



(11)

EP 3 481 149 A1

(12)

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

(43) Date of publication:
08.05.2019 Bulletin 2019/19

(51) Int Cl.:
H05B 6/74 (2006.01) H05B 6/68 (2006.01)

(21) Application number: **17819906.3**

(86) International application number:
PCT/JP2017/022304

(22) Date of filing: **16.06.2017**

(87) International publication number:
WO 2018/003546 (04.01.2018 Gazette 2018/01)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

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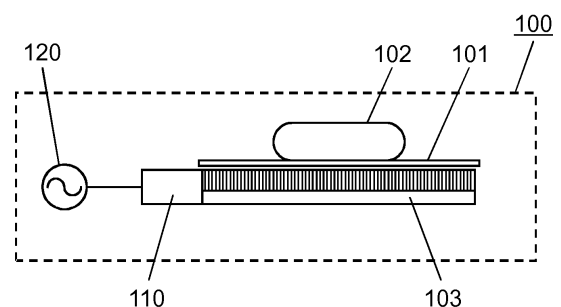
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(54) **HIGH-FREQUENCY HEATING DEVICE**

(57) High-frequency power generation unit (120) configured to generate high-frequency power, surface wave excitation body (103) configured to propagate the high-frequency power with a surface wave to heat heating-target object (102), high-frequency power supply unit (110) configured to supply the high-frequency power to surface wave excitation body (103), and mounting stand (101) on which heating-target object (102) is mounted. In accordance with a desired degree of surface concentration of the high-frequency power around surface wave excitation body (103), high-frequency power generation unit (120) sets a magnitude relationship between a frequency of the high-frequency power to be supplied to surface wave excitation body (103) and an exciting frequency of surface wave excitation body (103) to heat heating-target object (102). High-frequency heating device (100) capable of changing a heating state in a thickness direction of heating-target object (102) is therefore provided.

FIG. 1



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Description

TECHNICAL FIELD

[0001] The present invention relates to a high-frequency heating device equipped with a surface wave excitation body having a periodical structure.

BACKGROUND ART

[0002] Such a conventional technique is disclosed that relates to a high-frequency heating device configured to supply high-frequency power to a surface wave excitation body having a periodical structure to heat a heating-target object, such as a food product (e.g., see PTL 1).

[0003] A high-frequency heating device disclosed in PTL 1 includes a variable impedance unit configured to change, in a temporal manner, impedance of a termination of an interdigital tape wave guide (surface wave guide). The variable impedance unit changes standing wave distribution in a temporal manner to move a portion configured to radiate strong energy. A whole food product is therefore efficiently heated.

[0004] In other words, the high-frequency heating device described above changes impedance of the termination of the interdigital tape wave guide (surface wave guide) to change standing wave distribution in the interdigital tape wave guide (surface wave guide) to change the impedance of the termination in a temporal manner. With changes in standing wave distribution in a temporal manner, a whole food product is therefore heated.

[0005] However, the conventional high-frequency heating device cannot change radiation distribution of high-frequency power in a thickness direction of the heating-target object.

Citation List

Patent Literature

[0006] PTL 1: Unexamined Japanese Patent Publication No. 61-240589

SUMMARY OF THE INVENTION

[0007] The present invention provides a high-frequency heating device capable of changing radiation distribution of high-frequency power to a heating-target object to change a heating state of a heating-target part.

[0008] In other words, the high-frequency heating device according to the present invention includes a high-frequency power generation unit configured to generate high-frequency power, a surface wave excitation body configured to propagate the high-frequency power with a surface wave to heat a heating-target object, a high-frequency power supply unit configured to supply the high-frequency power to the surface wave excitation body, and a mounting stand on which the heating-target

object is mounted. In accordance with a desired degree of surface concentration of the high-frequency power around the surface wave excitation body, the high-frequency power generation unit sets a magnitude relationship between a frequency of the high-frequency power to be supplied to the surface wave excitation body and an exciting frequency of the surface wave excitation body to heat the heating-target object.

[0009] With this configuration, in accordance with a desired heating state in a thickness direction of the heating-target object, the magnitude relationship between the frequency of the high-frequency power to be supplied to the surface wave excitation body and the exciting frequency of the surface wave excitation body is set. In the thickness direction of the heating-target object, the heating-target object can therefore be heated in the desired heating state.

BRIEF DESCRIPTION OF DRAWINGS

[0010]

FIG. 1 is a block diagram illustrating a basic configuration of a high-frequency heating device according to an exemplary embodiment.

FIG. 2 is a block diagram illustrating a configuration of a high-frequency power supply unit of the high-frequency heating device according to the present exemplary embodiment.

FIG. 3A is a view illustrating an example of how a heating-target object is heated when a degree of surface concentration of an electric field is higher due to a surface wave excitation body of the high-frequency heating device according to the present exemplary embodiment.

