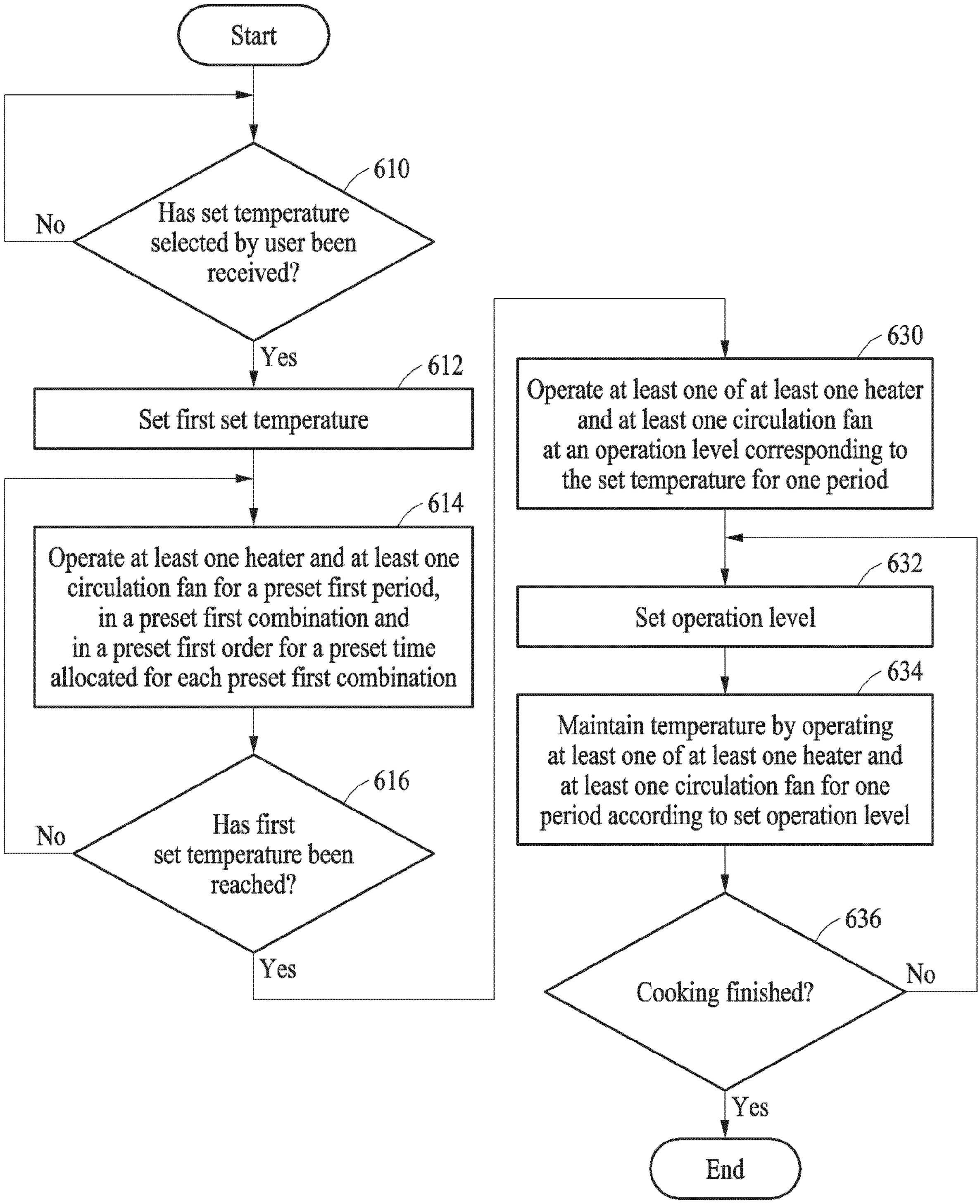
Start
610
No
Has set temperature selected by user been received?
Yes
612
Set first set temperature
614
Operate at least one heater and at least one circulation fan for a preset first period, in a preset first combination and in a preset first order for a preset time allocated for each preset first combination
616
No
Has first set temperature been reached?
Yes
630
Operate at least one of at least one heater and at least one circulation fan at an operation level corresponding to the set temperature for one period
632
Set operation level
634
Maintain temperature by operating at least one of at least one heater and at least one circulation fan for one period according to set operation level
636
Cooking finished?
No
Yes
End

