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(71) Applicant: **Panasonic Intellectual Property Management Co., Ltd.**
Osaka-shi, Osaka 540-6207 (JP)

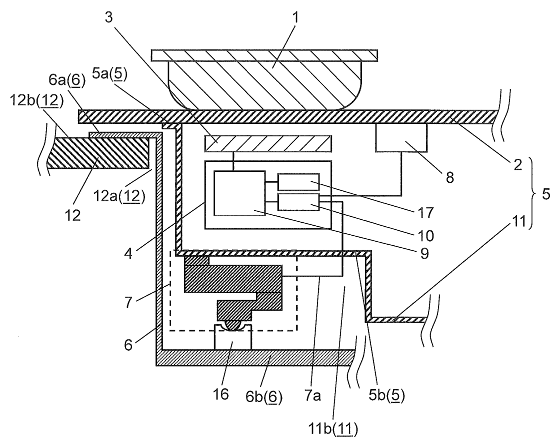
(72) Inventors:
- **OHTA Katsuyuki**
  Osaka-shi
  Osaka 540-6207 (JP)
- **FUJITA Atsushi**
  Osaka-shi
  Osaka 540-6207 (JP)

(74) Representative: **Schwabe - Sandmair - Marx Patentanwälte Rechtsanwalt Partnerschaft mbB**
Joseph-Wild-Straße 20
81829 München (DE)

(54) HEATING COOKER

(57) Heater (3) that heats a to-be-cooked object, weight detector (7) that measures a weight of the to-be-cooked object, information storage unit (17) that stores information associated with a kind of the to-be-cooked object selected, and controller (4) are included. Controller (4) compares a first weight value of the to-be-cooked object measured by weight detector (7), a second weight value corresponding to a weight of the to-be-cooked object heated by heater (3) after the measurement of the first weight value and measured by weight detector (7), and the information associated with the kind of the to-be-cooked object selected and stored in information storage unit (17) to estimate a state of the to-be-cooked object that has been heated and then cook the to-be-cooked object with heat. Accordingly, a heating cooker capable of finishing the to-be-cooked object to an optimum state is provided.

FIG. 1



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Description

TECHNICAL FIELD

[0001] The present invention relates to a heating cooker used in, for example, an ordinary household, a restaurant, and an office.

BACKGROUND ART

[0002] In recent years, ovens in which hot air or superheated steam circulates and heating cookers that are incorporated into, for example, built-in kitchens and apply heat to a cooking vessel such as a pot or a frying pan to heat an ingredient have been widely used. Examples of such a heating cooker incorporated in a built-in kitchen include an induction heating cooker that performs induction heating with an induction electromagnetic coil, a gas cooker that uses direct combustion of gas, and a heater heating cooker that performs heating with an electric heater.

[0003] In general, such a heating cooker is configured to measure an inside temperature and a temperature of a cooking vessel such as a pot or a frying pan and cook a cooking object with heat.

[0004] In addition to the heating cooker thus configured, a different heating cooker has been proposed that is capable of detecting, for example, a center temperature (core temperature) of a to-be-cooked object and checking a state of a center of the to-be-cooked object (refer to PTL 1, for example). Such a heating cooker includes a thermometer with a needle-shaped detection needle. The heating cooker is configured to measure and detect the core temperature with the detection needle directly inserted in the to-be-cooked object.

[0005] However, the heating cooker disclosed in PTL 1 requires the detection needle to be directly inserted into the to-be-cooked object, which makes a hole in the to-be-cooked object. This results in a poor appearance when the to-be-cooked object is arranged on a plate.

[0006] To cope with the problem, a heating cooker capable of detecting a temperature of a cooking vessel and a weight change of a to-be-cooked object to indirectly estimate a state of a center of the to-be-cooked object is disclosed (refer to PTL 2 or PTL 3, for example).

[0007] The heating cooker disclosed in PTL 2 and PTL 3 includes, in a cooker body, a weight detector that measures a weight of a to-be-cooked object together with a cooking vessel, and a temperature detector that measures a temperature of the cooking vessel. The heating cooker is configured to estimate a state of a center of the to-be-cooked object and cook the to-be-cooked object with heat in the following manner.

[0008] To be more specific, the heating cooker disclosed in PTL 2 first detects an initial weight of the to-be-cooked object that has not yet been heated. After a start of heating, the heating cooker detects a decrease in weight of the to-be-cooked object, the decrease in weight being caused by heating that evaporates water from the to-be-cooked object. Then, cooking the to-be-cooked object with heat is terminated when the weight of the to-be-cooked object decreases to an optimum relative weight, which is determined based on prestored information on a target cooking object. Accordingly, a finish state of the to-be-cooked object is determined in a non-contact manner rather than a manner based on a core temperature of the to-be-cooked object.

[0009] However, a thermal change of the to-be-cooked object depends on a proportion of a heating area where the to-be-cooked object actually comes into contact with the cooking vessel to a projected area on a heating side of the to-be-cooked object and a thickness of the to-be-cooked object and causes the finish state to be changed. Furthermore, for example, depending on a proportion of portions other than protein and water that form muscle structure of the to-be-cooked object, such as a proportion of a fat portion and a bone portion for meat or whether a sauté fish is in the form of a fillet or a whole fish, that is, a state of the to-be-cooked object, heat transfer into the to-be-cooked object changes. Accordingly, even with the same initial weight, a saute state of the to-be-cooked object, in other words, an amount of water evaporated from the to-be-cooked object changes. Thus, a weight relative to the initial weight before heating changes depending on the state of the to-be-cooked object. As a result, with the heating cooker disclosed in PTL 2, it is difficult to stably detect the finish state of the to-be-cooked object.

[0010] On the other hand, the heating cooker disclosed in PTL 3 first calculates chemical potential of a to-be-cooked object from a weight change of the to-be-cooked object per unit time and successive transition of supplied heating energy. The heating cooker is configured to estimate the state of the to-be-cooked object based on a value corresponding to the chemical potential calculated and perform cooking. Note that the chemical potential is a unique property a cooking object has.

[0011] The heating cooker is designed based on an idea in which the chemical potential calculated from the weight change measured per unit time and successive transition of supplied heating energy and the chemical potential the to-be-cooked object has are identical to each other. Thus, a description is given that what kind of ingredient is cooked can be estimated by comparing the value corresponding to the chemical potential calculated with information, stored in a storage device, on the chemical potential the ingredient has. That is, the heating cooker is configured to determine, based on chemical potential calculated rather than a core temperature of the to-be-cooked object, the finish state in a non-contact manner and cook the to-be-cooked object with heat.

[0012] However, with respect to the thermal change of the to-be-cooked object, heat transfer into the to-be-cooked object changes depending on the state of the to-be-cooked object. Thus, the amount of water evaporated by heating from the to-be-cooked object changes, and as a result, a difference arises in a rate of weight change per unit time. That is, even with the value corresponding to the chemical potential calculated in PTL 3, the finish state of the to-be-cooked object cannot be stably detected.

Citation List

Patent Literature

[0013]

PTL 1: Japanese Patent No. 5166054
PTL 2: Japanese Patent No. 5047216
PTL 3: DE 10353299 A1

SUMMARY OF THE INVENTION

[0014] The present invention provides a heating cooker capable of accurately determining a finish state of a core temperature from a weight change of a to-be-cooked object and cooking the to-be-cooked object.

[0015] That is, the heating cooker according to the present invention includes a heater that heats a to-be-cooked object, a weight detector that measures a weight of the to-be-cooked object, a selection part that selects a kind of the to-be-cooked object to be heated, an information storage unit that stores information associated with the kind of the to-be-cooked object selected by the selection part, and a controller that controls the heater based on a result of the measurement of the weight detector and the kind of the to-be-cooked object selected by the selection part. The controller compares a first weight value of the to-be-cooked object, a second weight value, and the information to estimate a state of the to-be-cooked object that currently heated and cook the to-be-cooked object with heat. The first weight value is measured by the weight detector, the second weight value corresponds to a weight of the to-be-cooked object heated by the heater after the measurement of the first weight value and measured by the weight detector, and the information is associated with the kind of the to-be-cooked object selected by the selection part and stored in the information storage unit.

[0016] In this configuration, the state of the to-be-cooked object such as a proportion of an actual heating contact area of the to-be-cooked object to a projected area on a heating side of the to-be-cooked object, a thickness of the to-be-cooked object, and a proportion of portions other than protein and water that form a muscle portion of the to-be-cooked object is estimated based on the weight change of the to-be-cooked object. Then, the controller controls the heater under a heating condition in accordance with an internal heat transfer state of the to-be-cooked object, based on the state of the to-be-cooked object estimated. That is, from the weight change of the to-be-cooked object, the controller accurately estimates the core temperature and determines the finish state of the to-be-cooked object. Accordingly, the heating capable of finishing the to-be-cooked object to an optimum state is provided.

BRIEF DESCRIPTION OF DRAWINGS

[0017]

FIG. 1 is a cross-sectional view of a heating cooker according to a first exemplary embodiment of the present invention, which illustrates a schematic configuration of the heating cooker.
FIG. 2 is a schematic configuration diagram illustrating main parts of the heating cooker.
FIG. 3 is a schematic configuration diagram illustrating main parts of the heating cooker.
FIG. 4 is a line chart showing calibration curves of weight changes and core temperature changes stored in an information storage unit in the heating cooker.
FIG. 5A is a line chart showing gradients of a rate of weight change by heating of a first stored state weight value of 100 g in the heating cooker.
FIG. 5B is a line chart showing gradients of a rate of weight change by heating of the first stored state weight value of 150 g in the heating cooker.
FIG. 5C is a line chart showing gradients of a rate of weight change by heating of the first stored state weight value of 200 g in the heating cooker.

FIG. 5D is a line chart showing gradients of a rate of weight change by heating of the first stored state weight value of 250 g in the heating cooker.

FIG. 6A is a line chart showing gradients of a rate of weight change by heating of the first stored state weight value of 300 g in the heating cooker.

FIG. 6B is a line chart showing gradients of a rate of weight change by heating of the first stored state weight value of 350 g in the heating cooker.

FIG. 6C is a line chart showing gradients of a rate of weight change by heating of the first stored state weight value of 400 g in the heating cooker.

FIG. 7 is a line chart illustrating a calculation of gradient (A) in the heating cooker.

FIG. 8 is a line chart illustrating a comparison between gradient (A) and the first stored state weight value stored in the information storage unit in the heating cooker.

FIG. 9 is a line chart illustrating a comparison between information on gradients (MX) stored in the information storage unit and gradient (A) calculated from a detected weight in the heating cooker.

FIG. 10 is a line chart illustrating a comparison between information on gradient (MX) stored in the information storage unit and gradient (B) calculated from a detected weight in the heating cooker.

FIG. 11 is a line chart illustrating an estimation of a core temperature value in the heating cooker.

FIG. 12 is a line chart showing a first stored state weight value and gradients (MX) of a rate of weight change in a heating cooker according to a second exemplary embodiment of the present invention.

FIG. 13 is a line chart illustrating a comparison between information on gradients (MX) stored in an information storage unit and gradient (A) calculated from a detected weight in the heating cooker.

FIG. 14 is a line chart illustrating a comparison between information on gradient (MX) stored in the information storage unit and gradient (B) calculated from a detected weight in the heating cooker.

FIG. 15 is a line chart illustrating an estimation of a core temperature value in the heating cooker.

DESCRIPTION OF EMBODIMENTS

[0018] Hereinafter, the exemplary embodiments of the present invention will be described with reference to the drawings. Note that the present invention is not limited to the exemplary embodiments.

(First exemplary embodiment)

[0019] A heating cooker according to a first exemplary embodiment of the present invention will be described below with reference to FIG. 1.

[0020] FIG. 1 is a cross-sectional view of the heating cooker according to the first exemplary embodiment of the present invention, which illustrates a schematic configuration of the heating cooker.

[0021] As illustrated in FIG. 1, the heating cooker according to the present exemplary embodiment includes, for example, cooking vessel 1, heater 3, controller 4, housing 5 including top plate 2 and steel plate 11, support part 6, weight detector 7, and placing table 12. Cooking vessel 1 stores a to-be-cooked object that is cooked by heat transferred thereto. Heater 3 heats the to-be-cooked object via cooking vessel 1. Controller 4 includes, for example, inverter 9, drive controller 10, and information storage unit 17, and controls, for example, an amount of heat from heater 3. Housing 5 includes top plate 2 that covers a top of housing 5, and accommodates at least heater 3, controller 4, and the like. That is, top plate 2 of housing 5 serves as a placing surface on which cooking vessel 1 is placed. Weight detector 7 measures a weight of the to-be-cooked object.

[0022] The heating cooker according to the present exemplary embodiment further includes operation display unit 8 that receives an operation input by a user and displays information from the heating cooker. Operation display unit 8 is connected to controller 4 and is disposed so as to allow the user to visually recognize operation display unit 8. Operation display unit 8 includes, for example, a selection part that allows the user to select the kind of to-be-cooked object to be heated, and a display function for displaying, for example, a weight value measured by weight detector 7.

[0023] Heater 3 includes, for example, an induction heating coil that generates a high-frequency electromagnetic field from a supplied high-frequency current so as to inductively heat cooking vessel 1.

[0024] Heater 3 is connected with drive controller 10 via inverter 9 that constitutes a part of controller 4. Drive controller 10 causes inverter 9 to modulate, for example, a frequency and amount of the high-frequency current to control the high-frequency electromagnetic field generated by the induction heating coil that constitutes heater 3.

[0025] That is, drive controller 10 primarily includes a microcomputer and a peripheral circuit of the microcomputer, constitutes a part of controller 4, and controls driving of inverter 9. To be more specific, drive controller 10 controls driving of inverter 9 based on an operation the user inputs from operation display unit 8 and information on a current, voltage, power, and the like that are supplied to inverter 9. In this manner, drive controller 10 controls the high-frequency current that is supplied from inverter 9 to the induction heating coil that constitutes heater 3. Then, drive controller 10 changes power used for heating cooking vessel 1 to suitably heat the to-be-cooked object.

[0026] As described above, a lower half of housing 5 is made of, for example, steel plate 11 having thickness t of about 1 mm. Steel plate 11 is formed into a box shape with an open top. An upper end of box-shaped steel plate 11 is bent outward to form flange 5a. Flange 5a is brought into contact with a lower surface of top plate 2 that constitutes an upper half of housing 5. Steel plate 11 of housing 5 is fixed to top plate 2 with, for example, a screw. This configuration causes box-shaped steel plate 11 and top plate 2 of housing 5 to form a substantially closed space (or closed space).

[0027] The substantially closed space (or closed space) of housing 5 accommodates, for example, heater 3, and controller 4.

[0028] Next, a configuration around support part 6 of the heating cooker according to the present exemplary embodiment will be described with reference to FIG. 2.

[0029] FIG. 2 is a schematic configuration diagram illustrating one example of a configuration around support part 6 of the heating cooker.

[0030] As illustrated in FIG. 2, support part 6 is made of a box-shaped steel plate with flange 6a, the box-shaped steel plate being substantially identical (or identical) in shape to steel plate 11 that constitutes the lower half of the housing 5. Support part 6 is larger in size than the box-shaped steel plate 11 of housing 5 so as to accommodate steel plate 11.

[0031] Opening 6bb of a large size is formed with bottom surface 6b of support part 6. Opening 6bb of bottom surface 6b is formed with consideration given to ensuring of strength of support part 6 and minimizing of the weight of support part 6.

[0032] Flange 6a of support part 6 has a width and a length so as not to extend beyond a periphery of top plate 2 when housing 5 is placed into support part 6 (refer to FIG. 1).

[0033] Note that a height of support part 6 is designed such that a gap of, for example, about 1 mm is formed between the lower surface of top plate 2 and an upper surface of flange 6a of support part 6 when housing 5 is placed into support part 6.