FIG. 3B is a view illustrating an example of how the heating-target object is heated when the degree of surface concentration of the electric field is lower due to the surface wave excitation body of the high-frequency heating device according to the present exemplary embodiment.

FIG. 4A is a graph illustrating an example of a change in the degree of surface concentration of the electric field relative to a distance from the surface wave excitation body when a frequency of high-frequency power is equal to an exciting frequency of the surface wave excitation body in the high-frequency heating device according to the present exemplary embodiment.

FIG. 4B is a graph illustrating an example of a change in the degree of surface concentration of the electric field relative to the distance from the surface wave excitation body when the frequency of the high-frequency power is lower than the exciting frequency of the surface wave excitation body in the high-frequency heating device according to the present exemplary embodiment.

FIG. 4C is a graph illustrating an example of a change

in the degree of surface concentration of the electric field relative to the distance from the surface wave excitation body when the frequency of the high-frequency power is higher than the exciting frequency of the surface wave excitation body in the high-frequency heating device according to the present exemplary embodiment.

DESCRIPTION OF EMBODIMENT

[0011] An exemplary embodiment of the present invention will now be described herein with reference to the accompanying drawings. Note that the present invention is not limited to this exemplary embodiment.

(Exemplary embodiment)

[0012] High-frequency heating device 100 according to the present exemplary embodiment will now be described herein with reference to FIG. 1.

[0013] FIG. 1 is a block diagram illustrating a basic configuration of high-frequency heating device 100 according to the present exemplary embodiment.

[0014] As illustrated in FIG. 1, high-frequency heating device 100 includes surface wave excitation body 103, high-frequency power supply unit 110, high-frequency power generation unit 120, and mounting stand 101 used to mount heating-target object 102. High-frequency heating device 100 heats heating-target object 102 mounted on mounting stand 101.

[0015] At this time, in high-frequency heating device 100, a frequency of high-frequency power to be generated by high-frequency power generation unit 120 and an exciting frequency of surface wave excitation body 103 are set to have a predetermined frequency relationship. The predetermined frequency relationship is set to heat heating-target object 102 in a desired heating state.

[0016] In high-frequency heating device 100 illustrated in FIG. 1, although such an example of a configuration is illustrated that includes a single surface wave excitation body, a single high-frequency power supply unit, and a single high-frequency power generation unit, the present invention is not limited to the example. A number of surface wave excitation bodies, a number of high-frequency power supply units, and a number of high-frequency power generation units are not limited to the numbers described above.

[0017] High-frequency heating device 100 operates as described below.

[0018] High-frequency power generation unit 120 first generates high-frequency power. The generated high-frequency power is supplied, via high-frequency power supply unit 110, to surface wave excitation body 103. The supplied high-frequency power is propagated or radiated with a surface wave around surface wave excitation body 103. Heating-target object 102 mounted on mounting stand 101 is therefore heated.

[0019] High-frequency heating device 100 according

to the present exemplary embodiment is configured, and operates as described above.

[0020] High-frequency power generation unit 120 described above includes a high-frequency transmitter configured to output high-frequency power at a frequency (e.g., microwave) and a magnitude appropriate for heating heating-target object 102.

[0021] Specifically, the high-frequency transmitter includes a magnetron, an inverter power supply circuit, a solid oscillator, and a power amplifier, for example.

[0022] The magnetron is a kind of oscillation vacuum tube configured to generate a kind of radio wave, i.e., strong, non-coherent microwaves, and is used for purposes with a higher output ranging from several hundred watts to several kilowatts, such as a radar and a microwave oven. To drive the magnetron, a higher voltage of several kilovolts is required. As an ordinary power supply for driving the magnetron, the inverter power supply circuit is therefore used. The inverter power supply circuit includes a converter circuit having a rectification function and an inverter circuit having a voltage raising (or lowering) function and an output frequency conversion function. The inverter power supply circuit is a technique widely used in lighting apparatuses and used for motor controlling.

[0023] On the other hand, the solid oscillator includes a semiconductor oscillation circuit equipped with a feedback circuit including high-frequency electronic components, such as transistors, capacitors, inductors, and resistors. The solid oscillator is a technique widely used in oscillators for purposes with a low-power output, such as communication devices.

[0024] Solid oscillators include oscillators having a high-frequency power output of approximately 50 watts, which are used in recent years, as well as include ordinary oscillators having a high-frequency power output ranging from several ten milliwatts to several hundred milliwatts. Such solid oscillators are not therefore appropriate for heating requiring a power output of several hundred watts. The solid oscillator is often used together with a power amplifier including, for example, transistors configured to amplify high-frequency power being output.

[0025] High-frequency power supply unit 110 corresponds to a power coupling unit configured to supply high-frequency power generated by high-frequency power generation unit 120 to surface wave excitation body 103. A configuration of high-frequency power supply unit 110 will be described later.