FIG. 6

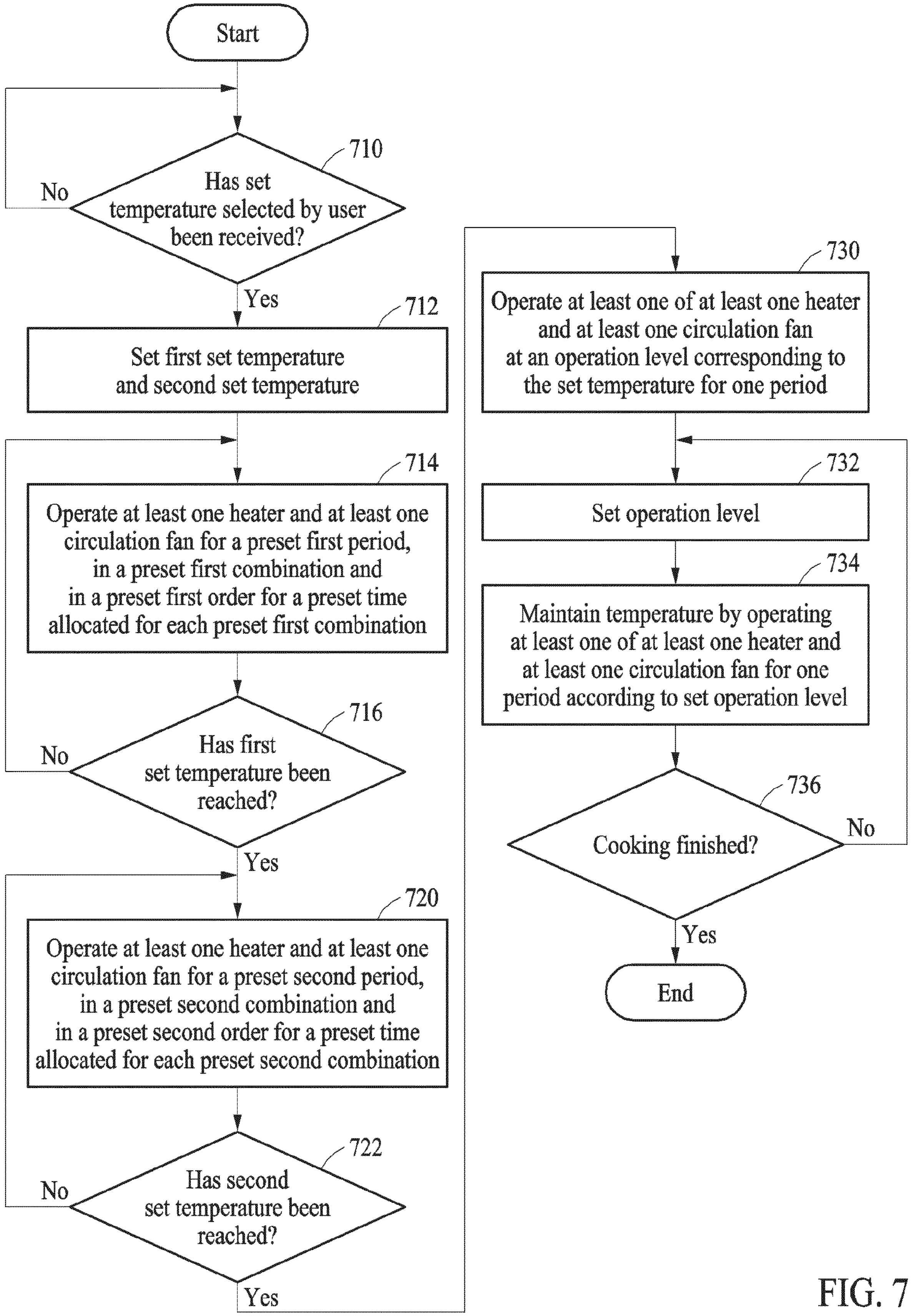
Start
Has set temperature selected by user been received?
710
No
Yes
Set first set temperature and second set temperature
712
Operate at least one heater and at least one circulation fan for a preset first period, in a preset first combination and in a preset first order for a preset time allocated for each preset first combination
714
Has first set temperature been reached?
716
No
Yes
Operate at least one heater and at least one circulation fan for a preset second period, in a preset second combination and in a preset second order for a preset time allocated for each preset second combination
720
Has second set temperature been reached?
722
No
Yes
Operate at least one of at least one heater and at least one circulation fan at an operation level corresponding to the set temperature for one period
730
Set operation level
732
Maintain temperature by operating at least one of at least one heater and at least one circulation fan for one period according to set operation level
734
Cooking finished?
736
No
Yes
End