[0034] Portions other than flange 6a of support part 6 are placed through opening 12a of placing table 12 that constitutes a kitchen counter on which cooking is made. Flange 6a has a size and a shape so as to be in contact with end 12aa of opening 12a of placing table 12. This configuration causes support part 6 to be placed hanging from placing table 12. At this time, support part 6 is placed in accordance with a positional relationship in which the gap is formed between the upper surface of flange 6a and the lower surface of top plate 2, as described above.

[0035] To be more specific, in a case where housing 5 and support part 6 are installed on placing table 12 in accordance with the positional relationship, a height of a portion extending upward from upper surface 12b of placing table 12 is about 6 mm that is the sum of a thickness of top plate 2 that is about 4 mm, a thickness of the steel plate of support part 6 that is about 1 mm, and the gap of 1 mm between top plate 2 and flange 6a of support part 6. This configuration allows the heating cooker to be disposed in a lower profile manner.

[0036] Next, configurations of and around weight detector 7 of the heating cooker will be described with reference to FIG. 3.

[0037] FIG. 3 is a schematic configuration diagram illustrating one example of the configuration around weight detector 7 of the heating cooker.

[0038] As illustrated in FIG. 3, weight detector 7 includes weight sensor 13 that is, for example, a load cell, fixed connecting part 14, load transfer part 15, and the like. Fixed connecting part 14 connects weight sensor 13 and steel plate 11 of housing 5. Load transfer part 15 receives a load caused by, for example, housing 5 and cooking vessel 1 and transfers the load to support part 6 via load receiving part 16 (described below).

[0039] To be more specific, weight sensor 13 is a beam type load cell having through hole 13a. Such a beam type load cell has a component height of only about 2 cm, but has excellent sensing accuracy.

[0040] Load transfer part 15 includes, at a tip thereof, convex part 15a having a convex lens shape. Convex part 15a of load transfer part 15 is placed in contact with concave part 16a with a lens shape of load receiving part 16 that is provided at a position on support part 6 so as to face convex part 15a. At this time, convex part 15a of load transfer part 15 and concave part 16a of load receiving part 16 are connected with each other in point contact. Note that support part 6, as described above, is larger in size than steel plate 11 of housing 5 so as to accommodate steel plate 11. The height of support part 6 is designed such that the gap of about 1 mm is formed between top plate 2 and flange 6a of support part 6 when housing 5 is placed into support part 6. This configuration causes housing 5 and support part 6 to be arranged in accordance with a positional relationship in which housing 5 and support part 6 are connected with each other via only weight detector 7.

[0041] That is, housing 5, as illustrated in FIG. 1, is supported, by support part 6 via weight detector 7, at a position lower than an opening plane of opening 12a of placing table 12. This configuration allows weight detector 7 to detect a weight of housing 5 and a weight of a placed object such as cooking vessel 1 placed on top plate 2.

[0042] Weight detector 7, as illustrated in FIG. 2, is disposed in, for example, recess 11b (refer to FIG. 1) located at each of four corners on bottom surface 5b of steel plate 11 of housing 5 and detects a load applied thereto. Note that recess 11b is formed by being recessed from bottom surface 5b of steel plate 11 toward top plate 2. A depth of recess 11b is designed such that at least a portion of load transfer part 15 of weight detector 7 extends downward beyond a lowermost portion of steel plate 11.

[0043] That is, weight detector 7 is disposed in recess 11b on bottom surface 5b located on an outer side of steel plate 11 of housing 5. This configuration causes weight detector 7 to be disposed between housing 5 and support part 6. This arrangement allows only weight detector 7 rather than the whole of housing 5 to be replaced in a case where weight detector 7 deteriorates in performance due to, for example, long-term use or shocks. This allows the user to continuously use the heating cooker with only simple replacement work.

[0044] An output signal detected by weight detector 7 is transmitted to drive controller 10 of controller 4 through signal line 7a illustrated in FIG. 1. Controller 4 converts the output signal thus input to a weight and displays the weight thus converted on operation display unit 8.

[0045] Furthermore, as described above, controller 4 includes information storage unit 17 in addition to drive controller 10.

[0046] Information storage unit 17 stores, for example, information associated with the kind of to-be-cooked object selected by the selection part of operation display unit 8.

[0047] To be more specific, information storage unit 17 stores, for example, a weight of a predetermined to-be-cooked object, a first stored weight value, a second stored weight value, information on a plurality of the second stored weight values, and information on a stored core temperature value corresponding to a center temperature (core temperature) inside of the to-be-cooked object that are associated with the kind of to-be-cooked object. The first stored weight value corresponds to a weight at the start of heating at a predetermined temperature. The second stored weight value corresponds to a weight after heating has been performed for a predetermined time since the measurement of the first stored weight value at the start of heating. The information on the plurality of second stored weight values corresponds to a plurality of pieces of information on a weight corresponding to the second stored weight value that gradually varies at predetermined time intervals. The information on the stored core temperature value corresponds to information containing, as the stored core temperature, the center temperature (core temperature) inside of the to-be-cooked object at the predetermined time intervals that are used for measurement of the second stored weight value.

[0048] Moreover, information storage unit 17 stores the first stored weight value, the second stored weight value, and the stored core temperature value with state factor 1, state factor 2, and state factor 3 (described below) set, as factors that influence heat conductivity of the to-be-cooked object, with respect to various states of the to-be-cooked object.

[0049] State factor 1 corresponds to a factor that relates to a proportion of a heating contact area where the to-be-cooked object actually comes into contact with a cooking vessel to a projected area on a heating side of the to-be-cooked object. State factor 2 corresponds to a factor that relates to a thickness of the to-be-cooked object. State factor 3 corresponds to a factor that relates to a ratio between protein and water that form muscle structure in the to-be-cooked object and portions other than the protein and the water.

[0050] Information storage unit 17 stores information containing the first stored state weight value, the second stored state weight value, and the stored state core temperature value at each of three levels of, for example, high, mid, and low that are defined for each of state factors 1, 2, 3.

[0051] First, a description will be given of state factor 1 with reference to an example in which the to-be-cooked object is a sauté chicken thigh fillet. In this case, the chicken thigh fillet has a smooth surface on a skin side and an uneven surface on a muscle side. Thus, when the surface on the muscle side of the chicken thigh is sautéed, only convex portions on the muscle side come into contact with a heating surface of the cooking vessel. At this time, spaces are formed between concave portions on the muscle side and the heating surface. Such spaces decrease an amount of heat transferred from the heating surface of the cooking vessel to the to-be-cooked object, which in turn suppresses a rate of increase in temperature of the center portion (core temperature). That is, state factor 1 corresponds to a factor indicating that the heat transfer speed changes depending on the proportion of the convex portions to the concave portions, that is, the proportion of an actual heating contact area of the to-be-cooked object to a projected area on a heating side of the to-be-cooked object.

[0052] State factor 2 corresponds to a factor indicating that the rate of increase in the center temperature (core temperature) of the to-be-cooked object is suppressed depending on the thickness of the to-be-cooked object. In other words, state factor 2 corresponds to a factor indicating that when a distance (thickness) to the center of the to-be-cooked object increases, a speed of an outflow of water, caused by heating, from the inside of the to-be-cooked object changes.

[0053] That is, heating causes muscle cells of the to-be-cooked object to contract. The contraction forces internal water bonded to the muscle cells to flow out. The water that has flowed out passes through between muscle fibers constituting the muscle cells and comes out on a surface of the to-be-cooked object. Accordingly, it is considered that a length of a path through which the water comes out, a change in pressure (speed) at which the water flows out due to muscle contraction, and the like influence an outflow rate of water from the to-be-cooked object. This suppresses the rate of increase in center temperature (core temperature) of the to-be-cooked object.

[0054] Furthermore, state factor 3 corresponds to a factor that relates to a ratio between a muscle portion and portions other than the muscle portion.

[0055] To be more specific, in a case where the to-be-cooked object is beef, state factor 3 is a proportion of portions other than a muscle portion, such as a proportion of fat or bone in rib steak.

[0056] Note that in a case where the to-be-cooked object is a fish fillet, the to-be-cooked object only includes a muscle portion and a skin portion, which eliminates the need for state factor 3. However, in a case where a whole fish is cooked, the to-be-cooked object includes a bone portion in addition to a muscle portion and a skin portion. Thus, state factor 3 indicating a ratio between the muscle portion and the portions other than the muscle portion is necessary.

[0057] For example, a detailed description will be given of an example in which beef rib steak of 300 g contains a muscle portion of 200 g and a remaining portion, which is a bone portion, of 100 g. In this case, a weight change due to heating of the muscle portion of 200 g is larger. Thus, in a case of rib steak of the same 300 g containing a muscle portion of 150 g, and a bone portion of 150 g that is larger in proportion than the bone portion (100 g) of the above-described rib steak, a rate of weight change decreases compared to the case of the muscle portion of 200 g. That is, in a case where the total weights are the same, but the ratios between the muscle portion and the bone portion in the to-be-cooked object are different, a difference arises in the rate of weight change. Thus, state factor 3 is set so that the state of the to-be-cooked object is more accurately checked during heating.

[0058] Hereinafter, a description will be given of one example in which, for each of state factors 1 to 3, the above-described three levels (high, mid, and low) are defined. Note that the definition of the three levels is given as an example, and it goes without saying the present invention is limited to the example.

[0059] First, for state factor 1, with the proportion of the actual heating contact area of the to-be-cooked object to the projected area on the heating side of the to-be-cooked object set to three levels (high, mid, and low) of 100%, 75%, and 50%, the rate of weight change and the rate of increase in the center temperature are checked with samples of the to-be-cooked object having the same weight.

[0060] For state factor 2, with the thickness of the to-be-cooked object set to three levels (high, mid, and low) of 30 mm, 20 mm, and 10 mm, the rate of weight change and the rate of increase in the center temperature are checked with samples of the to-be-cooked object having the same weight.

[0061] For state factor 3, with the proportion of the bone portion set to three levels (high, mid, and low) of 30%, 20%, and 10% or the proportion of the fat portion set to three levels of 10%, 6%, and 3% in accordance with the kind of the to-be-cooked object, the rate of weight change and the rate of increase in the center temperature are checked with samples of the to-be-cooked object having the same weight.

[0062] Then, respective calibration curves are set between the heating time and the weight change at the three levels of each state factor and between the heating time and the core temperature change that are checked in advance.

[0063] Hereinafter, a description will be given of one example in which each calibration curve is set based on the above-described conditions, with reference to FIG. 4 to FIG. 6C.

[0064] FIG. 4 is a line chart showing one example of calibration curves at a level (mid: the thickness of the to-be-cooked object is 20 mm) of state factor 2.

[0065] The calibration curves shown in FIG. 4 are stored in information storage unit 17 of controller 4 as information on two linear correlation lines in the form of primary curves indicating the first stored state weight value, the second stored state weight value at each predetermined time interval, and the stored state core temperature value at each predetermined time interval.

[0066] Furthermore, FIG. 5A to FIG. 6C show calibration curves at the three levels of state factors 1 to 3 with changes in the first stored state weight value in a case where the to-be-cooked object is beef steak as an example.

[0067] To be more specific, FIG. 5A to FIG. 5D show cases where the first stored state weight value is set to 100 g, 150 g, 200 g, and 250 g, respectively. Similarly, FIG. 6A to FIG. 6C show cases where the first stored state weight value is set to 300 g, 350 g, and 400 g, respectively.

[0068] That is, FIG. 5A to FIG. 6C show cases where a plurality of reference weight values from a low weight value (100 g) to a high weight value (400 g) are set at equal intervals (50 g) as the first stored state weight value. Then, with respect to the reference weight value of the first stored state weight value thus set, information on the second stored state weight value and the stored state core temperature value is collected beforehand and is stored in information storage unit 17 of controller 4.

[0069] Hereinafter, a description will be given of one example of calibration curves stored in information storage unit 17, with reference to FIG. 5A to FIG. 6C.

[0070] Note that FIG. 5A to FIG. 6C only show calibration curves that can be obtained from the first stored state weight value and the second stored state weight value and do not show a calibration curve of the stored state core temperature value.

[0071] Furthermore, gradient (M1), gradient (M2), to gradient (M9) shown in the charts indicate calibration curves at the three levels (high, mid, and low) of state factors 1 to 3.

[0072] Herein, as shown in FIG. 5A to FIG. 6C, the calibration curves at the three levels that result from subdivision of each of state factors 1 to 3 correspond to pieces of information that are different from each other. Thus, the use of the calibration curves allows an internal state of the to-be-cooked object to be determined more precisely based on each of the calibration curves.

[0073] The heating cooker according to the present exemplary embodiment is configured as described above.

[0074] Hereinafter, a description will be given of an operation and an action of the above-described heating cooker with reference to FIG. 7.

[0075] FIG. 7 is a line chart illustrating a calculation of gradient (A) in the heating cooker.

[0076] First, at the start of cooking, the user places cooking vessel 1 used for cooking with heat at a position corresponding to heater 3 on top plate 2. Then, the user pours, for example, a predetermined amount of oil into cooking vessel 1. Then, preparation of cooking of the to-be-cooked object is completed.

[0077] Once the preparation is completed, the user selects the kind of to-be-cooked object (for example, beef, pork, chicken, Spanish mackerel, salmon, or the like) and the kind of cooking method (for example, frying, deep frying, or the like) from a cooking menu on operation display unit 8. Moreover, the user selects a start of "cooking with finish determination" from a menu on operation display unit 8. When the user makes the selection, controller 4 holds a detection output signal output from weight detector 7 and displays "0 g" on operation display unit 8 with the detection output signal as a reference weight.

[0078] Next, controller 4 controls heater 3 to start heating cooking vessel 1. At this time, controller 4 automatically sets the heating temperature so as to meet a reference temperature condition associated with a combination of the kind of to-be-cooked object and the kind of cooking method thus selected and starts heating. In a case where the user selects, for example, "beef' as the kind of to-be-cooked object and "frying" as the kind of cooking method, a core temperature value that is prestored in information storage unit 17 and associated with a combination of the kind of to-be-cooked object and the kind of cooking method is set.

[0079] In this case, heating the to-be-cooked object is set to start at, for example, 170°C under the reference temperature condition.

[0080] Note that a temperature of a bottom surface of cooking vessel 1 is detected as the temperature of cooking vessel 1 by a temperature detector (not illustrated) disposed directly below a position on top plate 2 where cooking vessel 1 is heated. Then, when the temperature of the bottom surface reaches the temperature under the reference temperature condition (170°C in the above description), a sign prompting the user to start putting the to-be-cooked object (beef in the above description) is displayed on operation display unit 8 to inform the user.

[0081] Next, when the user puts the to-be-cooked object into cooking vessel 1, a load applied to weight detector 7 increases, which amplifies the detection output signal. Controller 4 detects an increase in amplitude of the detection output signal. At this time, immediately after the user puts the to-be-cooked object, inertia and the like cause the detection output signal from weight detector 7 to oscillate (fluctuate) centering around the weight of the to-be-cooked object. Thus, controller 4 waits a predetermined time for the next detection of the detection output signal until the amplitude of the detection output signal is close to zero. When the amplitude is close to zero or the predetermined time has elapsed, controller 4 converts the detection output signal into the weight of the to-be-cooked object put. Then, controller 4 stores, in information storage unit 17, the weight thus obtained as a first weight value of the to-be-cooked object. For example, in a case where steak meat having a weight of 220 g and a thickness of 23 mm is put, controller 4 stores "about 220 g" as first weight value (A) in information storage unit 17.

