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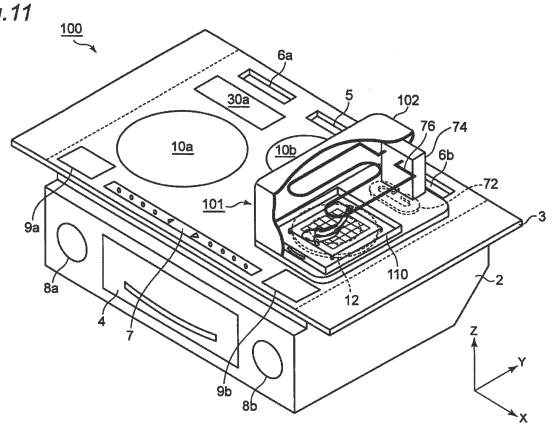
(54) INDUCTION COOKING APPARATUS, COMBINED COOKING APPARATUS, AND INDUCTION COOKING SYSTEM EQUIPPED WITH THESE

(57) An aspect of the present invention provides an induction-heating cooking system comprising an induction-heating cooker and a combined cooker. The combined cooker comprises: an induction-heated part inductively heated with a first electric power by the high-frequency magnetic field generated by the first magnetic field generator; an electric generator electromagnetically induced by the high-frequency magnetic field generated by the second magnetic field generator to generate a second electric power; and a cooking support unit operating by using the second electric power acquired by the electric generator. When the induction-heated part of the combined cooker is placed on the induction heating area and the electric generator of the combined cooker is placed on the cooking device area, the controller controls the first and second inverter circuits independently of each other such that a food cooked by the combined cooker is heated by the induction-heated part while cooking of the food on the induction-heated part is supported by the cooking support unit.

Fig.11



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Description

TECHNICAL FIELD

[0001] The present invention relates to an induction-heating cooker, a combined cooker, and an induction-heating cooking system equipped with these and, more particularly, to an induction-heating cooker including a plurality of magnetic field generators arranged under a plurality of placement areas, a combined cooker including an induction-heated part and an electric generator placed above the placement areas, and an induction-heating cooking system equipped with these.

[0002] A common induction-heating cooker supplies a high-frequency current of 20 kHz to 100 kHz to an induction heating coil to form a high-frequency magnetic field so as to interlink the high-frequency magnetic field with a cooking device made of metal such as a pan and a frying pan that is an heated body, thereby forming an eddy current, so that Joule heat is generated due to the eddy current for induction heating of the cooking device itself.

[0003] A non-contact power feeding apparatus proposed in Patent Document 1 supplies a high-frequency current to a single induction heating coil for induction heating of an heated body such as a pan, or transfers an electric power via a high-frequency magnetic field generated by the induction heating coil (primary coil) to a secondary coil of a power receiving apparatus (in a non-contact manner).

[0004] The power receiving apparatus described in Patent Document 1 is, for example, a coffee mill or a hot water dispenser, and a required electric energy is small as compared to the heated body such as a pan. The non-contact power feeding apparatus according to Patent Document 1 can use a load judgement part to judge whether a load placed on a top plate is an heated body that should be induction-heated or a power receiving apparatus including the secondary coil electromagnetically coupled to the primary coil, thereby supplying an electric energy suitable for the load.

[0005] An induction-heating cooker proposed in Patent Document 2 has a multi-coil configuration with a plurality of heating coils capable of cooperating for induction heating of an heated body and efficiently feeding power to a non-contact power receiving apparatus. The power receiving apparatus described in Patent Document 2 is, for example, a coffee grinder, and the induction-heating cooker according to Patent Document 2 can supply high-frequency currents in the same phase (having a phase difference of zero) to a plurality of heating coils so as to highly efficiently feed power to a power receiving device.