FIG. 7

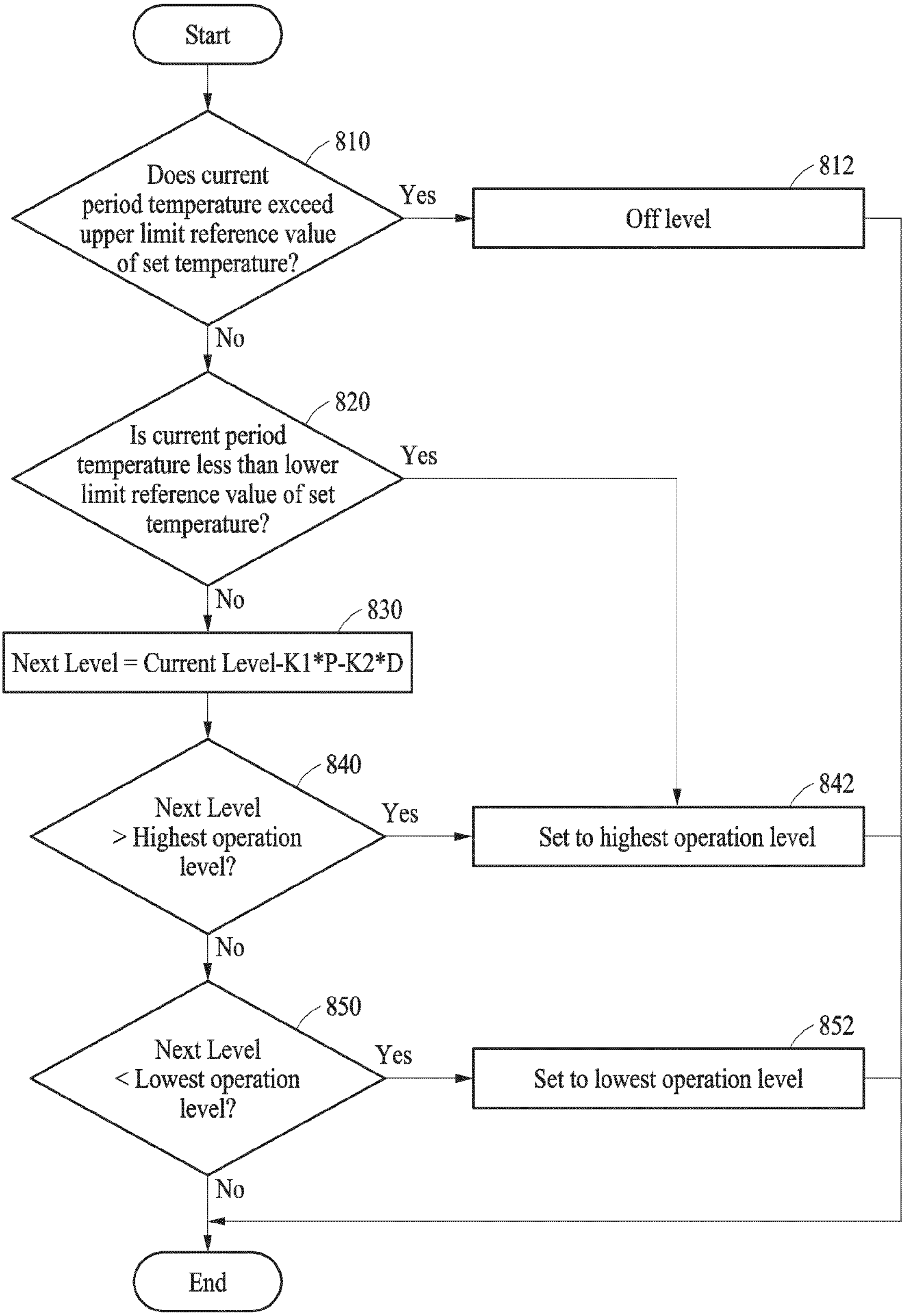
Start
810
Does current period temperature exceed upper limit reference value of set temperature?
Yes
812
Off level
No
820
Is current period temperature less than lower limit reference value of set temperature?
Yes
No
830
Next Level = Current Level-K1*P-K2*D
840
Next Level > Highest operation level?
Yes
842
Set to highest operation level
No
850
Next Level < Lowest operation level?
Yes
852
Set to lowest operation level
No
End