[0026] Surface wave excitation body 103 includes a metallic periodical structure with impedance elements made of metallic plates arranged periodically, and dielectric plates, for example. For the metallic periodical structure, a stub type surface wave excitation body or an interdigital type surface wave excitation body is used, for example. The stub type surface wave excitation body is formed by disposing, on a metallic flat plate, as illustrated in FIG. 1, a plurality of metallic flat plates at constant intervals in a vertical direction toward a heating-target

object. The interdigital type surface wave excitation body is formed by punching a metallic flat plate in an interdigital shape. The dielectric plate may be an alumina plate or a Bakelite plate.

[0027] At this time, an exciting frequency of surface wave excitation body 103 is determined based on a material used, a physical structural size, and other factors. For example, when the stub type surface wave excitation body is used, by changing heights of a plurality of metallic flat plates arranged on the metallic flat plate, or by changing the intervals of the metallic flat plates, the exciting frequency of surface wave excitation body 103 can be changed. In general, the exciting frequency of surface wave excitation body 103 increases when the heights of the metallic flat plates are lowered, or when the intervals of the metallic flat plates are narrowed. By adjusting the heights or the intervals of the metallic flat plates, surface wave excitation body 103 having a desired exciting frequency can therefore be formed.

[0028] Surface wave excitation body 103 allows high-frequency power supplied from high-frequency power generation unit 120 via high-frequency power supply unit 110 to concentrate around its surface, and propagates the high-frequency power with a surface wave. Further, surface wave excitation body 103 can radiate the high-frequency power to a space in high-frequency heating device 100, for example. Heating-target object 102 mounted on mounting stand 101 adjacent to surface wave excitation body 103 is therefore heated by the high-frequency power propagated, with a surface wave, from around the surface of surface wave excitation body 103, or the high-frequency power radiated from surface wave excitation body 103.

[0029] Next, the configuration of high-frequency power supply unit 110 according to the present exemplary embodiment will now be described herein with reference to FIG. 2.

[0030] FIG. 2 is a block diagram illustrating an example of the configuration of high-frequency power supply unit 110.

[0031] As illustrated in FIG. 2, high-frequency power supply unit 110 is disposed to introduce high-frequency power to be generated by high-frequency power generation unit 120, via rectangular wave guide 130, to high-frequency power supply unit 110.

[0032] Rectangular wave guide 130 is a hollow wave guide mainly used to transmit electromagnetic waves, such as microwaves. The hollow wave guide is an ordinary wave guide made from a metallic tube having a rectangular cross section (e.g., rectangle). An electromagnetic wave forms an electromagnetic field in accordance with a shape, a size, a wavelength, or a frequency of rectangular wave guide 130, and propagates inside rectangular wave guide 130.

[0033] The high-frequency power propagated from high-frequency power generation unit 120 is supplied, via rectangular wave guide 130 and tapered rectangular wave guide 131, to surface wave excitation body 103.

Tapered rectangular wave guide 131 is configured to suppress reflection of a microwave being propagated at a joint to reduce a loss.

[0034] In other words, as illustrated by a broken line in FIG. 2, high-frequency power supply unit 110 includes a part of rectangular wave guide 130, tapered rectangular wave guide 131, and a part of surface wave excitation body 103.

[0035] High-frequency power generated by the high-frequency power generation unit 120 is therefore introduced, via rectangular wave guide 130, to high-frequency power supply unit 110, and then efficiently supplied, via tapered rectangular wave guide 131, to surface wave excitation body 103.

[0036] At this time, high-frequency heating device 100 according to the present exemplary embodiment sets, as desired, a predetermined frequency relationship between the frequency of the high-frequency power to be generated by high-frequency power generation unit 120 and the exciting frequency of surface wave excitation body 103. As will be described later, heating-target object 102 is therefore heated in a desired heating state.

[0037] High-frequency heating device 100 according to the present exemplary embodiment is configured as described above to heat heating-target object 102, for example.

[0038] Next, how high-frequency heating device 100 described above heats heating-target object 102 will be described with reference to FIGS. 3A and 3B.

[0039] FIGS. 3A and 3B schematically illustrate, when heating-target object 102 is mounted on mounting stand 101, how heating-target object 102 is heated under field intensity distribution of high-frequency power supplied around the surface of surface wave excitation body 103.

[0040] In other words, FIG. 3A illustrates field intensity distribution 141 formed around the surface of surface wave excitation body 103 when a frequency of high-frequency power generated by high-frequency power generation unit 120 and an exciting frequency of surface wave excitation body 103 are set to increase a degree of surface concentration of the high-frequency power.