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0006]

Patent Document 1: WO 2013/094174 A1
Patent Document 2: Japanese Laid-Open Patent Aplication Publication JP 2014-044819 A

SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0007] The non-contact power feeding apparatus according to Patent Document 1 has a single induction heating coil (primary coil) and judges whether a load placed on a top plate is an heated body or a power receiving apparatus so as to supply an electric energy suitable for the load, and only either the heated body or the power receiving apparatus must be placed on the top plate.

[0008] A plurality of heating coils of the induction-heating cooker according to Patent Document 2 is supplied with high-frequency currents having zero phase difference when a power receiving device is placed on a top plate, and is supplied with high-frequency currents having a phase difference ($\pi/2$ to 0) for uniform heating or a phase difference (π to $\pi/2$) for high-power heating when an heated body is placed on the top plate. However, when the power receiving device and the heated body are placed in parallel on the top plate, the high-efficiency power feeding (phase difference: 0) to the power receiving device and the high-power heating (phase difference: π to $\pi/2$) of the heated body cannot simultaneously be achieved for the plurality of heating coils arranged below them.

[0009] The non-contact power feeding apparatus according to Patent Document 1 and the induction-heating cooker according to Patent Document 2 selectively perform induction heating or power feeding of either the heated body or the power receiving device and include no suggestion on a combined cooker induction-heated and supplied with electric power at the same time by high-frequency magnetic fields generated by induction heating coils, and an induction-heating

cooker efficiently performing the induction heating and the power feeding of such a combined cooker is not implemented.

[0010] It is therefore an object of an aspect of the present invention to provide a combined cooker directly induction-heating an heated body such as a frying pan and supplied with electric power to improve or support a cooking technique of food on the heated body, an induction-heating cooker performing induction heating and power feeding for the combined cooker, and an induction-heating cooking system equipped with the combined cooker and the induction-heating cooker.

MEANS FOR SOLVING THE PROBLEM

[0011] An aspect of the present invention relates to an induction-heating cooker, a combined cooker, and induction-heating cooking system equipped with these.

the induction-heating cooker comprises a top plate having an induction heating area and a cooking device area, first and second magnetic field generators disposed under the induction heating area and the cooking device area, first and second inverter circuits respectively supplying high-frequency currents to the first and second magnetic field generators so as to generate high-frequency magnetic fields, and a controller controlling the first and second inverter circuits.

[0012] The combined cooker comprises an induction-heated part inductively heated with a first electric power by the high-frequency magnetic field generated by the first magnetic field generator, an electric generator electromagnetically induced by the high-frequency magnetic field generated by the second magnetic field generator to generate a second electric power, and a cooking support unit operating by using the second electric power acquired by the electric generator, and when the induction-heated part of the combined cooker is placed on the induction heating area and the electric generator of the combined cooker is placed on the cooking device area, the controller controls the first and second inverter circuits independently of each other such that a food cooked by the combined cooker is heated by the induction-heated part while cooking of the food on the induction-heated part is supported by the cooking support unit.

EFFECT OF THE INVENTION

[0013] According to an aspect of the present invention, an heated body such as a pan can directly be induction-heated while the cooking of the food above the heated body can be supported by using the cooking support unit and, for example, the food can be heated from above while the orientation of the food is changed for uniform heating and the combined cooker is illuminated inside. The combined cooker supports the cooking of the food by changing the orientation of an additional heater or the food and therefore can shorten a cooking time and improve the finish of the cooking. Furthermore, since the combined cooker can be illuminated inside, a user can visually check a progress of cooking and adjust the cooking time etc. as necessary so as to further improve the finish of the cooking.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014]