[0082] Next, controller 4 measures the weight of the to-be-cooked object every about one second, for example, after the first weight value is stored and then stores the weight thus measured as a second weight value in information storage unit 17. Then, controller 4 calculates an averaged linear correlation line, shown in FIG. 7, from the first weight value and the second weight values measured every second for about 30 seconds after the first weight value is stored. Accordingly, gradient (A) of the rate of weight change of the to-be-cooked object per unit time is derived by the calculation.

[0083] Note that each plotted point shown in FIG. 7 is a second weight value detected every about one second. Furthermore, a primary curve shown in FIG. 7 is a correlation line resulting from averaging the plotted points. Accordingly, a slope of the correlation line obtained by the calculation is derived as "gradient (A)" of the rate of weight change.

[0084] A description will be given below of the weight change of the to-be-cooked object.

[0085] First, water molecules are bonded to myofibrillar protein that forms muscle cells of the to-be-cooked object. When being heated, the myofibrillar protein of the muscle cells coagulates. This causes the myofibrillar protein to contract, which forces water in the muscle cells to flow out. The water that has flowed out drops onto the heating surface of cooking vessel 1 and then evaporates. As a result, the to-be-cooked object decreases in weight.

[0086] In such a mechanism, the weight change of the to-be-cooked object occurs.

[0087] Next, controller 4 selects each of the above-described state factors from information prestored in information storage unit 17 in accordance with gradient (A) derived and the kind of the to-be-cooked object and the kind of cooking method selected at the start.

[0088] To be more specific, as illustrated in FIG. 8, controller 4 selects, from the information stored in information storage unit 17, each of the state factors that has the first stored state weight value closest to the first weight value of the to-be-cooked object that has been put. For example, in a case of the above-described steak meat (220 g), controller 4 selects an information group associated with the first stored state weight value of 200 g from the information stored.

[0089] Next, controller 4, as illustrated in FIG. 9, reads, from information storage unit 17, gradients (M1, M2, M3, to

M9) of the rate of weight change associated with the first stored state weight value of 200 g and calculated from the first stored state weight value and the second stored state weight value of each of the state factors.

[0090] Next, controller 4 performs a comparison operation on gradient (A), illustrated in FIG. 9, calculated from the weight change of the to-be-cooked object and each of gradients (MX where X ranges from 1 to 9) read from information storage unit 17. At this time, controller 4 performs the comparison operation to obtain gradient (MX) that has a minimal result of (|gradient (A) - gradient (MX)|). Then, controller 4 selects gradient (MX) corresponding to the closest level of a state factor among the three levels of the state factors.

[0091] Herein, the thick line shown in FIG. 9 indicates a linear correlation line calculated from the weight change of steak meat (220 g) described in the previous example. At this time, a thickness of the steak meat (220 g) is 23 mm, which indicates that the correlation line calculated has a gradient similar to gradient (M5) corresponding to the mid level among gradient (M4), gradient (M5), and gradient (M6) that indicate the three levels of state factor 2. Then, controller 4 selects gradient (M5) that corresponds to the mid level of state factor 2.

[0092] Next, in order to make gradient (MX) of the rate of weight change for the state factor of the to-be-cooked object selected identical to gradient (A) of the rate of weight change of the to-be-cooked object, controller 4 controls a heating condition of heater 3 as follows.

[0093] For example, in a case where gradient (MX) > gradient (A) is satisfied, controller 4 controls heater 3 to increase the heating temperature by 5°C. On the other hand, in a case where gradient (MX) < gradient (A) is satisfied, controller 4 controls heater 3 to decrease the heating temperature by 5°C.

[0094] Note that, to control the heating temperature, drive controller 10 of controller 4 controls driving of inverter 9 such that a high-frequency current to be output to the induction heating coil that constitutes heater 3 gradually increases or decreases. At this time, drive controller 10 monitors a voltage, a current, and power applied to inverter 9. Accordingly, drive controller 10 checks if inverter 9 operates within a set range. Then, drive controller 10 drives inverter 9 to achieve a required heating temperature, which heats cooking vessel 1.

[0095] Next, controller 4, as illustrated in FIG. 10, stores again, in information storage unit 17, a weight of the to-be-cooked object, as first weight value (B), measured when the heating condition is changed such that gradient (M5) selected is identical to gradient (A) of the to-be-cooked object. Note that the initial first weight value (for example, 220 g) stored at the start of heating is used for calculation (described below); thus, the first weight value is left in information storage unit 17 as separate first weight value (A).

[0096] Next, after first weight value (B) is detected, controller 4 detects a weight of the to-be-cooked object every about one second and stores the weight as a second weight value in the same manner as illustrated in FIG. 7. Then, controller 4 calculates an averaged linear correlation line shown in FIG. 10 from first weight value (B) and each of the second weight values stored every second for about ten seconds after first weight value (B) is stored in the same manner as the above-described calculation of gradient (A). Accordingly, gradient (B) of the rate of weight change per unit time is derived by the calculation.

[0097] Next, controller 4 performs a comparison operation on gradient (B) derived and gradient (MX) of the state factor selected before the heating condition is changed in accordance with the following (Inequality 1). Note that FIG. 10 also shows gradient (M5) selected in the above-described example before the heating condition is changed.

$$(|\text{gradient (B)} - \text{gradient (MX)}|) < (\text{set value}) \qquad \text{(Inequality 1)}$$

[0098] At this time, in a case where a difference between gradient (B) and gradient (MX: in this case, M5) is out of a range of a predetermined set value that has been preset, controller 4 controls heater 3 again to adjust the heating temperature of cooking vessel 1. Then, a correlation line is calculated again, and a gradient of the rate of weight change per unit time is newly derived by the calculation.

[0099] Next, controller 4 performs a comparison operation on a gradient that has been newly calculated, in accordance with (Inequality 1).

[0100] Then, until a difference between the gradient calculated and gradient (MX) is within the range of the predetermined set value, controller 4 repeatedly controls heater 3 for heating and performs the above-described operation. Accordingly, once the difference from gradient (MX) is within the range of the predetermined set value, a difference between the second weight value and the second stored state weight value remains within a substantially constant range. At this time, as illustrated in FIG. 11, an estimation can be made that the stored state core temperature value that correlates with the second stored state weight value relative to the second weight value is substantially identical to the core temperature value of the to-be-cooked object.

[0101] Next, when the core temperature value of the to-be-cooked object estimated reaches a set core temperature value, controller 4 determines that the finish state of the to-be-cooked object that has been heated is an optimum state.

[0102] Then, controller 4 stops heating cooking vessel 1 by heater 3. At the same time, controller 4 informs the user, via operation display unit 8, that cooking has been completed.

[0103] As described above, according to the present exemplary embodiment, a correlation between the weight change and the core temperature change of the to-be-cooked object due to heating can be more accurately achieved. Therefore, even when a state of the to-be-cooked object, such as the proportion of the actual heating contact area of the to-be-cooked object to the projected area on the heating side of the to-be-cooked object, the thickness of the to-be-cooked object, or the proportion of portions other than protein and water that form the muscle portion of the to-be-cooked object, is different, the state of the to-be-cooked object can be accurately estimated. Accordingly, controller 4 can control heater 3 under a suitable heating condition in accordance with an internal heat transfer state in the state of the to-be-cooked object. That is, from the weight change of the to-be-cooked object, the finish state of the core temperature can be accurately determined.

[0104] Note that, in the present exemplary embodiment, a description has been given, as an example, of a configuration in which first weight value (A) detected at the start of the heating process is displayed on operation display unit 8, but the present invention is not limited to the configuration. For example, a proportion of the second weight value to first weight value (A) may be displayed on operation display unit 8. For example, a relative weight value after a to-be-cooked object is cooked may be described in, for example, a recipe book as a reference value. Accordingly, the above-described proportion is displayed on operation display unit 8, which allows the user to visually recognize a change of a state of the to-be-cooked object.

[0105] Moreover, a configuration may be employed in which when a gradient of the rate of weight change of the to-be-cooked object is substantially identical to gradient (MX) of the rate of weight change of the state factor of the to-be-cooked object selected, a stored state core temperature value that correlates with the second stored state weight value relative to the second weight value is obtained, and a core temperature value estimated may be displayed on operation display unit 8. Accordingly, the user can more visually recognize the finish state of the to-be-cooked object. Thus, when the finish state of the core temperature value is changed to a finish state according to a user's preference, the change can be made with a rough indication. As a result, usability of the heating cooker and convenience to use the heating cooker are enhanced.

[0106] Furthermore, a description has been given above of an example in which a desired finish state is selected based on the core temperature value, but the present invention is not limited to the example. For example, in a case where the to-be-cooked object is beef steak, a configuration may be employed in which representations of "rare", "medium", "well-done", and the like that each correspond to the core temperature value are displayed on operation display unit 8, and the user selects one of the representations. Such a configuration allows the user to intuitively select a desired finish state.

[0107] Furthermore, a configuration may be employed in which the user can change the setting of the stored state core temperature value to a desired core temperature value previously set. Accordingly, the user can be automatically informed of a desired finish state from the next time. As a result, usability of the heating cooker is further enhanced.

[0108] Moreover, in the present exemplary embodiment, information on calibration curves (the first stored state weight value, the second stored state weight value, and the stored state core temperature value) of an optimum heating change for each of the state factors rather than reference heating temperature conditions is stored associated with each of the state factors. Accordingly, after the state factor is selected as a state of the to-be-cooked object, a change to a calibration curve of the optimum heating change for the state factor can be made. Accordingly, heating control of the to-be-cooked object can be performed so as to meet the calibration curve. As a result, regardless of the state of the to-be-cooked object, a determination of the finish state can be made stably under an optimum heating condition.

[0109] Furthermore, in the present exemplary embodiment, a description has been given of an example in which state factor 3 corresponds to a ratio between protein and water that form the muscle portion in the to-be-cooked object and portions other than the protein and the water, but the present invention is not limited to the example. For example, in case of meat with bone, each country has unique gastronomy; thus, a large variety of meat with bone exists. Therefore, "meat with bone" is added as the kind of the to-be-cooked object, and, with "meat with bone" and "meat without bone" distinguished from each other, state factor 3 may be set. Accordingly, even in a case of "meat with bone", cooking with heat can be made with the core temperature more accurately estimated.

[0110] Furthermore, in the present exemplary embodiment, a description has been given, as an example, of a configuration in which heater 3 that is an induction heating coil inductively heats cooking vessel 1, but the present invention is not limited to the configuration. For example, an electric heater may be used for heating. Alternatively, direct combustion of gas may be used for heating. This configuration enhances flexibility.

(Second exemplary embodiment)

[0111] Hereinafter, a description will be given below of a heating cooker according to a second exemplary embodiment of the present invention.

[0112] The heating cooker according to the present exemplary embodiment has a configuration that is substantially identical to the configuration of the heating cooker according to the first exemplary embodiment, but has a method for calculating the core temperature value of the to-be-cooked object that is different from the corresponding method according to the first exemplary embodiment. Other configurations and methods are the same; thus, a description will be given of different portions.

[0113] Information storage unit 17 of the heating cooker according to the present exemplary embodiment stores state factor 1, state factor 2, and state factor 3 (described below) that are associated with the kind of the to-be-cooked object and are set.

[0114] State factor 1 corresponds to a factor that relates to a proportion of an actual heating contact area of the to-be-cooked object to a projected area on a heating side of the to-be-cooked object. State factor 2 corresponds to a factor that relates to a thickness of the to-be-cooked object. State factor 3 corresponds to a factor that relates to a ratio between protein and water that form muscle structure of the to-be-cooked object and portions other than the protein and the water.

[0115] Moreover, information storage unit 17 stores information containing the first stored state weight value, the second stored state weight value, and the stored state core temperature value at each of three levels of, for example, high, mid, and low that are defined for each of state factors 1, 2, 3.

[0116] At this time, the first stored state weight values for state factors 1, 2, 3 are set to the same reference weight value in accordance with the kind of the to-be-cooked object.

[0117] To be more specific, for example, in a case where the kind of the to-be-cooked object is "steak meat", the reference weight value is set to 200 g as illustrated in FIG. 12. Then, information on calibration curves obtained from the first stored state weight value and the second stored state weight value at each of the levels for state factors 1, 2, 3 relative to the reference weight value is stored in information storage unit 17.

[0118] Note that FIG. 12 only shows calibration curves that can be obtained from the first stored state weight value and the second stored state weight value and does not show a calibration curve of the stored state core temperature value.

[0119] The heating cooker according to the present exemplary embodiment is configured as described above.

[0120] Hereinafter, a description will be given of an operation and an action of the above-described heating cooker with reference to FIG. 13.

[0121] FIG. 13 is a line chart illustrating a comparison between information on gradients (MX) stored in information storage unit 17 and gradient (A) calculated from a detected weight in the heating cooker.

[0122] First, as with the first exemplary embodiment, after preparation of cooking is completed, the user selects, at the start of cooking, the kind of to-be-cooked object and the kind of cooking method from a cooking menu on operation display unit 8.

[0123] Then, controller 4 holds, as a reference weight, a weight detected by weight detectors 7 with no to-be-cooked object placed and displays "0 g" on operation display unit 8.

[0124] Next, controller 4 controls heater 3 to start heating cooking vessel 1, and continues to heat cooking vessel 1 so as to reach, for example, a temperature under a reference temperature condition.

[0125] Next, once the temperature under the reference temperature condition is reached, the user puts the to-be-cooked object into cooking vessel 1. Then, as with the first exemplary embodiment, controller 4 measures the first weight value and the second weight value of the to-be-cooked object and stores the first weight value and the second weight value in information storage unit 17.

[0126] Next, controller 4 calculates gradient (A) of the rate of weight change per unit time from a linear correlation line averaged based on each of the measured values.

[0127] The above-described operation steps are identical to the steps in the first exemplary embodiment.

[0128] Next, controller 4 reads, from information storage unit 17, gradient (A) obtained by the calculation, and gradients (M1, M2, M3, to M9) of the rate of weight change associated with a combination of the kind of to-be-cooked object and the kind of cooking method selected at the start and calculated from the first stored state weight value and the second stored state weight value of each of the state factors prestored in information storage unit 17.

[0129] Next, controller 4 performs a comparison operation (|gradient (A) - gradient (MX)|) to obtain gradient (MX) that has a minimal result of (|gradient (A) - gradient (MX)|). Then, controller 4 selects smallest gradient (MX) corresponding to the closest level of a state factor among the three levels of the state factors.

[0130] Herein, the thick line shown in FIG. 13 indicates a correlation line resulting from averaging values corresponding to detected weight changes of the to-be-cooked object (steak meat: 300 g) due to heating. Then, FIG. 13 illustrates that gradient (M5) corresponding to the mid level of state factor 2 is selected, a difference of gradient (M5) with respect to gradient (A) derived by the calculation being smallest.

[0131] Next, in order to make gradient (MX: in this case, M5) of the rate of weight change for the state factor of the to-be-cooked object selected identical to gradient (A) of the rate of weight change of the to-be-cooked object, controller 4 controls a heating condition of heater 3.

[0132] Next, controller 4, as illustrated in FIG. 14, stores again, in information storage unit 17, a weight measured when the heating condition is changed as first weight value (B). Note that the first weight value stored at the start of heating is used for calculation (described below); thus, the first weight value is left in controller 4 as separate first weight value (A).

[0133] Next, after first weight value (B) is detected, controller 4 detects a weight of the to-be-cooked object every about one second and stores the weight as a second weight value in the same manner as illustrated in FIG. 7 according to the first exemplary embodiment. Then, controller 4 calculates an averaged linear correlation line, shown in FIG. 14, from the first weight value (B) and the second weight values stored every second for about ten seconds after the first weight value (b) is stored. Accordingly, gradient (B) of the rate of weight change per unit time is derived from the correlation line by the calculation.