[0041] FIG. 3B illustrates field intensity distribution 142 formed around the surface of surface wave excitation body 103 when the frequency of high-frequency power and the exciting frequency are set to lower the degree of surface concentration of the high-frequency power.

[0042] In FIGS. 3A and 3B, intensity of electric fields in field intensity distributions 141 and 142 is represented with shading of a color. In this case, the darker the color, the stronger the electric field.

[0043] In FIG. 3A, the relationship between the frequency of high-frequency power and the exciting frequency of surface wave excitation body 103 is set to increase a degree of surface concentration of the high-frequency power around surface wave excitation body 103. Intensity of an electric field around the surface of surface wave excitation body 103 therefore becomes stronger. A surface and an internal portion, adjacent to

surface wave excitation body 103, of heating-target object 102 are therefore locally and strongly heated. The larger a distance from surface wave excitation body 103, the weaker the field intensity. A degree of heating in heating-target object 102 therefore lowers.

[0044] On the other hand, in FIG. 3B, the relationship between the frequency of high-frequency power and the exciting frequency of surface wave excitation body 103 is set to lower the degree of surface concentration of the high-frequency power around surface wave excitation body 103. In this case, although the field intensity weakens around the surface of surface wave excitation body 103, a degree of lowering in field intensity is smaller even in an area away from surface wave excitation body 103. The surface, adjacent to surface wave excitation body 103, of heating-target object 102 would therefore be less likely to be locally and strongly heated. In other words, whole heating-target object 102 is relatively evenly heated.

[0045] As described above, high-frequency heating device 100 heats heating-target object 102 based on the relationship between the frequency of high-frequency power and the exciting frequency of surface wave excitation body 103.

[0046] A relationship between a distance from the surface of surface wave excitation body 103 and field intensity will now be described herein based on the magnitude relationship between the frequency of high-frequency power and the exciting frequency of surface wave excitation body 103, as described above, with reference to FIGS. 3A and 3B and using FIGS. 4A to 4C.

[0047] FIGS. 4A to 4C schematically illustrate examples of changes in a degree of surface concentration of high-frequency power (electric field) formed around the surface of surface wave excitation body 103, based on the relationship between frequency f_p of high-frequency power to be supplied to surface wave excitation body 103 and exciting frequency f_c of surface wave excitation body 103.

[0048] Specifically, FIGS. 4A to 4C illustrate, in graphs, changes in field intensity relative to the distance from the surface of surface wave excitation body 103, based on the relationship between frequency f_p of high-frequency power to be supplied to surface wave excitation body 103 and exciting frequency f_c of surface wave excitation body 103. At this time, horizontal axes in FIGS. 4A to 4C illustrate a distance from the surface of the surface wave excitation body, while vertical axes illustrate field intensity. In the drawings, the greater the inclination of the graph, the more the concentration of an electric field formed on the surface of surface wave excitation body 103.

[0049] In FIG. 4A, graph 151 illustrates a degree of field intensity relative to a distance from the surface of surface wave excitation body 103 when frequency f_p of high-frequency power to be supplied to surface wave excitation body 103 is approximately equal to exciting frequency f_c of surface wave excitation body 103, and, in

FIG. 4B, graph 152 illustrates a degree of field intensity when frequency f_p of high-frequency power is lower than exciting frequency f_c . Further, in FIG. 4C, graph 153 illustrates a degree of field intensity when frequency f_p of high-frequency power is higher than exciting frequency f_c .

[0050] First, as illustrated in FIG. 4A, when frequency f_p of high-frequency power and exciting frequency f_c are set approximately identical to each other, graph 151 illustrating the degree of field intensity relative to the distance from the surface of surface wave excitation body 103 has a greatest inclination. In other words, an electric field concentrates around the surface of surface wave excitation body 103, as approximate to FIG. 3A. The surface of heating-target object 102 is therefore locally heated. The relationship between frequency f_p and exciting frequency f_c , described above, is therefore appropriate for intentionally burning the surface of heating-target object 102.

[0051] As illustrated in FIG. 4B, when frequency f_p of high-frequency power is set lower than exciting frequency f_c , graph 152 has a gentle inclination, compared with the inclination of graph 151 in FIG. 4A. In other words, a degree of concentration of an electric field on the surface of surface wave excitation body 103 lowers, and the high-frequency power reaches farther from the surface of surface wave excitation body 103. Although the field intensity around the surface of surface wave excitation body 103 is therefore relatively greater, the field intensity does not suddenly drop even at a position away from the surface of surface wave excitation body 103. In other words, the high-frequency power reaches to a position slightly away from the surface of surface wave excitation body 103. The relationship between frequency f_p and exciting frequency f_c , described above, is therefore appropriate for heating heating-target object 102 without allowing heating-target object 102 to get burned.