FIG. 1	is a schematic perspective view of an entire induction-heating cooker according to the present invention.
FIG. 2	is a plan view of an IH cooker installed in a storage part of a kitchen.
FIG. 3	is a schematic of a state when various pans and pans are placed on induction heating areas and an auxiliary cooker is placed on a cooking device area.
FIG. 4(a) and FIG. 4(b)	show plan views of an exemplary heating coil.
FIG. 5(a)	is a plan view of an exemplary power-feeding coil; and
FIG. 5(b) and FIG. 5(c)	show schematic cross-sectional views of the auxiliary cooker placed on the cooking device area.
FIG. 6(a)	is a perspective view of an alternative power-feeding coil.
FIG. 6(b)	is a plan view of an alternative power-feeding coil.
FIG. 7(a) to FIG. 7(c)	show plan views of other alternative power-feeding coils and transformers.
FIG. 8	is a block circuit diagram of an electric circuit configuration of the induction-heating cooker according to the present invention.
FIG. 9 I	is a graph of a relationship between a load resistance value and a frequency of a heated body and a power-receiving coil.
FIG. 10	is a partially cutaway perspective view of a combined cooker according to the present invention.
FIG. 11	is a partially cutaway perspective view of the combined cooker placed on a top plate of the induction-heating cooker.
FIG. 12	is a block circuit diagram of an electric circuit configuration of an induction-heating cooking

system made up of the induction-heating cooker and the combined cooker.

FIG. 13(a) is an end view parallel to an XZ plane of the combined cooker of FIG. 11 and

FIG. 11(b) is a cross-sectional view parallel to a YZ plane of the combined cooker of FIG. 11.

FIG. 14 is a plan view of the induction-heating cooker similar to FIG. 2, showing a heated body and auxiliary cookers placed on a top plate.

FIG. 15 is a flowchart of a control method of misplacement detection according to Modification Example 1.

FIG. 16 is a flowchart of another control method of misplacement detection according to Modification Example 1.

FIG. 17 is a plan view of the induction-heating cooker similar to FIG. 2, showing the combined cooker placed back to front in an improper position on the top plate.

FIG. 18 is a plan view of the induction-heating cooker similar to FIG. 2, showing the combined cooker placed in an improper position shifted in a left-right direction on the top plate.

FIG. 19 is a flowchart of a control method of misplacement detection according to Modification Example 1.

FIG. 20 is a chart of change in electric power before and after electric power demand in a ratio distribution mode.

FIG. 21 is a chart of change in electric power before and after electric power demand in an induction heating mode.

FIG. 22 is a chart of change in electric power before and after electric power demand in a feeding electric power mode.

FIG. 23 is a chart of change in electric power after the electric power demand in the ratio distribution mode and after stopping an operation of one heating coil.

FIG. 24 is a flow chart for explaining multiple electric power demands.

FIG. 25 is a flow chart for explaining multiple electric power demands.

MODES FOR CARRYING OUT THE INVENTION

[0015] Embodiments of an induction-heating cooker, a combined cooker, and an induction-heating cooking system equipped with these according to the present invention will now be described with reference to the accompanying drawings. Although terms indicative of direction (e.g., "front", "back", "left", "right", "X", "Y", "Z") are used as needed in the description of the embodiments for facilitating understanding, this is for illustrative purpose, and these terms do not limit the present invention. In the following accompanying drawings, the same constituent components will be referred to by the same reference numerals.

First Embodiment

[0016] An induction-heating cooking system 100 according to an embodiment of the present invention is made up of an induction-heating cooker 1 and a combined cooker 101 and, first, the induction-heating cooker 1 and the combined cooker 101 will each individually be described.

A. Induction-Heating Cooker

[0017] A first embodiment of the induction-heating cooker according to the present invention will be described in detail below with reference to FIGS. 1 to 9. FIG. 1 is a schematic perspective view of the entire induction-heating cooker (hereinafter simply referred to as "IH cooker") 1 according to the present invention. The IH cooker 1 shown in FIG. 1 is a built-in type apparatus installed in a storage part (not shown) disposed in a kitchen, and FIG. 2 is a plan view of the IH cooker 1 installed in the storage part of the kitchen.