FIG. 8

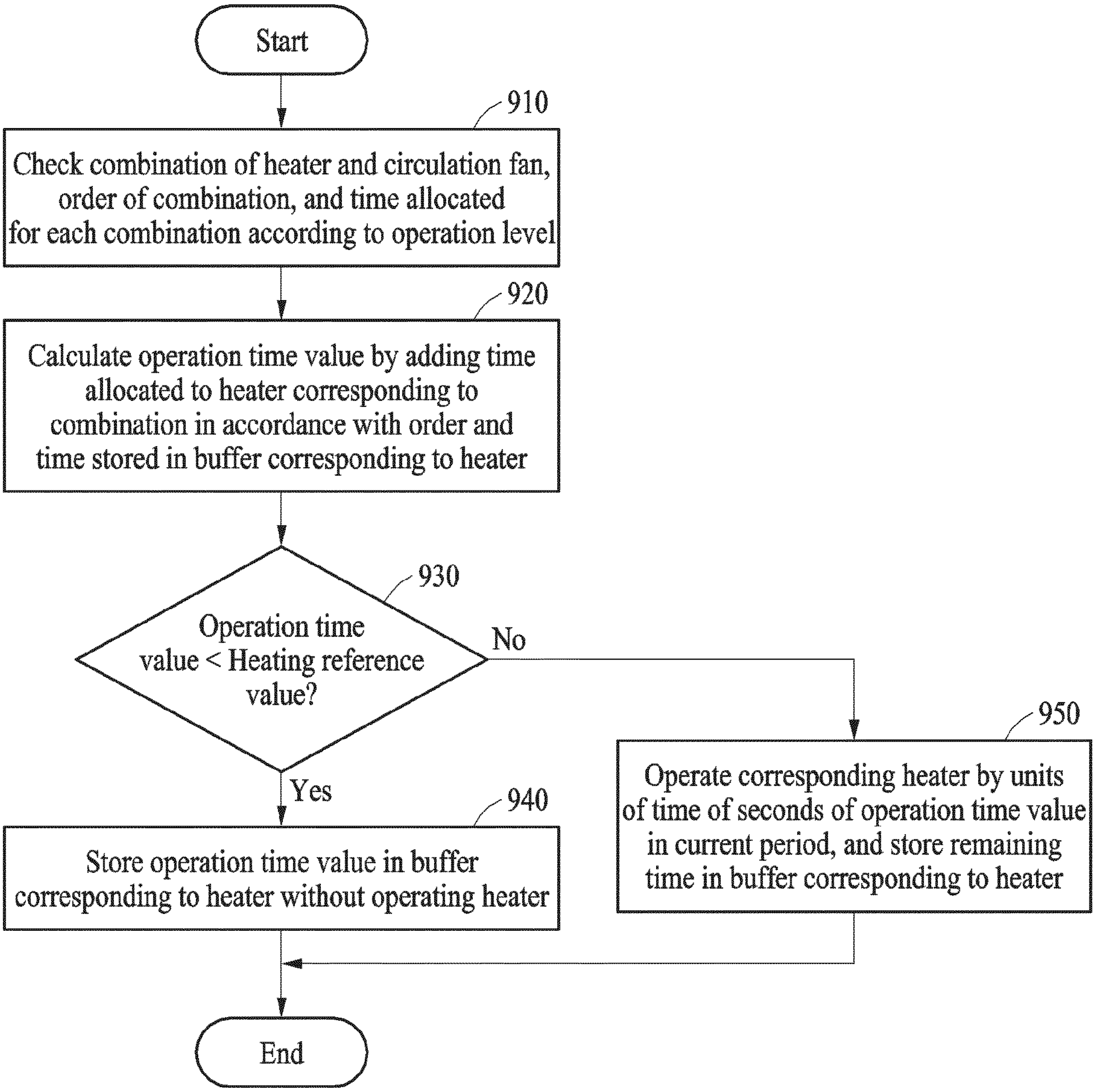
Start
910
Check combination of heater and circulation fan, order of combination, and time allocated for each combination according to operation level
920
Calculate operation time value by adding time allocated to heater corresponding to combination in accordance with order and time stored in buffer corresponding to heater
930
Operation time value < Heating reference value?
No
Yes
940
Store operation time value in buffer corresponding to heater without operating heater
950
Operate corresponding heater by units of time of seconds of operation time value in current period, and store remaining time in buffer corresponding to heater
End