[0134] Next, controller 4 performs a comparison operation on gradient (B) derived and gradient (MX: in this case, M5) of the state factor selected before the heating condition is changed in accordance with (Inequality 1) of the first exemplary embodiment. Note that FIG. 14 also shows gradient (M5) selected before the heating condition is changed.

[0135] At this time, in a case where a difference between gradient (B) and gradient (MX) is out of a range of a predetermined set value that has been preset, controller 4 controls the heating temperature again to adjust the temperature of cooking vessel 1.

[0136] Next, controller 4 calculates another gradient and performs a comparison operation on the gradient thus calculated, in accordance with (Inequality 1).

[0137] Then, until a difference between the gradient calculated and gradient (MX) is within the range of the predetermined set value, controller 4 repeatedly controls heater 3 for heating and performs the above-described operation.

[0138] Accordingly, once the difference from gradient (MX) is within the range of the predetermined set value, a difference between the second weight value and the second stored state weight value remains in a relative relationship with a constant proportion. At this time, in the above-described state, a water evaporation rate is the same between the weight change of the to-be-cooked object and the calibration curve of the state factor selected, which makes it possible to estimate that the core temperature value is also substantially the same.

[0139] Next, controller 4 calculates, with (Equation 2) shown below, the second stored state weight value that has a water evaporation rate identical to the water evaporation rate of the second weight value from a correlation line of rates of weight change calculated from the first stored state weight value and the second stored state weight value.

[0140] Then, as illustrated in FIG. 15, controller 4 estimates the current core temperature value of the to-be-cooked object from the stored state core temperature value corresponding to second stored state weight value (B) that is approximate to the second weight value.

$$\text{second stored state weight value (B)} = (\text{first stored state weight value/first weight value (A)}) \times \text{second weight value} \ldots \text{(Equation 2)}$$

[0141] Next, controller 4 repeatedly performs a comparison operation for estimating the above-described core temperature value until a predetermined core temperature value is reached.

[0142] Next, when the core temperature value of the to-be-cooked object estimated reaches the predetermined core temperature value, controller 4 determines that the finish state of the to-be-cooked object that has been heated is an optimum state.

[0143] Then, controller 4 stops heating cooking vessel 1 by heater 3. At the same time, controller 4 informs the user, via the operation display unit, that cooking has been completed.

[0144] According to the present exemplary embodiment, an amount of information to be checked beforehand can be reduced, which eliminates the need to store a large amount of information. As a result, information storage unit 17 may have a smaller memory capacity.

[0145] As described above, the heating cooker according to the present invention includes a heater that heats a to-be-cooked object, a weight detector that measures a weight of the to-be-cooked object, a selection part that selects a kind of the to-be-cooked object to be heated, an information storage unit that stores information associated with the kind of the to-be-cooked object selected by the selection part, and a controller that controls the heater based on a result of the measurement of the weight detector and the kind of the to-be-cooked object selected by the selection part. The controller compares a first weight value of the to-be-cooked object, a second weight value of the to-be-cooked object, and the information to estimate a state of the to-be-cooked object that currently heated and perform heating control. The first weight value is measured by the weight detector, the second weight value is measured by the weight detector during heating by the heater after the measurement of the first weight value, and the information is associated with the kind of the to-be-cooked object selected by the selection part and stored in the information storage unit.

[0146] In this configuration, heating the to-be-cooked object is controlled under a heating condition in accordance with an internal heat transfer state in the state of the to-be-cooked object. Accordingly, from the weight change of the to-be-cooked object, the controller can accurately estimate the core temperature and determine the finish state of the to-be-cooked object. As a result, the to-be-cooked object can be finished to an optimum state.

[0147] Furthermore, in the heating cooker according to the present invention, the first weight value of the to-be-cooked object corresponds to a value resulting from measurement of the to-be-cooked object made by the weight detector at at least one of timing when heating the to-be-cooked object is started, timing when a first predetermined time elapses after the start of heating of the to-be-cooked object, and timing when a temperature of the to-be-cooked object reaches a first predetermined temperature after the start of heating of the to-be-cooked object. Moreover, the second weight value of the to-be-cooked object may correspond to a value resulting from measurement of the to-be-cooked object made by the weight detector at at least one of timing when a second predetermined time elapses after the measurement of the first weight value and timing when the temperature of the to-be-cooked object reaches a second predetermined temperature after the start of heating of the to-be-cooked object, the second predetermined temperature being different from the first predetermined temperature.

[0148] Accordingly, the heating time and the weight change due to heating can be more accurately checked. Thus, the information on the to-be-cooked object stored in the information storage unit and the weight change due to heating can be more accurately compared.

[0149] Furthermore, in the heating cooker according to the present invention, the state of the to-be-cooked object may correspond to at least one of a proportion of an actual heating contact area of the to-be-cooked object to a projected area on a heating side of the to-be-cooked object, a thickness of the to-be-cooked object, and a ratio between protein and water that form muscle in the to-be-cooked object and portions other than the protein and the water.

[0150] Accordingly, a difference in a state of heat transfer into the to-be-cooked object during heating can be accurately determined.

[0151] Furthermore, in the heating cooker according to the present invention, the information stored in the information storage unit may include a first stored weight value of the to-be-cooked object, a second stored weight value at a time when heating has been performed for a predetermined time, and a stored core temperature value of the to-be-cooked object estimated from the first stored weight value and the second stored weight value that are associated with the kind of the to-be-cooked object.

[0152] Accordingly, from an amount of the weight change of the to-be-cooked object relative to the heating time, the state of the core temperature of the to-be-cooked object can be estimated.

[0153] Furthermore, in the heating cooker according to the present invention, the information stored in the information storage unit may include a first stored state weight value of the to-be-cooked object, a second stored state weight value at a time when heating has been performed for a predetermined time, a rate of weight change calculated from the first stored state weight value and the second stored state weight value, and a stored state core temperature value of the to-be-cooked object estimated from the first stored state weight value and the second stored state weight value that are associated with the state of the to-be-cooked object.

[0154] Accordingly, the amount of the weight change of the to-be-cooked object relative to the heating time can be compared with the state of the to-be-cooked object. Thus, a change of the heating condition suitable for the state of the to-be-cooked object and the state of the core temperature of the to-be-cooked object can be more accurately estimated.

[0155] Furthermore, in the heating cooker according to the present invention, the controller may control the heater to achieve the rate of weight change stored in the information storage unit in accordance with the state estimated of the to-be-cooked object that currently heated.

[0156] Accordingly, the finish state of the to-be-cooked object and the state of the core temperature of the to-be-cooked object can be more accurately estimated.

[0157] Furthermore, in the heating cooker according to the present invention, the controller may control the heater to achieve the rate of weight change stored in the information storage unit in accordance with the state estimated of the to-be-cooked object that currently heated. The controller may perform, when the second weight value proportional to the second stored state weight value corresponding to the stored state core temperature value predetermined is reached, at least one of stopping the heater and announcing the stored state core temperature value predetermined.

[0158] This makes it possible to prevent the to-be-cooked object from scorching due to excessive heating and prevent the finish state of the to-be-cooked object from being degraded, such as being tough. As a result, cooking the to-be-cooked object can be completed in an optimum finish state.

[0159] The heating cooker according to the present invention further includes an operation display unit. The controller may control the heater to achieve the rate of weight change stored in the information storage unit in accordance with the state estimated of the to-be-cooked object that currently heated, and displays, on the operation display unit, at least one of the second weight value, and a stored state core temperature value of the to-be-cooked object estimated from a proportion of the second weight value to the first weight value measured before and after the start of heating or the second stored state weight value.

[0160] Accordingly, the user can visually recognize state change of the to-be-cooked object. Thus, even when the user changes the heating condition in the middle of cooking with heat, every change of the to-be-cooked object can be checked. As a result, the user can cook the to-be-cooked object with a sense of security.

[0161] Furthermore, in the heating cooker according to the present invention, the controller may control the heater to achieve the rate of weight change stored in the information storage unit in accordance with the state estimated of the to-be-cooked object that currently heated, and allow, when the second stored state weight value corresponding to the stored state core temperature value predetermined is reached, the stored state core temperature value predetermined to be changed.

[0162] Accordingly, once a desired finish state is stored, heating can be performed until the desired finish state thus stored is achieved in the next cooking. As a result, usability of the heating cooker is enhanced.

INDUSTRIAL APPLICABILITY

[0163] The heating cooker according to the present invention is capable of accurately estimating a core temperature of a to-be-cooked object from a weight change, caused by heating, of the to-be-cooked object to finish the to-be-cooked object to an optimum state. Accordingly, the heating cooker can be used in various applications requiring cooking with heat that achieves an appropriate finish state.

REFERENCE MARKS IN THE DRAWINGS

[0164]

1: cooking vessel
2: top plate
3: heater
4: controller
5: housing
5a, 6a: flange
5b, 6b: bottom surface
6: support part
6bb, 12a: opening
7: weight detector
7a: signal line
8: operation display unit
9: inverter
10: drive controller
11: steel plate
11b: recess
12: placing table
12b: upper surface
12aa: end
13: weight sensor
13a: through hole
14: fixed connecting part
15: load transfer part
15a: convex part
16: load receiving part
16a: concave part
17: information storage unit

Claims

1. A heating cooker comprising:

a heater that heats a to-be-cooked object;
a weight detector that measures a weight of the to-be-cooked object;
a selection part that selects a kind of the to-be-cooked object to be heated;
an information storage unit that stores information associated with the kind selected by the selection part; and
a controller that controls the heater based on a result of the measurement of the weight detector and the kind selected by the selection part,
wherein the controller compares a first weight value of the to-be-cooked object, a second weight value, and the

information to estimate a state of the to-be-cooked object that currently heated and perform heating control,
the first weight value being measured by the weight detector,
the second weight value corresponding to a weight of the to-be-cooked object heated by the heater after the measurement of the first weight value and measured by the weight detector, and
the information being associated with the kind selected by the selection part and stored in the information storage unit.

2. The heating cooker according to claim 1, wherein
the first weight value of the to-be-cooked object corresponds to a value resulting from measurement of the to-be-cooked object made by the weight detector at at least one of timing when heating the to-be-cooked object is started, timing when a first predetermined time elapses after the start of heating of the to-be-cooked object, and timing when a temperature of the to-be-cooked object reaches a first predetermined temperature after the start of heating of the to-be-cooked object, and
the second weight value of the to-be-cooked object corresponds to a value resulting from measurement of the to-be-cooked object made by the weight detector at at least one of timing when a second predetermined time elapses after the measurement of the first weight value and timing when the temperature of the to-be-cooked object reaches a second predetermined temperature after the start of heating of the to-be-cooked object, the second predetermined temperature being different from the first predetermined temperature.

3. The heating cooker according to claim 1, wherein the state of the to-be-cooked object corresponds to at least one of a proportion of an actual heating contact area of the to-be-cooked object to a projected area on a heating side of the to-be-cooked object, a thickness of the to-be-cooked object, and a ratio between protein and water that form muscle in the to-be-cooked object and portions other than the protein and the water.

4. The heating cooker according to claim 1, wherein the information includes:

a first stored weight value of the to-be-cooked object;
a second stored weight value at a time when heating has been performed for a predetermined time; and
a stored core temperature value of the to-be-cooked object estimated from the first stored weight value and the second stored weight value that are associated with the kind of the to-be-cooked object.

5. The heating cooker according to claim 1, wherein the information includes:

a first stored state weight value of the to-be-cooked object;
a second stored state weight value at a time when heating has been performed for a predetermined time;
a rate of weight change calculated from the first stored state weight value and the second stored state weight value; and
a stored state core temperature value of the to-be-cooked object estimated from the first stored state weight value and the second stored state weight value that are associated with the state of the to-be-cooked object.

6. The heating cooker according to claim 5, wherein the controller controls the heater to achieve the rate of weight change stored in the information storage unit in accordance with the state estimated of the to-be-cooked object that currently heated.

7. The heating cooker according to claim 5, wherein
the controller controls the heater to achieve the rate of weight change stored in the information storage unit in accordance with the state estimated of the to-be-cooked object that currently heated, and
performs, when the second weight value proportional to the second stored state weight value corresponding to the stored state core temperature value predetermined is reached, at least one of stopping the heater and announcing the stored state core temperature value predetermined.

8. The heating cooker according to claim 5, further comprising an operation display unit,
wherein the controller controls the heater to achieve the rate of weight change stored in the information storage unit in accordance with the state estimated of the to-be-cooked object that currently heated, and
displays, on the operation display unit, at least one of the second weight value, and a stored state core temperature value of the to-be-cooked object estimated from a proportion of the second weight value to the first weight value measured before and after the start of heating or the second stored state weight value.

9. The heating cooker according to claim 5, wherein
the controller controls the heater to achieve the rate of weight change stored in the information storage unit in accordance with the state estimated of the to-be-cooked object that currently heated, and
allows, when the second stored state weight value corresponding to the stored state core temperature value predetermined is reached, the stored state core temperature value predetermined to be changed.