[0018] The IH cooker 1 generally has a main body 2 mainly made of sheet metal etc., a heat resistant top plate (hereinafter referred to as "top plate") 3 made of glass etc. substantially entirely covering an upper surface thereof, multiple induction heating areas 10a, 10b, 10c, multiple cooking device areas 30a, 30b, and a cooking oven 4. The multiple induction heating areas 10a, 10b, 10c and the multiple cooking device areas 30a, 30b are arranged independently of each other in respective different regions on the top plate 3.

[0019] Hereinafter, for convenience of description, the induction heating areas 10a, 10b, 10c shown in FIGS. 1 and 2 will respectively be referred to as the left induction heating area 10a, the center induction heating area 10b, and the right induction heating area 10c, and the cooking device areas 30a, 30b are respectively referred to as the left cooking device area 30a and the right cooking device area 30b.

[0020] Although not shown, the IH cooker 1 has various circuit components and generally comprises: heating coils

12a, 12b, 12c (also collectively referred to as "first magnetic field generator") induction-heating an heated body 110 such as a pan, under the induction heating areas 10a, 10b, 10c; power-feeding coils 32a, 32b (also collectively referred to as "second magnetic field generator") supplying electric power (feeding power) to an auxiliary cooker (power receiving apparatus) 70 or a combined cooker 101 described later; first inverter circuits 14a, 14b, 14c supplying high-frequency currents to the heating coils 12a, 12b, 12c; second inverter circuits 34a, 34b supplying high-frequency currents to the power-feeding coils 32a, 32b; a power source 40 applying DC voltages to the first and second inverter circuits 14, 34; and a controller 50 controlling the high-frequency currents supplied by the first and second inverter circuits 14, 34. The power source 40 may individually be disposed for each of the first and second inverter circuits 14, 34.

[0021] Additionally, the IH cooker 1 comprises: an intake window 5 and exhaust windows 6a, 6b disposed on the back side of the top plate 3; an upper console(operation panel) 7 used by a user for operating the heating coils 12a, 12b, 12c, the power-feeding coils 32a, 32b, and the cooking oven 4; front consoles (heating-power adjustment dials) 8a, 8b for adjusting "heating-power (output electric power)"; and displays 9a, 9b using a liquid crystal display element etc. for displaying a control state, an operation guide, etc. for the operation panel 7 and the heating-power adjustment dials 8a, 8b. In the present invention, the air supply/exhaust windows 5, 6, the operation parts 7, 8, the heating-power adjustment dials 8 and the displays 9 are not limited to those described above and may have any configurations.

[0022] In the following description, the IH cooker 1 having a so-called center-grill structure with the cooking oven 4 disposed substantially at the center of the main body 2 will be exemplarily described; however, the present invention is not limited thereto and is also applicable to an IH cooker with the cooking oven 4 off-centered on either side (an IH cooker having a so-called side-grill structure) or an IH cooker without the cooking oven 4. Although the IH cooker 1 shown in FIGS. 1 and 2 is shown as the apparatus having the three induction heating areas 10a, 10b, 10c and the two cooking device areas 30a, 30b, the present invention is not limited thereto, and the IH cooker may have any configuration having at least one induction heating area 10 and a cooking device area 30.

[0023] FIG. 3 is a schematic of a state when a large pan 110a, a small pan 110b, and a frying pan 110c are placed on the induction heating areas 10a, 10b, 10c on the top plate 3 and the auxiliary cooker 70 such as a blender described later is placed on the right cooking device area 30b. The user can heat a food F and perform a treatment of food before heating at the same time.

[0024] The configurations and operations of the constituent components of the IH cooker 1 will be described in detail.

A. Heating Coil and Power-feeding coil

("First and Second Magnetic Field Generation Part")

[0025] The heating coil 12a is supplied with a high-frequency current from the first inverter circuit 14 to form a high-frequency magnetic field so that the heated body 110 such as a pan interlinks with the high-frequency magnetic field, and thereby generates Joule heat due to an eddy current to directly induction-heat the heated body 110.