[0052] As illustrated in FIG. 4C, when frequency f_p of high-frequency power is set higher than exciting frequency f_c , graph 153 has almost no inclination, achieving flat field intensity distribution. In other words, an electric field does not concentrate around the surface of surface wave excitation body 103, but is widely distributed in a whole area. This means that the high-frequency power to be supplied to surface wave excitation body 103 is not propagated with a surface wave to surface wave excitation body 103, but is radiated into a space. The relationship between frequency f_p and exciting frequency f_c , described above, is therefore appropriate for relatively evenly heating whole heating-target object 102.

[0053] As described above, in accordance with a degree, corresponding to a heating state desired by a user, of surface concentration of high-frequency power around the surface of surface wave excitation body 103, high-frequency heating device 100 according to the present exemplary embodiment sets the magnitude relationship between frequency f_p of high-frequency power to be supplied to surface wave excitation body 103 and exciting

frequency f_c of surface wave excitation body 103. How high-frequency power is propagated with a surface wave to surface wave excitation body 103 can therefore be changed. Accordingly, field intensity distribution around the surface of surface wave excitation body 103 changes. As a result, heating-target object 102 can be heated in a heating state desired by a user.

[0054] In other words, the relationship between frequency f_p and exciting frequency f_c is set to allow frequency f_p of high-frequency power to be supplied to surface wave excitation body 103 to be equal to or lower than exciting frequency f_c of surface wave excitation body 103. In this case, the high-frequency power supplied to surface wave excitation body 103 is propagated with a surface wave to surface wave excitation body 103. That is, the high-frequency power is propagated under an operation in a "surface wave mode". At this time, by adjusting how frequency f_p of high-frequency power is lowered relative to exciting frequency f_c of surface wave excitation body 103 (by adjusting a difference), a degree of surface concentration of high-frequency power to be propagated with a surface wave to surface wave excitation body 103 can be adjusted. Therefore, in accordance with a heating state desired by a user in the thickness direction of a heating-target object, heating-target object 102 can be appropriately heated.

[0055] On the other hand, the relationship between frequency f_p and exciting frequency f_c is set to allow frequency f_p of high-frequency power to be supplied to surface wave excitation body 103 to be higher than exciting frequency f_c of surface wave excitation body 103. In this case, the high-frequency power supplied to surface wave excitation body 103 is not propagated with a surface wave to surface wave excitation body 103, but is radiated into a space. That is, the high-frequency power is radiated under an operation in a "radiation mode". Whole heating-target object 102 can therefore be relatively evenly heated.

[0056] In the exemplary embodiment described above, although the example of the configuration is described to allow high-frequency power generation unit 120 of high-frequency heating device 100 to generate high-frequency power at frequency f_p being fixed, the present invention is not limited to the example. For example, high-frequency power generation unit 120 may include a variable frequency high-frequency transmitter configured to generate high-frequency power at a frequency to be set.

[0057] The variable frequency high-frequency oscillator can be achieved by using a variable voltage element (e.g., varactor diode) as an element determining a resonance frequency of a resonant circuit configuring the semiconductor oscillation circuit described above. The variable frequency high-frequency oscillator is generally referred to as a voltage controlled oscillator (VCO). Since a technique of a VCO is already known, its detailed description is omitted. In this case, a controller is provided to the high-frequency oscillator to supply voltage information corresponding to a frequency to the VCO. A fre-

quency of the high-frequency oscillator can therefore be changed.

[0058] The variable frequency high-frequency oscillator may be a phase locked loop (PLL) oscillator including a reference signal generator and a phase comparator. Since a technique of the PLL oscillator is already known, its detailed description is omitted. In this case, a controller is provided to the PLL oscillator to supply an information signal corresponding to a frequency to the phase comparator. A frequency of the PLL oscillator can therefore be changed.

[0059] With the single high-frequency power generation unit, high-frequency power at a plurality of frequencies can therefore be generated. The magnitude relationship between frequency f_p of high-frequency power to be supplied to surface wave excitation body 103 and exciting frequency f_c of surface wave excitation body 103, described above, can therefore be easily and freely set. That is, the magnitude relationship between frequency f_p of high-frequency power to be supplied to surface wave excitation body 103 and exciting frequency f_c of surface wave excitation body 103 can be freely changed. Therefore, with a simple configuration, a heating state in the thickness direction of heating-target object 102 can be changed as desired by a user to heat heating-target object 102.

[0060] In high-frequency heating device 100 according to the present exemplary embodiment, surface wave excitation body 103 may be a variable exciting frequency surface wave excitation body configured to change an exciting frequency.

[0061] Specifically, when the surface wave excitation body is formed with the stub type surface wave excitation body described above, dielectric bodies are inserted under a mechanical control into gaps between the metallic flat plates arranged at constant intervals on the metallic flat plate. The exciting frequency of the surface wave excitation body can therefore be changed.