FIG. 1

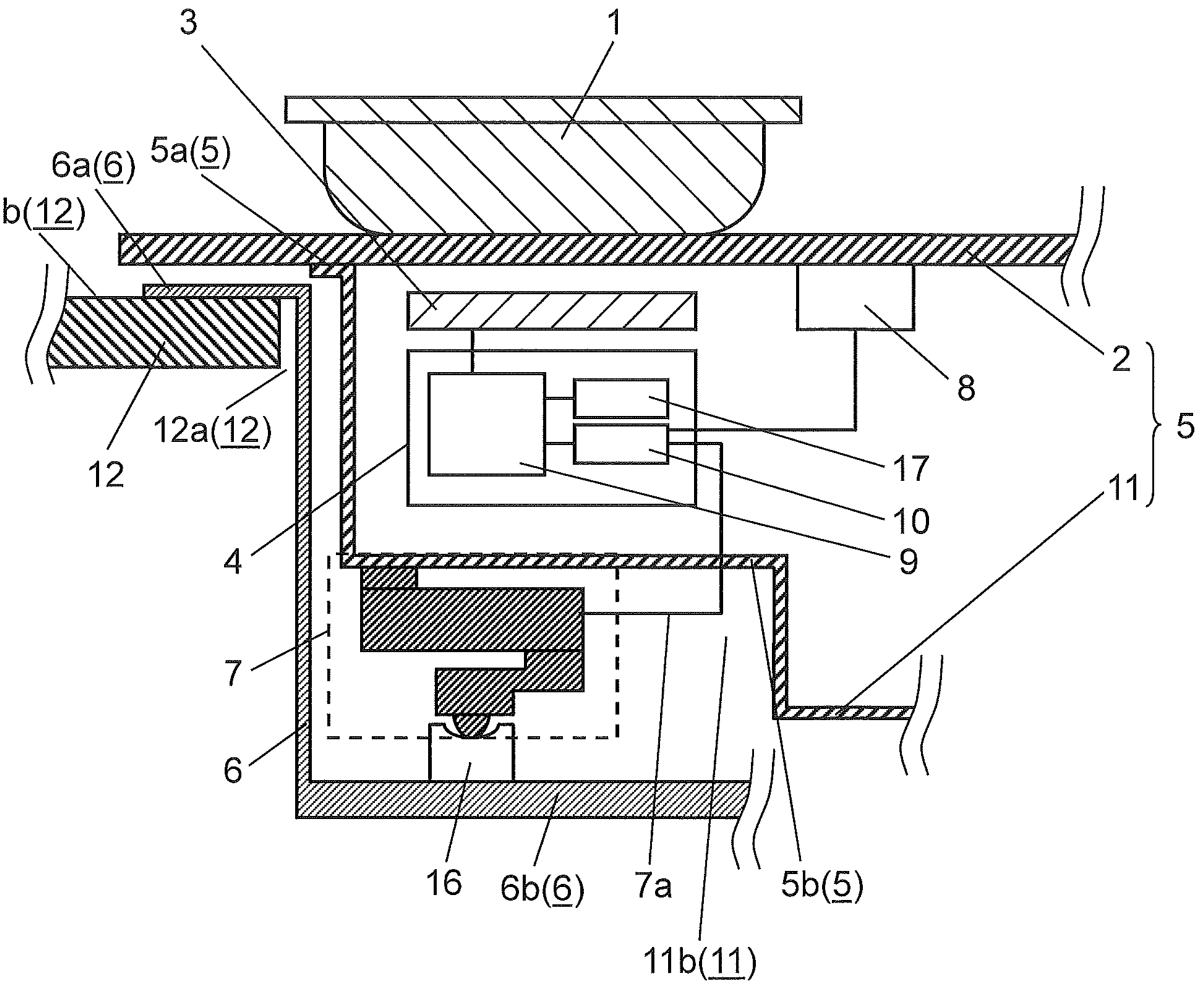


FIG. 2

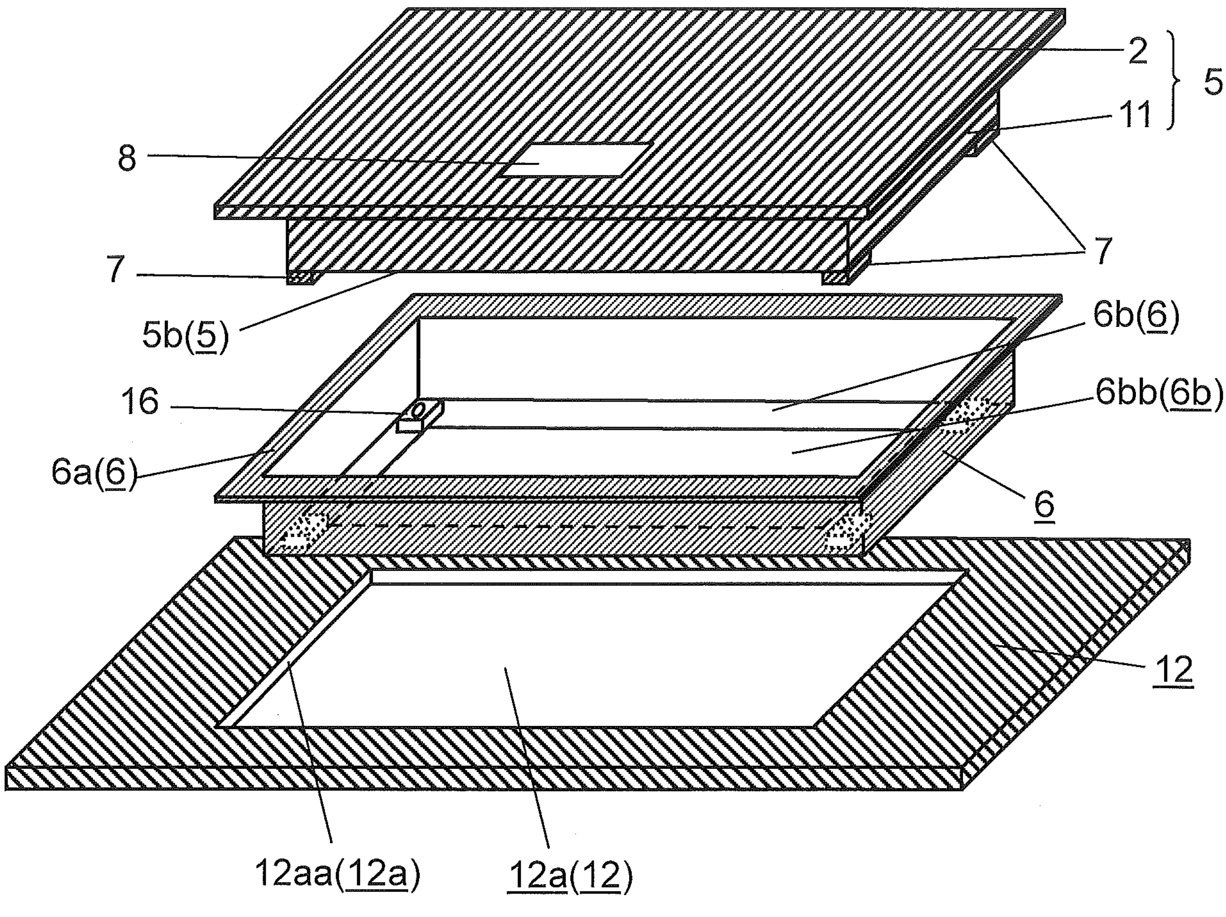


FIG. 3

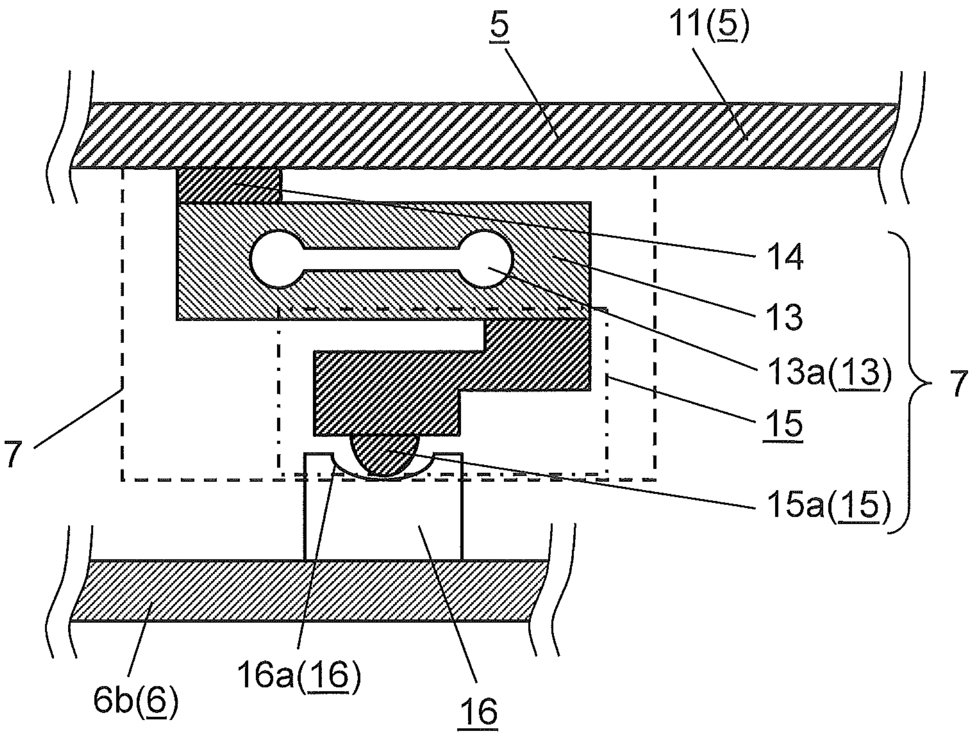


FIG. 4

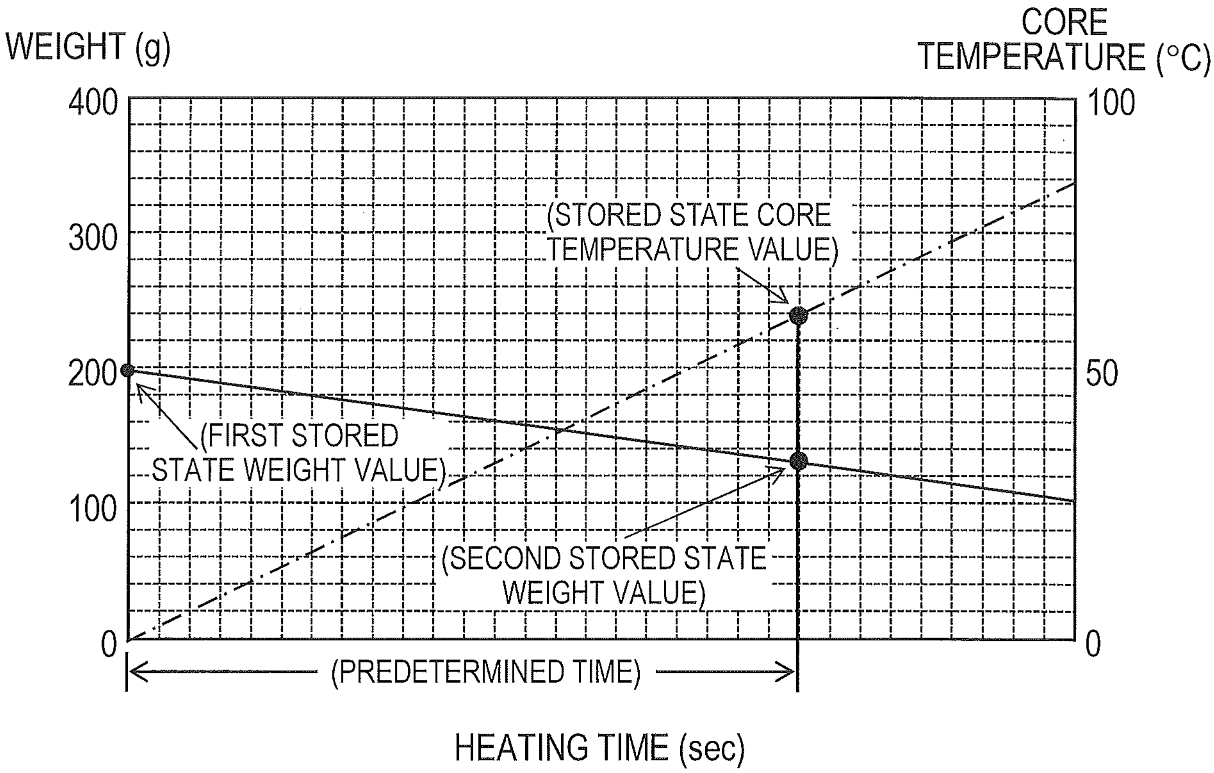

WEIGHT (g)
CORE TEMPERATURE (°C)
400
300
200
100
0
100
50
0
(STORED STATE CORE TEMPERATURE VALUE)
(FIRST STORED STATE WEIGHT VALUE)
(SECOND STORED STATE WEIGHT VALUE)
(PREDETERMINED TIME)
HEATING TIME (sec)

FIG. 5A

FIRST STORED STATE WEIGHT VALUE=100(g)

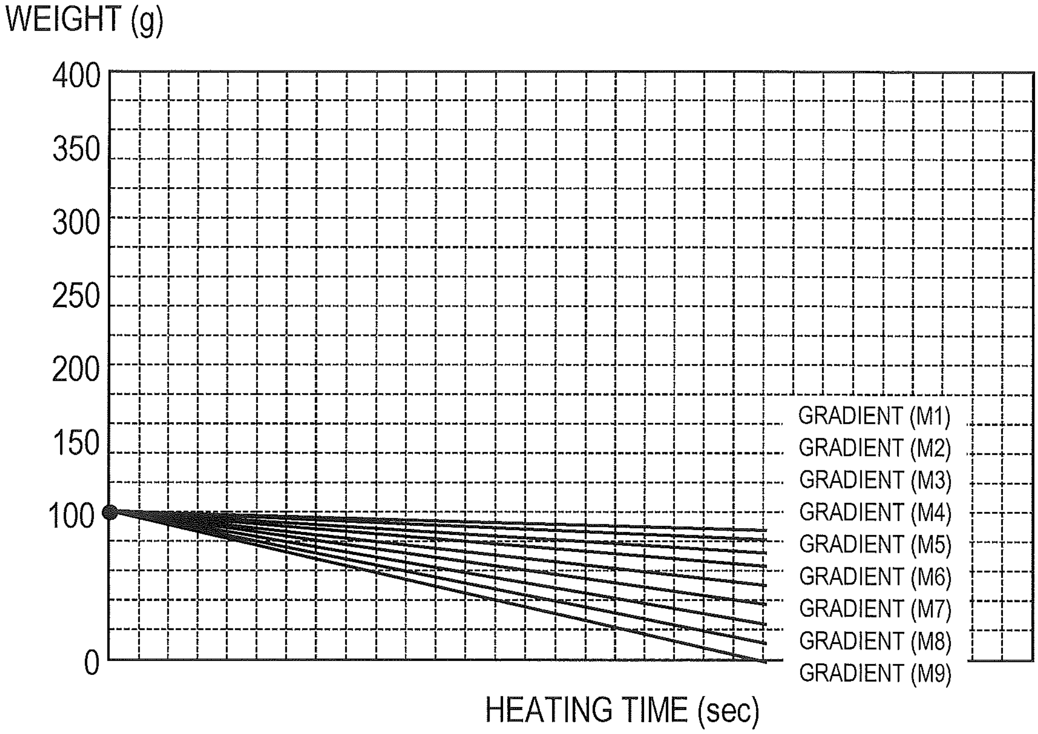


FIG. 5B

FIRST STORED STATE WEIGHT VALUE=150(g)