FIG. 9

INTERNATIONAL SEARCH REPORT

International application No. **PCT/KR2022/015669**

A. CLASSIFICATION OF SUBJECT MATTER

F24C 7/08(2006.01)i; **F24C 15/32**(2006.01)i

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)

F24C 7/08(2006.01); A47J 27/10(2006.01); B65B 31/02(2006.01); F24C 15/00(2006.01); F24C 3/12(2006.01)

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

Korean utility models and applications for utility models: IPC as above
Japanese utility models and applications for utility models: IPC as above

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

eKOMPASS (KIPO internal) & keywords: 오븐(oven), 수비드(sous-vide), 순환팬(circulating fan), 주기(period), 온도(temperature), 히터(heater), 레벨(level), 유지(maintain), 반복(repetition), 조리(cook), 제어(control)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	WO 2018-148363 A1 (ELECTROLUX HOME PRODUCTS, INC.) 16 August 2018 (2018-08-16) See paragraphs [0012]-[0013] and [0033]; claim 1; and figure 1.	1,9,15 2-8,10-14
A	US 2015-0354827 A1 (ELECTROLUX HOME PRODUCTS CORPORATION N.V.) 10 December 2015 (2015-12-10) See paragraphs [0060]-[0085]; and figures 1-2.	1-15
A	US 2019-0110630 A1 (PERLICK CORPORATION) 18 April 2019 (2019-04-18) See claims 9-20; and figures 2-3.	1-15
A	EP 3686495 A1 (VESTEL BEYAZ ESYA SANAYI VE TICARET A.S.) 29 July 2020 (2020-07-29) See claims 1-3; and figure 2.	1-15
A	EP 3165135 A1 (SOUTH BANK UNIVERSITY ENTERPRISES LTD.) 10 May 2017 (2017-05-10) See claims 1-18; and figures 1-5.	1-15

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

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

Date of the actual completion of the international search	Date of mailing of the international search report
14 December 2022	**14 December 2022**
Name and mailing address of the ISA/KR **Korean Intellectual Property Office** **Government Complex-Daejeon Building 4, 189 Cheongsa-ro, Seo-gu, Daejeon 35208** Facsimile No. **+82-42-481-8578**	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2022/015669

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
WO 2018-148363 A1	16 August 2018	EP 3580496 A1	18 December 2019
		US 10721948 B1	28 July 2020
		US 11457651 B1	04 October 2022
US 2015-0354827 A1	10 December 2015	EP 2754355 A1	16 July 2014
		EP 2754355 B1	11 March 2020
		WO 2014-108504 A2	17 July 2014
		WO 2014-108504 A3	04 September 2014
US 2019-0110630 A1	18 April 2019	None	
EP 3686495 A1	29 July 2020	None	
EP 3165135 A1	10 May 2017	None	

Form PCT/ISA/210 (patent family annex) (July 2022)