[0026] Similarly, the power-feeding coils 32a, 32b are supplied with a high-frequency current from the second inverter circuit 34 to form a high-frequency magnetic field, so that a power-receiving coil 72 disposed in the auxiliary cooker 70 or the combined cooker 101 described later is electromagnetically induced by receiving the high-frequency magnetic field, thereby generating an electromotive force. Thus, since the heating coils 12 and the power-feeding coils 32 have a common function or action in that the coils are supplied with a high-frequency current to form a high-frequency magnetic field, these coils are also referred to as the first and second magnetic field generators 12, 32.

[0027] FIGS. 4(a) and 4(b) are plan views of the exemplary heating coil 12. The heating coil 12 (first magnetic field generator) is disposed under the induction heating area 10, and has center coils 13a, 13b and four peripheral coils 16a to 16d each formed of multiple turns of a wound litz wire that is a stranded wire made of multiple copper wires coated with resin, for example. The center coils 13a, 13b have the inner sub-coil 13a and the outer sub-coil 13b wound concentrically, and each of the peripheral coils 16a to 16d is formed by winding into a semi-arc shape (banana shape or cucumber shape) along the outer sub-coil 13b of the center coil. The inner sub-coil 13a and the outer sub-coil 13b of FIG. 4(a) may be connected in series or in parallel, or may individually be driven independently of each other so that the small pan P can efficiently be heated.

[0028] As shown in FIG. 4(b), the heating coil 12 may have the center coils 13a, 13b and the peripheral coils 16a, 16b similarly formed of multiple turns of the concentrically wound litz wires. The center coil 13 of FIG. 4(b) may be made up of the sub-coils 13a, 13b connected in series and the peripheral coil 16 may be made up of sub-coils 16a, 16b connected in series in the same way, or the sub-coils 13a, 13b, 16a, 16b may be connected in parallel with each other, or the sub-coils 13a, 13b, 16a, 16b may individually be driven independently of each other so that the pan P having an arbitrary size can efficiently be heated. The configuration of the connection of the coils constituting the heating coil does not limit the present invention.

[0029] FIG. 5(a) is a plan view of the exemplary power-feeding coil 32. A power-feeding coil 32 (second magnetic field generator) has a circular coil 32a and a rectangular coil 32b larger than this coil similarly formed of multiple turns of the

wound litz wires. FIGS. 5(b) and 5(c) are cross-sectional views of the auxiliary cookers 70 that are a blender and a fish roasting cooker, respectively, placed on the cooking device area 30 on the top plate 3. Depending on a size of the power-receiving coil 72 of the auxiliary cooker 70 or the combined cooker 101, a high-frequency current is supplied to the circular or rectangular coil 32a, 32b or both of the coils, so that the power-receiving coil 72 of the auxiliary cooker 70 or the combined cooker 101 can receive a desired electric energy.

[0030] For example, the blender 70 of FIG. 5(b) can rotate a motor to shred or stir a food by utilizing the electromotive force generated by the power-receiving coil 72 receiving the high-frequency magnetic field, and the fish roasting cooker 70 of FIG. 5(c) can heat a food such as fish from above by supplying the electromotive force acquired and generated by the power-receiving coil 72 in the same way to a resistance heating element such as a radiant heater that is a load. The power-feeding coil 32 may be configured to have a circular shape, a rectangular shape, or a polygonal shape as long as a high-frequency magnetic field is generated. The case of placing the combined cooker 101 on the top plate 3 will be described later.

[0031] FIGS. 6(a) and 6(b) are a perspective view and a plan view of the alternative power-feeding coil 32. This power-feeding coil 32 is formed by bending an endless (donut-shaped) metal plate made of metal such as copper and iron and has an excitation part 63 facing the top plate 3 and a power-receiving part 64 inserted into an opening 66 of a transformer 65. The transformer 65 has a base portion 67 made of a magnetic material, a pair of walls 68 extending in a direction perpendicular thereto, and the opening 66 formed between the paired walls 68 and constitutes a primary coil formed by winding an insulating-coated coil 69 around the pair of the walls 68 made mainly of a magnetic material.