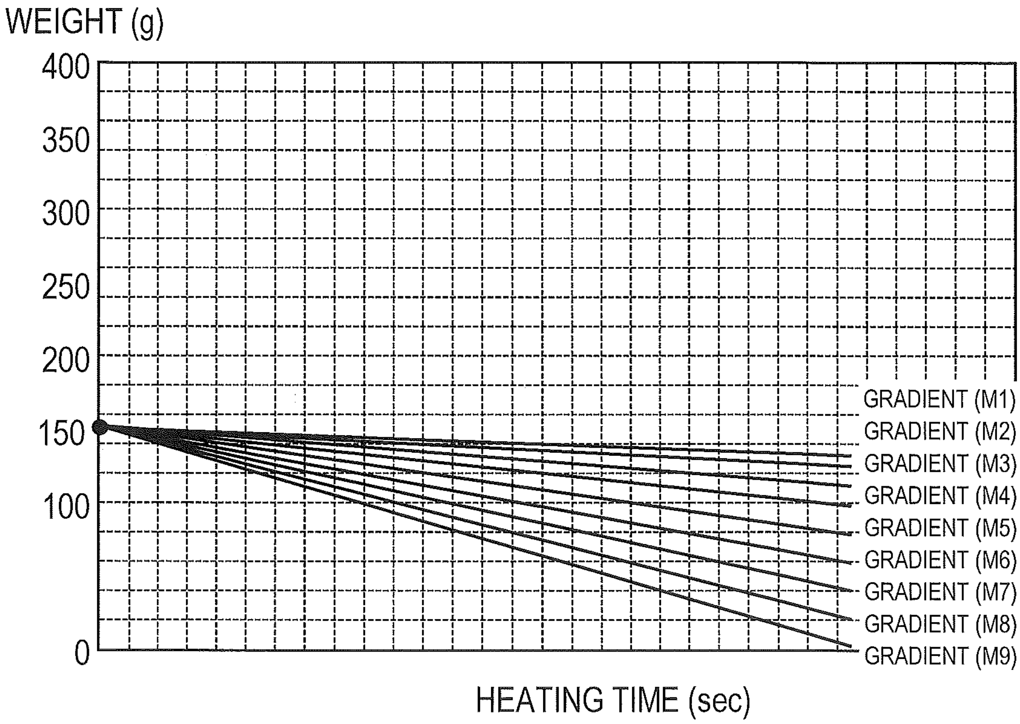


FIG. 5C

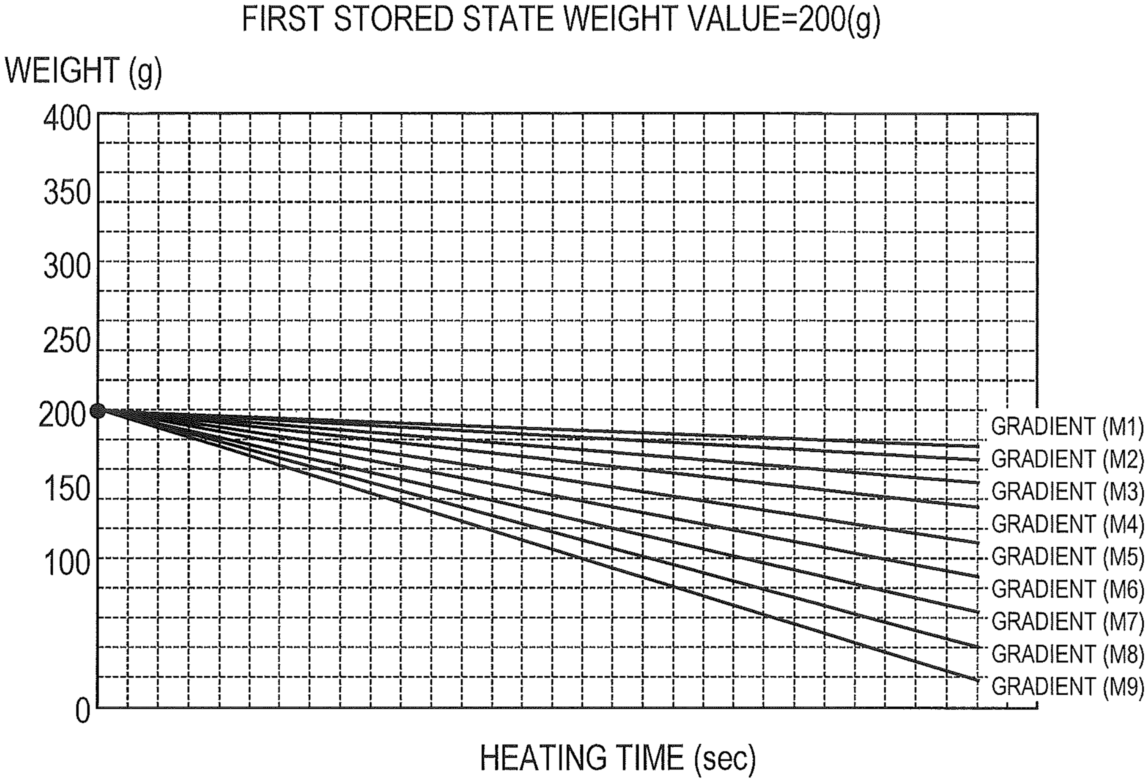

FIRST STORED STATE WEIGHT VALUE=200(g)
WEIGHT (g)
400
350
300
250
200
150
100
0
GRADIENT (M1)
GRADIENT (M2)
GRADIENT (M3)
GRADIENT (M4)
GRADIENT (M5)
GRADIENT (M6)
GRADIENT (M7)
GRADIENT (M8)
GRADIENT (M9)
HEATING TIME (sec)

FIG. 5D

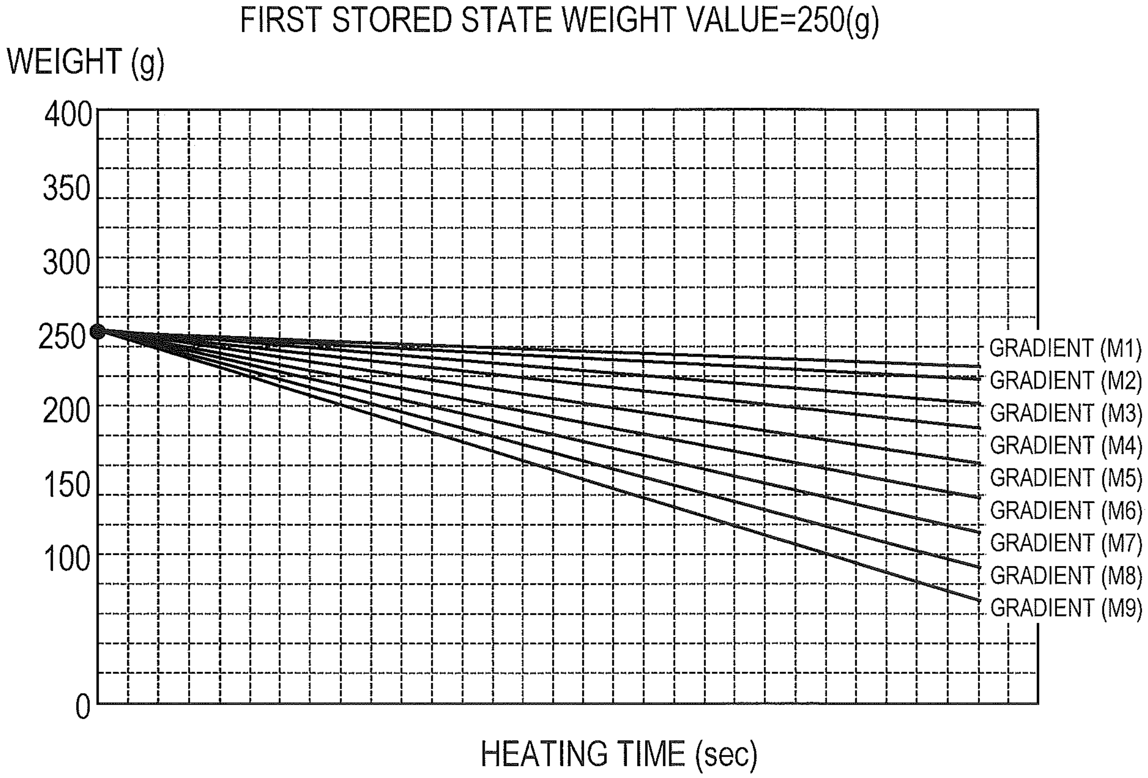

FIRST STORED STATE WEIGHT VALUE=250(g)
WEIGHT (g)
400
350
300
250
200
150
100
0
GRADIENT (M1)
GRADIENT (M2)
GRADIENT (M3)
GRADIENT (M4)
GRADIENT (M5)
GRADIENT (M6)
GRADIENT (M7)
GRADIENT (M8)
GRADIENT (M9)
HEATING TIME (sec)

FIG. 6A

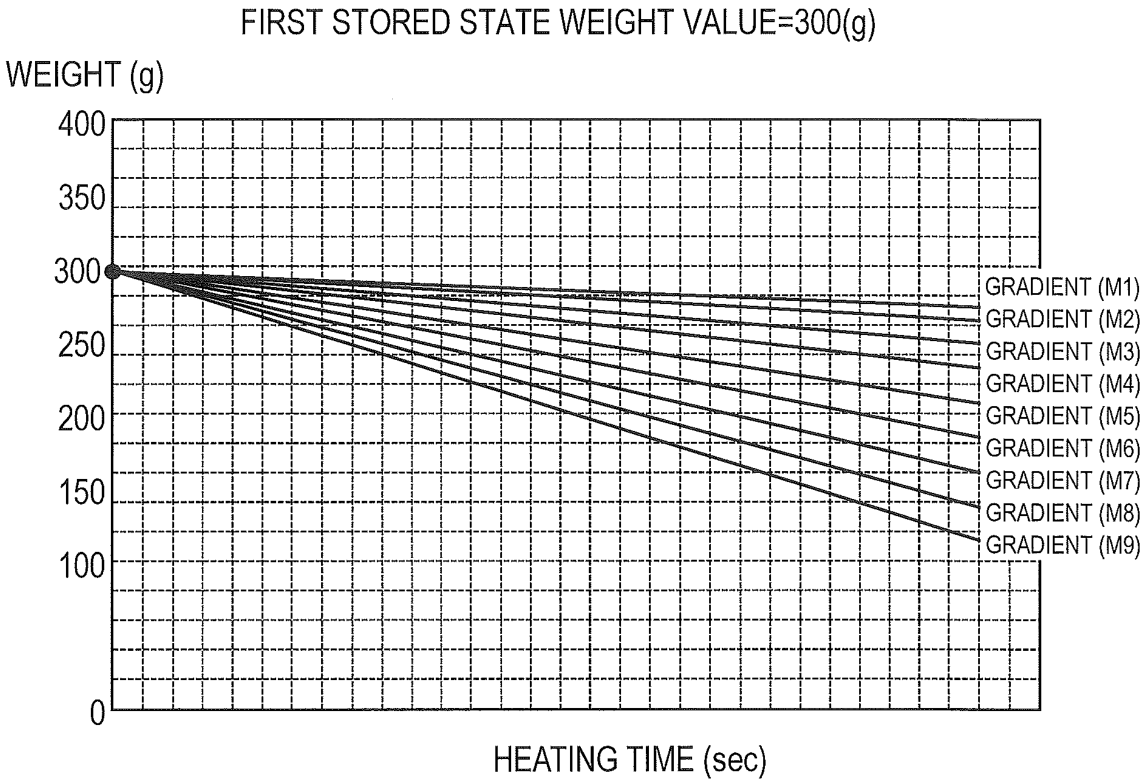

FIRST STORED STATE WEIGHT VALUE=300(g)
WEIGHT (g)
400
350
300
250
200
150
100
0
GRADIENT (M1)
GRADIENT (M2)
GRADIENT (M3)
GRADIENT (M4)
GRADIENT (M5)
GRADIENT (M6)
GRADIENT (M7)
GRADIENT (M8)
GRADIENT (M9)
HEATING TIME (sec)

FIG. 6B

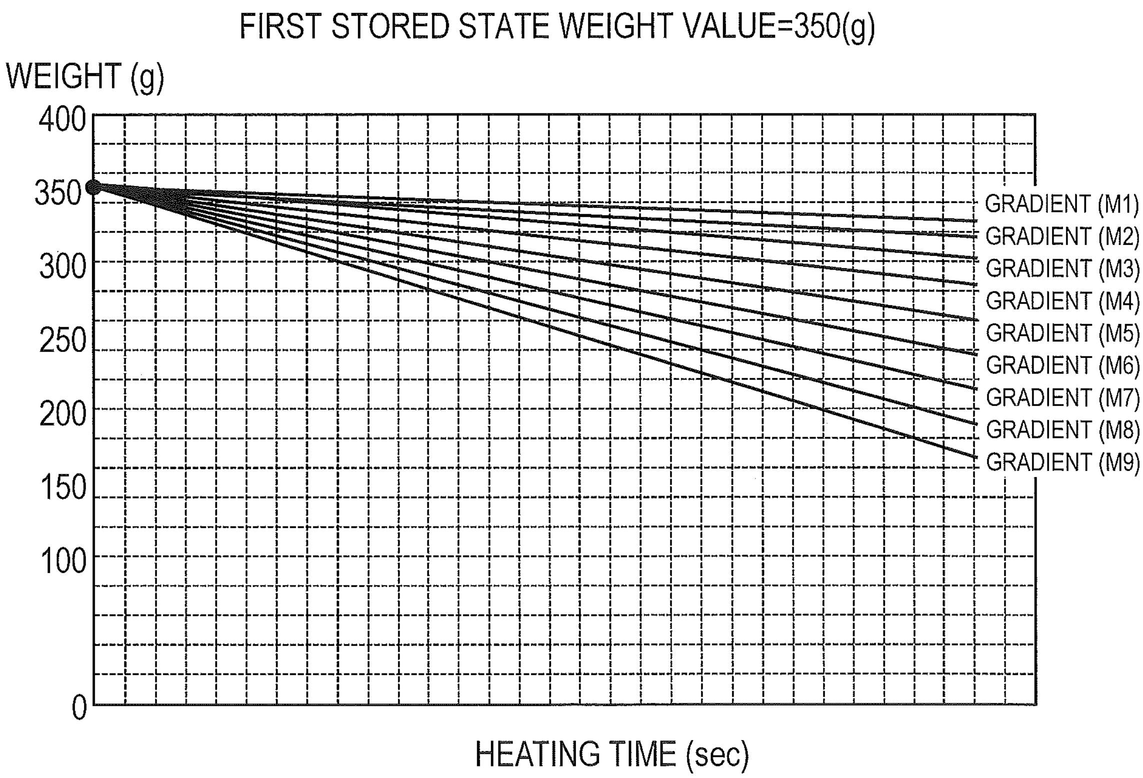

FIRST STORED STATE WEIGHT VALUE=350(g)
WEIGHT (g)
400
350
300
250
200
150
100
0
GRADIENT (M1)
GRADIENT (M2)
GRADIENT (M3)
GRADIENT (M4)
GRADIENT (M5)
GRADIENT (M6)
GRADIENT (M7)
GRADIENT (M8)
GRADIENT (M9)
HEATING TIME (sec)

FIG. 6C

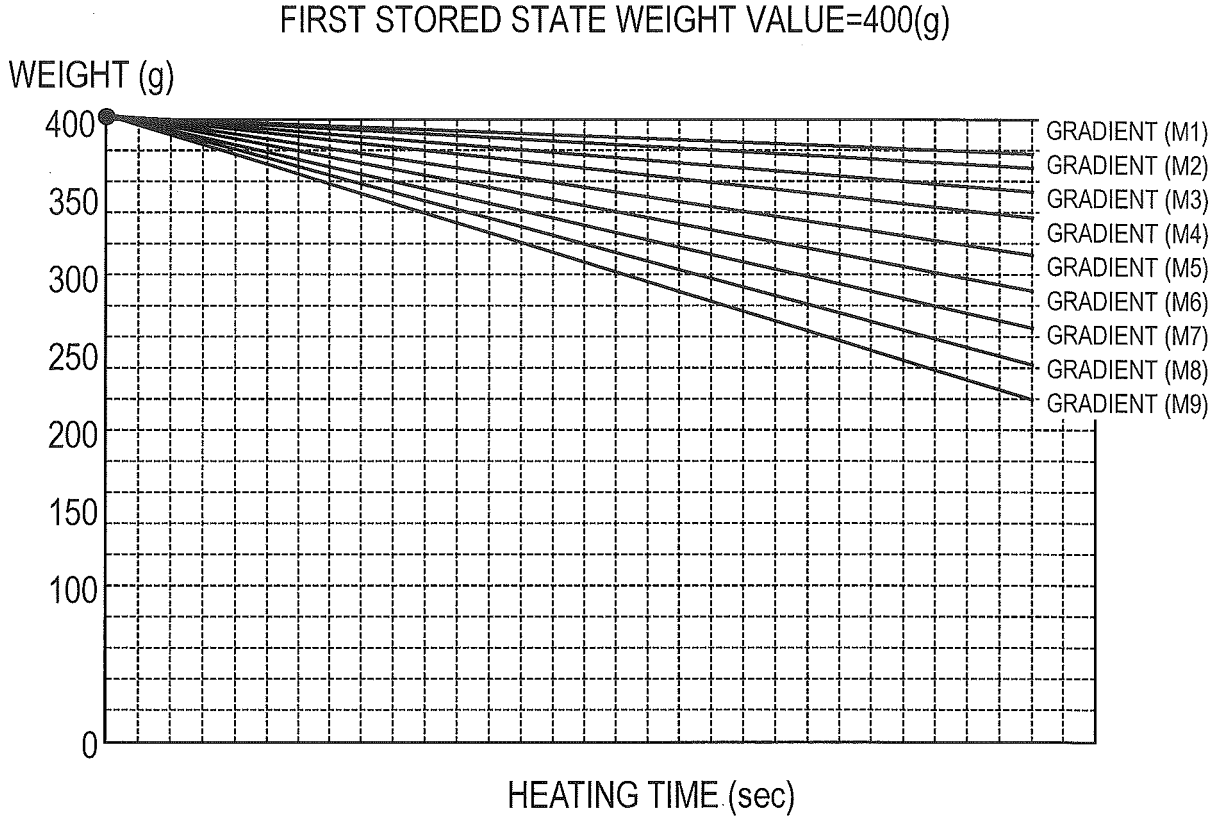

FIRST STORED STATE WEIGHT VALUE=400(g)
WEIGHT (g)
400
350
300
250
200
150
100
0
GRADIENT (M1)
GRADIENT (M2)
GRADIENT (M3)
GRADIENT (M4)
GRADIENT (M5)
GRADIENT (M6)
GRADIENT (M7)
GRADIENT (M8)
GRADIENT (M9)
HEATING TIME (sec)