[0062] In this case, a dielectric constant of the dielectric body may be changed under electrical control, instead of the mechanical control, to change the exciting frequency of the surface wave excitation body. The exciting frequency of the surface wave excitation body can therefore be relatively greatly changed. The heating state in the thickness direction of the heating-target object can therefore be greatly changed. A range of the heating state can therefore be expanded as desired by a user to variously heat the heating-target object.

[0063] Although, in the exemplary embodiment described above, purposes of the high-frequency heating device have not been specifically described, a basic configuration similar to an ordinary cooking microwave oven may be applied, for example.

[0064] That is, the microwave oven at least includes a heating chamber, a high-frequency power generation unit, a wave guide, a surface wave excitation body configuring a heating unit, a door, and a door choking groove, for example. The heating chamber is formed into an ap-

proximately rectangular parallelepiped shape (including a rectangular parallelepiped shape), and is to be internally mounted with a heating-target object. The high-frequency power generation unit includes a magnetron, for example, to supply high-frequency power to the heating chamber. The high-frequency power generation unit is provided below the housing or beside the housing. The wave guide supplies microwaves generated by the high-frequency power generation unit to the heating chamber. The surface wave excitation body is provided below, behind, or above the heating chamber to propagate high-frequency power to heat a heating-target object. The door is provided on a front of the housing for opening and closing of the heating chamber. The door choking groove is provided around the door to prevent electromagnetic waves, such as microwaves, from leaking.

[0065] Although the high-frequency heating device according to the present invention has been described based on the exemplary embodiment, the present invention is not limited to the exemplary embodiment. Without departing from the gist of the present invention, any modifications conceivable by those skilled in the art to the exemplary embodiment, as well as any forms configured by combining components in different exemplary embodiments are also included within the scope of the present invention.

[0066] As described above, the high-frequency heating device according to the present invention includes the high-frequency power generation unit configured to generate high-frequency power, the surface wave excitation body configured to propagate the high-frequency power with a surface wave to heat a heating-target object, the high-frequency power supply unit configured to supply the high-frequency power to the surface wave excitation body, and the mounting stand on which the heating-target object is mounted. In accordance with a desired degree of surface concentration of the high-frequency power around the surface wave excitation body, the high-frequency power generation unit sets a magnitude relationship between a frequency of the high-frequency power to be supplied to the surface wave excitation body and an exciting frequency of the surface wave excitation body to heat the heating-target object.

[0067] With this configuration, in the thickness direction of the heating-target object, in accordance with a heating state desired by a user, the magnitude relationship between the frequency of the high-frequency power to be supplied to the surface wave excitation body and the exciting frequency of the surface wave excitation body is set. In the thickness direction of the heating-target object, the heating-target object can therefore be heated in the desired heating state.

[0068] In the high-frequency heating device according to the present invention, the frequency of the high-frequency power to be supplied to the surface wave excitation body may be set equal to or lower than the exciting frequency of the surface wave excitation body.

[0069] With this configuration, the high-frequency power

er supplied to the surface wave excitation body is propagated with a surface wave around the surface of the surface wave excitation body under an operation in the "surface wave mode". A side, adjacent to the surface wave excitation body, of the heating-target object can therefore be locally heated.

[0070] In the high-frequency heating device according to the present invention, the frequency of the high-frequency power to be supplied to the surface wave excitation body may be set higher than the exciting frequency of the surface wave excitation body.

[0071] With this configuration, the high-frequency power supplied to the surface wave excitation body is not propagated with a surface wave around the surface of the surface wave excitation body, but is radiated into a space under an operation in the "radiation mode". The whole heating-target object can therefore be evenly heated.

[0072] In the high-frequency heating device according to the present invention, the high-frequency power generation unit may be a variable high-frequency oscillator configured to generate the high-frequency power at a variable frequency.

[0073] With this configuration, a frequency of high-frequency power to be supplied to the surface wave excitation body can be changed. A frequency of high-frequency power relative to an exciting frequency of the surface wave excitation body can therefore be set as desired. As a result, field intensity distribution to be formed on the surface wave excitation body can be adjusted as desired. In the thickness direction of a heating-target object, the heating-target object can therefore be heated in various heating states.

[0074] In the high-frequency heating device according to the present invention, a surface wave excitation body may be a variable surface wave excitation body configured to change an exciting frequency.

[0075] With this configuration, an exciting frequency of the surface wave excitation body can be changed relative to a frequency of high-frequency power to be supplied to the surface wave excitation body. In the thickness direction of a heating-target object, the heating-target object can therefore be heated in various heating states.

INDUSTRIAL APPLICABILITY

[0076] Under demanded heating in a desired heating state in a thickness direction of a heating-target object in cooking appliances including microwave heater, the present invention is useful for the cooking appliances including the microwave heaters.