FIG. 7

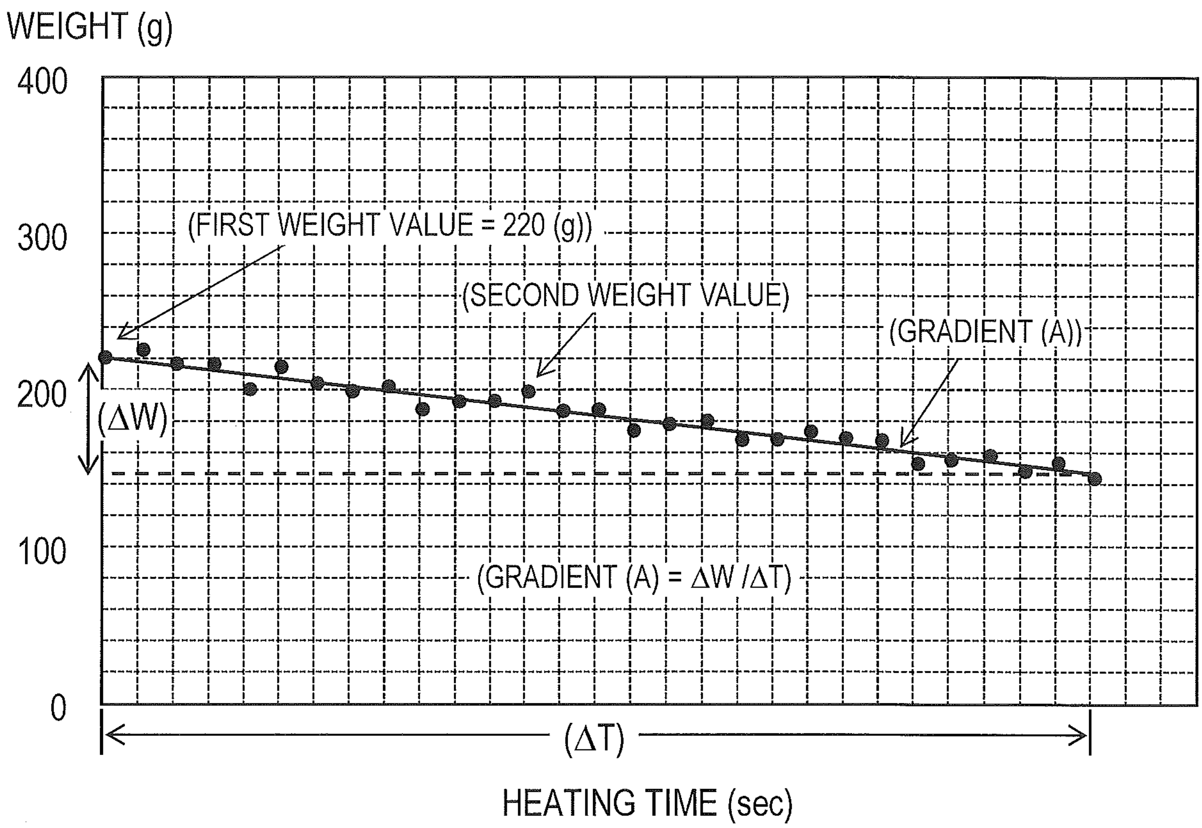

WEIGHT (g)
400
300
200
100
0
(FIRST WEIGHT VALUE = 220 (g))
(SECOND WEIGHT VALUE)
(GRADIENT (A))
(ΔW)
(GRADIENT (A) = ΔW /ΔT)
(ΔT)
HEATING TIME (sec)

FIG. 8

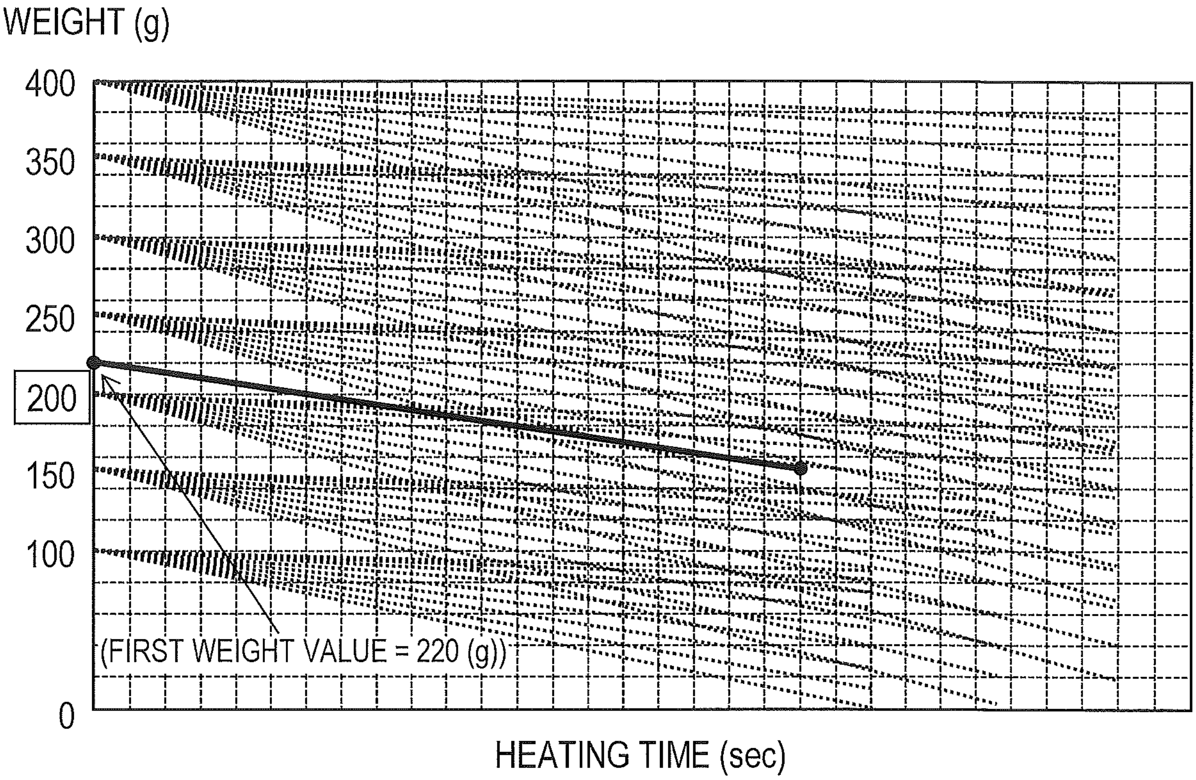

WEIGHT (g)
400
350
300
250
200
150
100
0
(FIRST WEIGHT VALUE = 220 (g))
HEATING TIME (sec)

FIG. 9

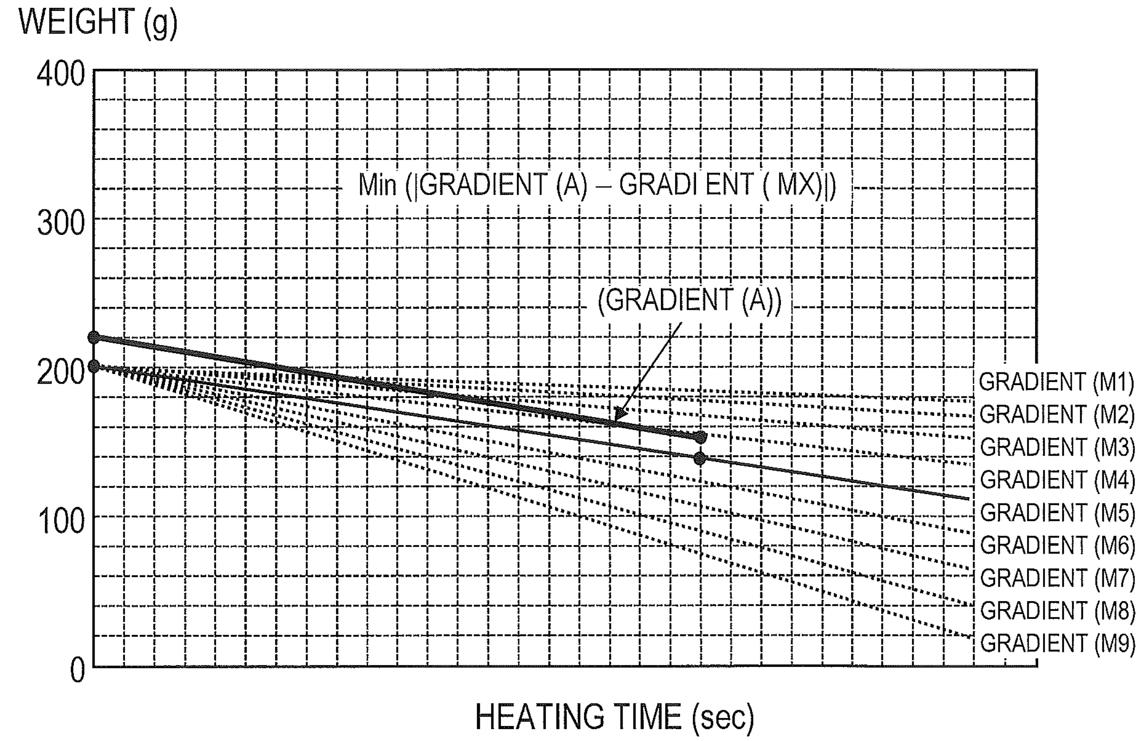

WEIGHT (g)
400
300
200
100
0
Min (|GRADIENT (A) – GRADI ENT (MX)|)
(GRADIENT (A))
GRADIENT (M1)
GRADIENT (M2)
GRADIENT (M3)
GRADIENT (M4)
GRADIENT (M5)
GRADIENT (M6)
GRADIENT (M7)
GRADIENT (M8)
GRADIENT (M9)
HEATING TIME (sec)

FIG. 10

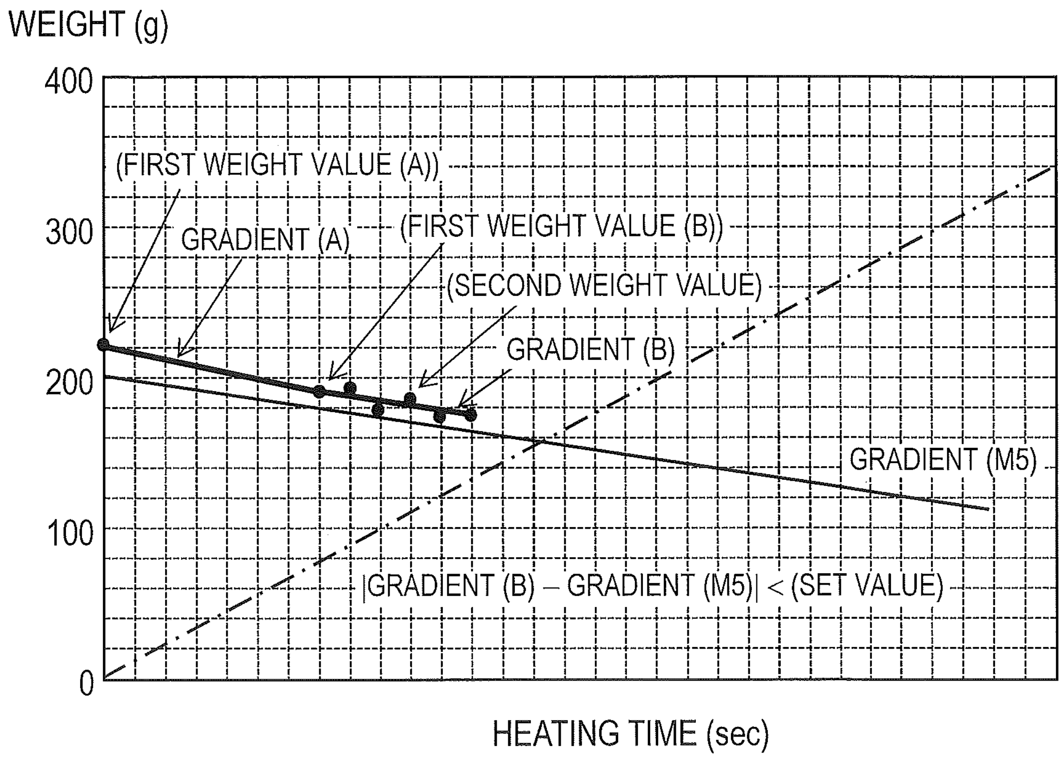

WEIGHT (g)
400
300
200
100
0
(FIRST WEIGHT VALUE (A))
GRADIENT (A)
(FIRST WEIGHT VALUE (B))
(SECOND WEIGHT VALUE)
GRADIENT (B)
GRADIENT (M5)
|GRADIENT (B) – GRADIENT (M5)| < (SET VALUE)
HEATING TIME (sec)

FIG. 11

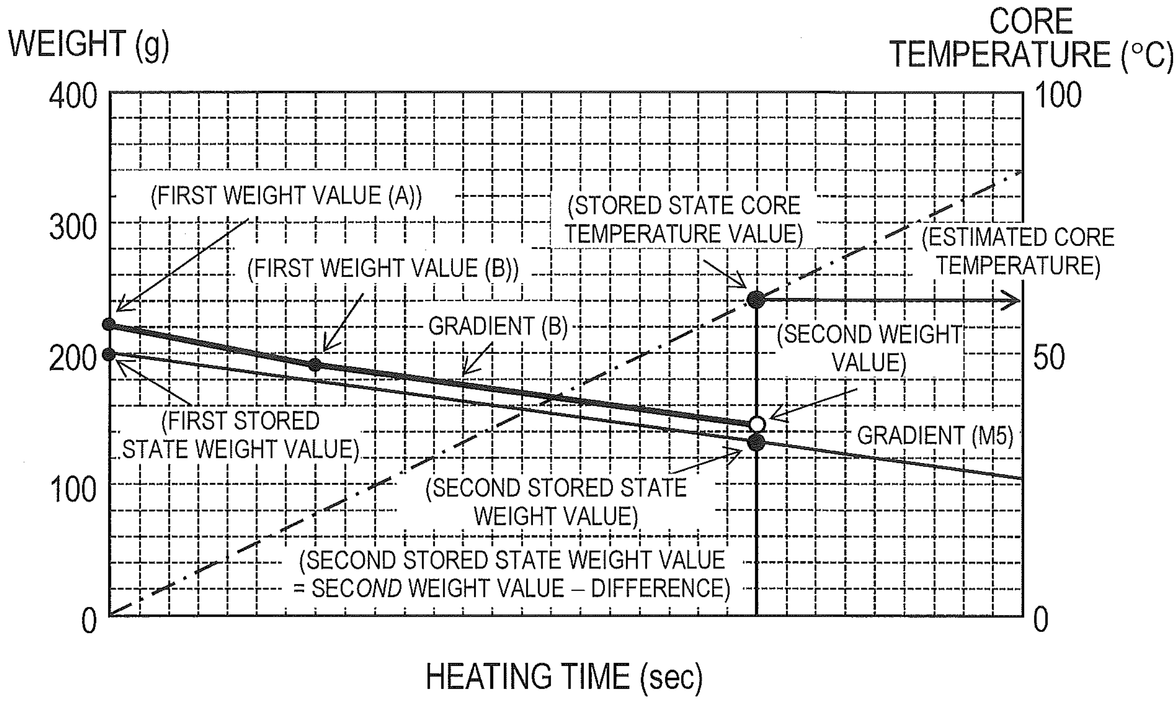

WEIGHT (g)
CORE TEMPERATURE (°C)
400
300
200
100
0
100
50
0
(FIRST WEIGHT VALUE (A))
(FIRST WEIGHT VALUE (B))
GRADIENT (B)
(STORED STATE CORE TEMPERATURE VALUE)
(ESTIMATED CORE TEMPERATURE)
(SECOND WEIGHT VALUE)
GRADIENT (M5)
(FIRST STORED STATE WEIGHT VALUE)
(SECOND STORED STATE WEIGHT VALUE)
(SECOND STORED STATE WEIGHT VALUE = SECOND WEIGHT VALUE – DIFFERENCE)
HEATING TIME (sec)

FIG. 12

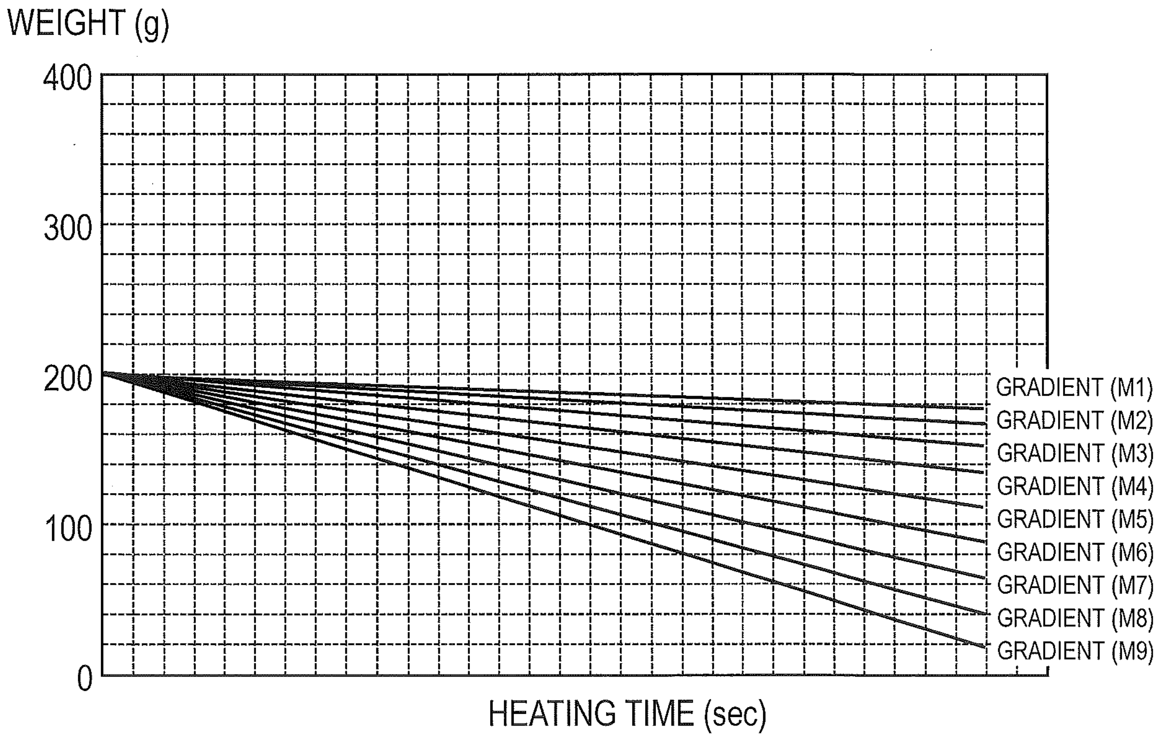

WEIGHT (g)
400
300
200
100
0
GRADIENT (M1)
GRADIENT (M2)
GRADIENT (M3)
GRADIENT (M4)
GRADIENT (M5)
GRADIENT (M6)
GRADIENT (M7)
GRADIENT (M8)
GRADIENT (M9)
HEATING TIME (sec)

FIG. 13

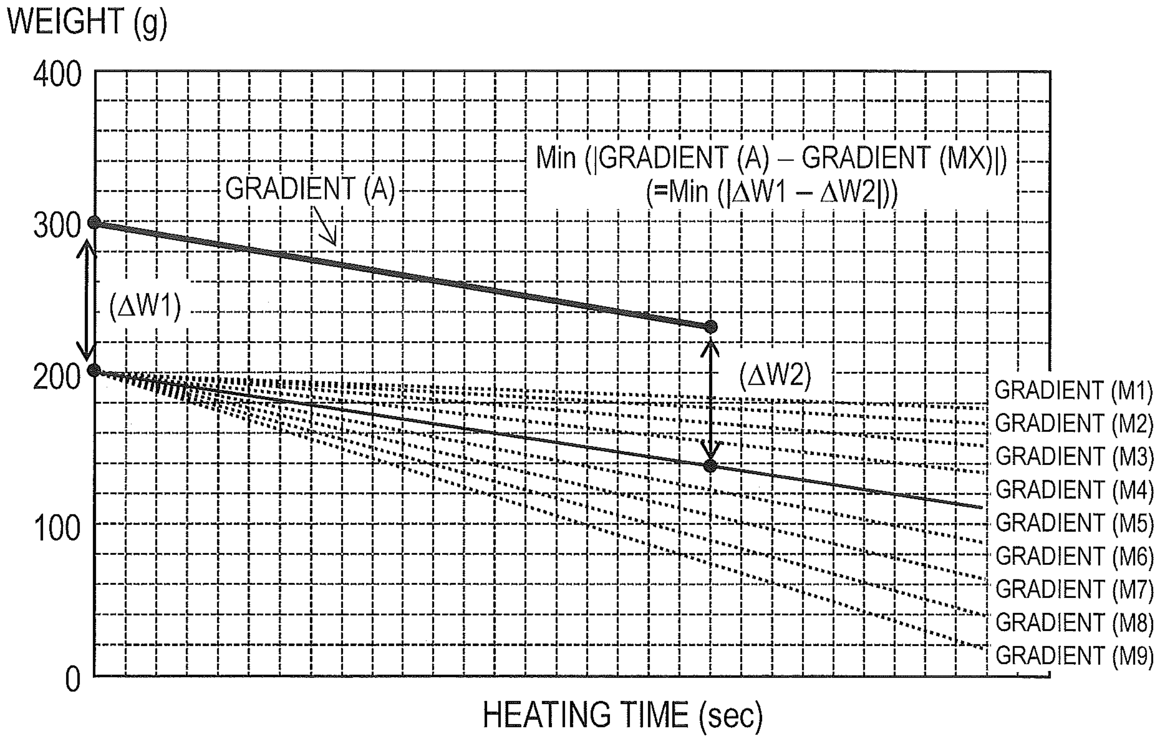

WEIGHT (g)
400
300
200
100
0
GRADIENT (A)
Min (|GRADIENT (A) – GRADIENT (MX)|)
(=Min (|ΔW1 – ΔW2|))
(ΔW1)
(ΔW2)
GRADIENT (M1)
GRADIENT (M2)
GRADIENT (M3)
GRADIENT (M4)
GRADIENT (M5)
GRADIENT (M6)
GRADIENT (M7)
GRADIENT (M8)
GRADIENT (M9)
HEATING TIME (sec)

FIG. 14

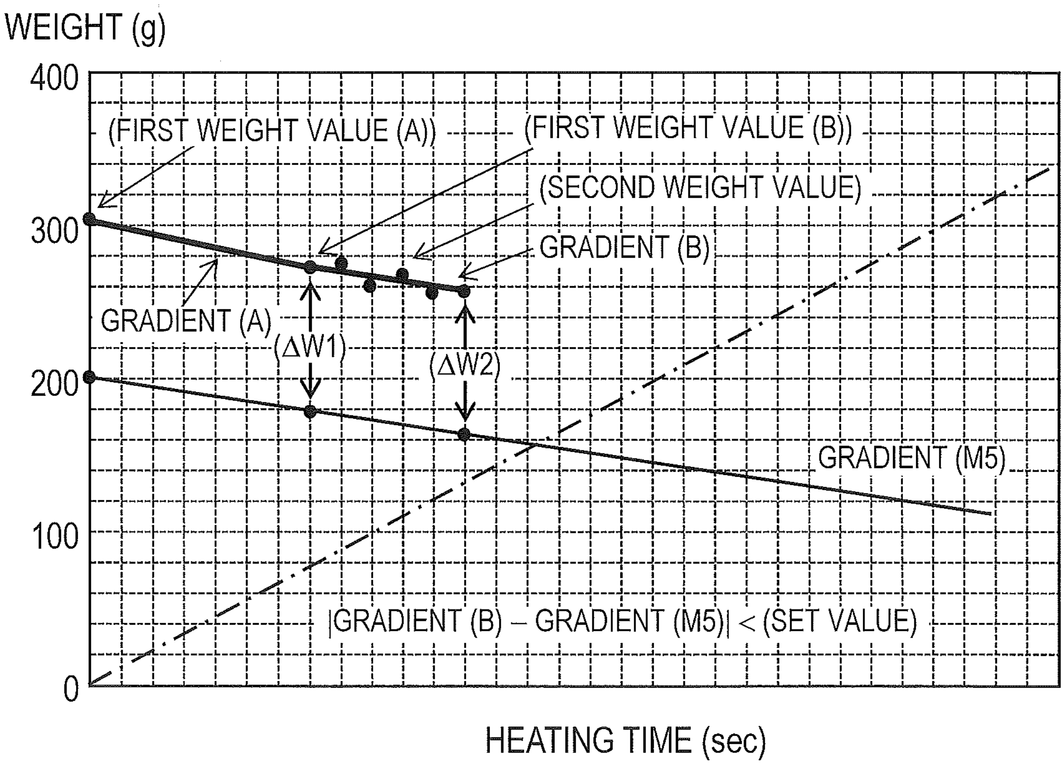
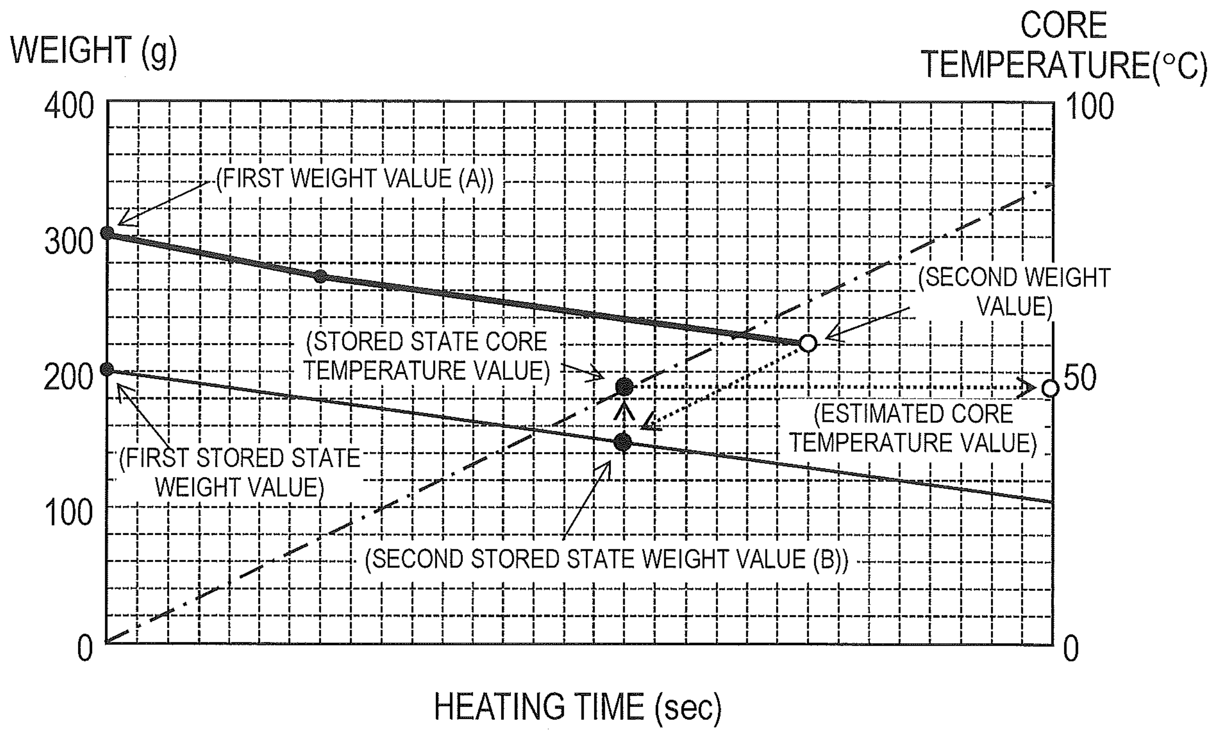

WEIGHT (g)
400
300
200
100
0
(FIRST WEIGHT VALUE (A))
(FIRST WEIGHT VALUE (B))
(SECOND WEIGHT VALUE)
GRADIENT (B)
GRADIENT (A)
(ΔW1)
(ΔW2)
GRADIENT (M5)
|GRADIENT (B) – GRADIENT (M5)| < (SET VALUE)
HEATING TIME (sec)

FIG. 15


WEIGHT (g)
CORE TEMPERATURE(°C)
400
300
200
100
0
100
50
0
(FIRST WEIGHT VALUE (A))
(SECOND WEIGHT VALUE)
(STORED STATE CORE TEMPERATURE VALUE)
(ESTIMATED CORE TEMPERATURE VALUE)
(FIRST STORED STATE WEIGHT VALUE)
(SECOND STORED STATE WEIGHT VALUE (B))
HEATING TIME (sec)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/001161

A. CLASSIFICATION OF SUBJECT MATTER
F24C7/04(2006.01)i, *F24C7/08*(2006.01)i, *H05B6/12*(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)
F24C7/04, F24C7/08, H05B6/12

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2017
Kokai Jitsuyo Shinan Koho	1971-2017	Toroku Jitsuyo Shinan Koho	1994-2017

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 8-112066 A (Matsushita Electric Industrial Co., Ltd.), 07 May 1996 (07.05.1996), paragraphs [0005] to [0025] (Family: none)	1-3
X	JP 5-113219 A (Matsushita Electric Industrial Co., Ltd.), 07 May 1993 (07.05.1993), paragraphs [0002] to [0030] & US 5389764 A & EP 529644 A2 & DE 69221043 T & AU 2135792 A & CA 2077018 A1	1-5

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

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- "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
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- "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
22 March 2017 (22.03.17)	04 April 2017 (04.04.17)

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

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INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2017/001161

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2004-245540 A (Matsushita Electric Industrial Co., Ltd.), 02 September 2004 (02.09.2004), paragraphs [0010] to [0032] (Family: none)	1-5
A	JP 5-113220 A (Matsushita Electric Industrial Co., Ltd.), 07 May 1993 (07.05.1993), entire text; all drawings (Family: none)	1-9
A	JP 11-132468 A (Toshiba Corp.), 21 May 1999 (21.05.1999), entire text; all drawings (Family: none)	1-9
A	JP 6-241463 A (Matsushita Electric Industrial Co., Ltd.), 30 August 1994 (30.08.1994), entire text; all drawings (Family: none)	1-9
A	JP 2007-218545 A (Hitachi Appliances, Inc.), 30 August 2007 (30.08.2007), entire text; all drawings & CN 101025275 A	1-9
A	JP 2007-327700 A (Matsushita Electric Industrial Co., Ltd.), 20 December 2007 (20.12.2007), entire text; all drawings (Family: none)	1-9

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Patent documents cited in the description

- JP 5166054 B **[0013]**
- JP 5047216 B **[0013]**
- DE 10353299 A1 **[0013]**