REFERENCE MARKS IN THE DRAWINGS

[0077]

100	high-frequency heating device
101	mounting stand

102	heating-target object	
103	surface wave excitation body	
110	high-frequency power supply unit	
120	high-frequency power generation unit	
130	rectangular wave guide	5
131	tapered rectangular wave guide	
141, 142	field intensity distribution	

Claims 10

1. A high-frequency heating device comprising:

a high-frequency power generation unit configured to generate high-frequency power; 15
a surface wave excitation body configured to propagate the high-frequency power with a surface wave to heat the heating-target object;
a high-frequency power supply unit configured to supply the high-frequency power to the surface wave excitation body; and 20
a mounting stand on which the heating-target object is mounted,
wherein, in accordance with a desired degree of surface concentration of the high-frequency power around the surface wave excitation body, 25
the high-frequency power generation unit sets a magnitude relationship between a frequency of the high-frequency power to be supplied to the surface wave excitation body and an exciting frequency of the surface wave excitation body 30
to heat the heating-target object.

2. The high-frequency heating device according to claim 1, wherein the frequency of the high-frequency power to be supplied to the surface wave excitation body is equal to or lower than the exciting frequency of the surface wave excitation body. 35

3. The high-frequency heating device according to claim 1, wherein the frequency of the high-frequency power to be supplied to the surface wave excitation body is higher than the exciting frequency of the surface wave excitation body. 40

4. The high-frequency heating device according to claim 1, wherein the high-frequency power generation unit is a variable high-frequency oscillator configured to generate the high-frequency power at a variable frequency. 45 50

5. The high-frequency heating device according to claim 1, wherein the surface wave excitation body is a variable surface wave excitation body configured to change the exciting frequency. 55

FIG. 1

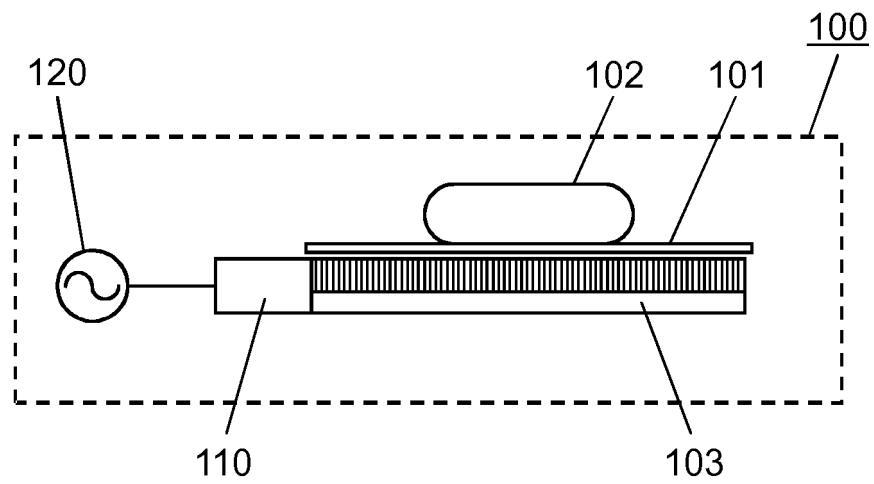


FIG. 2

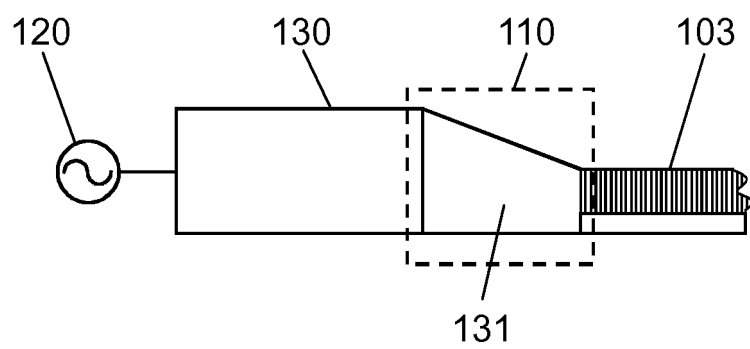


FIG. 3A

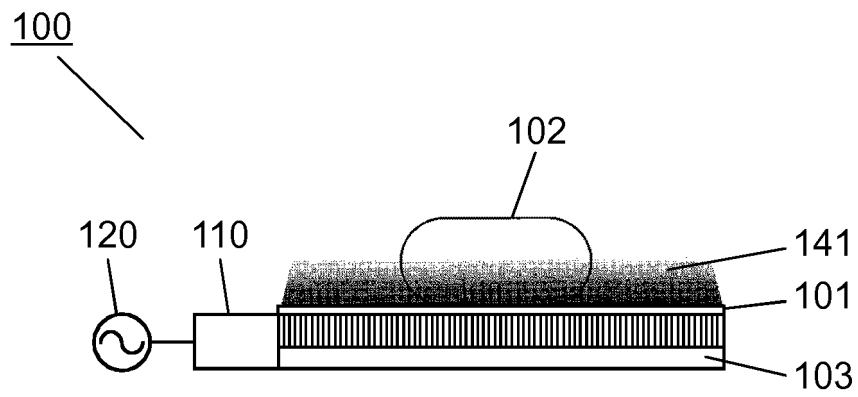


FIG. 3B

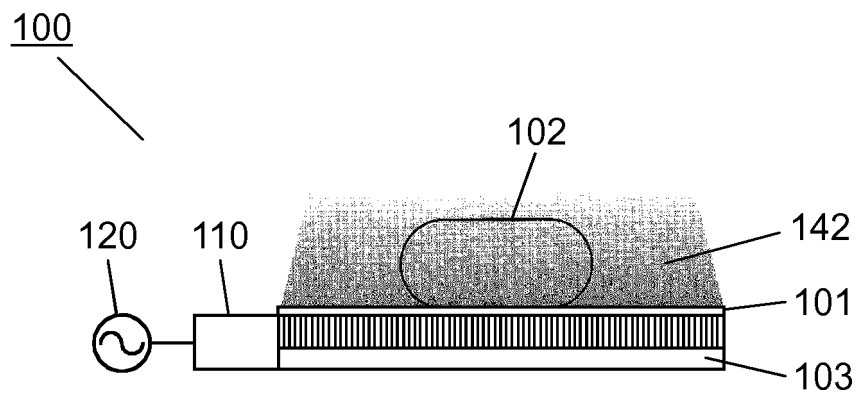


FIG. 4A

$$f_p \approx f_c$$

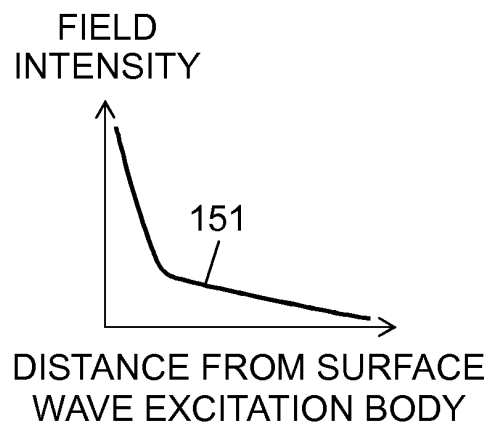


FIG. 4B

$$f_p < f_c$$

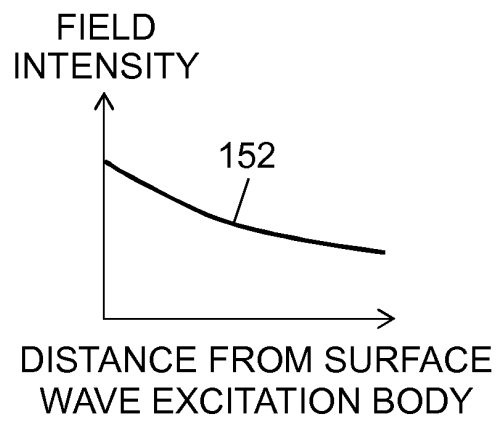
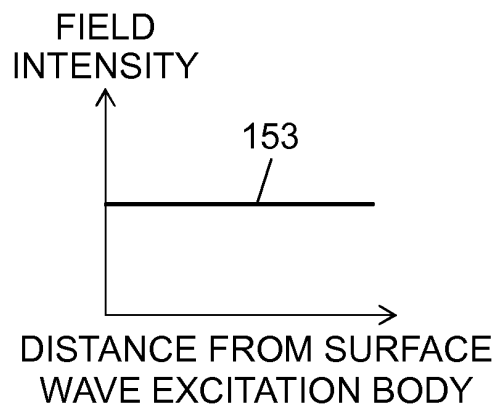


FIG. 4C

$$f_p > f_c$$



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/022304

A. CLASSIFICATION OF SUBJECT MATTER

H05B6/74(2006.01)i, H05B6/68(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)

H05B6/74, H05B6/68

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 2015-162273 A (Panasonic Corp.),	1-3, 5
Y	07 September 2015 (07.09.2015), paragraphs [0021] to [0023], [0028] to [0032]; fig. 1, 4, 5 (Family: none)	4
Y	JP 2015-220189 A (Panasonic Intellectual Property Management Co., Ltd.), 07 December 2015 (07.12.2015), paragraphs [0032] to [0095]; fig. 1 to 7 (Family: none)	4

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

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"&" document member of the same patent family

Date of the actual completion of the international search
30 June 2017 (30.06.17)Date of mailing of the international search report
11 July 2017 (11.07.17)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 61240589 A [0006]