[0032] Although the heating coil 12 configured by winding the litz wire shown in FIGS. 4 and 5 forms a high-frequency magnetic field when a high-frequency current is supplied to both ends of the litz wire, the power-feeding coil 32 made up of an endless metal plate shown in FIG. 6 forms a high-frequency magnetic field between the paired walls 68 when a high-frequency current is supplied to the coil 69, and the power-receiving part 64 of the power-feeding coil 32 is interlinked with (magnetically coupled like a secondary coil to) the high-frequency magnetic field so that a high-frequency eddy current flows in the excitation part 63, resulting in a high-frequency magnetic field formed around the excitation part 63.

[0033] The high-frequency magnetic field formed in this way is propagated through the top plate 3 and interlinked with the power-receiving coil 72 of the auxiliary cooker 70 or the combined cooker 101 to generate an electromotive force. In this way, the power-feeding coil 32 shown in FIG. 6 is made up of a portion of an endless metal plate.

[0034] FIGS. 7(a) to 7(c) are plan views of other alternative power-feeding coils 32 and transformers 65 having various forms. The planar shape of the excitation part 63 of the power-feeding coil 32 may have a rectangular shape, a polygonal (octagonal) shape, or a circular shape as shown in the figures. The power-feeding coil 32 may be configured as a portion of an endless metal plate as described above or may be configured as a portion of an endless metal thin film laminated on an insulating substrate, for example.

[0035] In the above description, the heating coil 12 and the power-feeding coil 32 are described as having different forms from each other; however, for example, the heating coil 12 and the power-feeding coil 32 may be made up of a portion of an endless metal plate and a wound litz wire, respectively, and may have any forms as long as the coils function as magnetic field generators generating high-frequency magnetic fields.

B. Electric Circuit Configuration

[0036] FIG. 8 is a block circuit diagram of an electric circuit configuration of the IH cooker 1 according to the present invention. The IH cooker 1 shown in FIG. 8 generally comprises the first inverter circuit 14 supplying a high-frequency current to the heating coil 12, the second inverter circuit 34 supplying a high-frequency current to the power-feeding coil 32, and the power source 40 applying DC voltages to the first and second inverter circuits 14, 34. The IH cooker 1 also comprises the controller 50 controlling the high-frequency currents supplied to the heating coil 12 and the power-feeding coil 32 from the first and second inverter circuits 14. 34, and the operation parts 7, 8 and the display 9 are electrically connected to the controller 50.

[0037] The IH cooker 1 further comprises a pan detecting unit (first detecting unit) 15 detecting electric characteristics (including load characteristics such as a load resistance and a resonance frequency) of the heated body 110 placed above the heating coil 12, a coil detecting unit (second detecting unit) 35 detecting electric characteristics of the power-receiving coil 72 of the auxiliary cooker 70 or the combined cooker 101 placed above the power-feeding coil 32, and a power detecting unit 45 detecting the electric power consumed in the power source 40.

[0038] Although the heated body 110 placed above the heating coil 12 and the power-receiving coil 72 of the auxiliary cooker 70 or the combined cooker 101 placed above the power-feeding coil 32 are distinguished in the above description, both are objects placed on the top plate 3 and are sometimes collectively referred to as "placed objects".

[0039] Therefore, the "placed objects" include the heated body 110 and the auxiliary cooker 70 or the combined cooker 101 equipped with the power-receiving coil 72. Although the power source 40 applies a DC voltage to the first and second inverter circuits 14, 34, multiple power sources may be disposed to independently apply DC voltages to the respective

inverter circuits, and similarly, multiple power detecting units may be disposed in the respective power sources.

[0040] As shown in FIG. 8, the power source 40 comprises a converter (e.g., a diode bridge) 42 converting a single-phase AC power source 41 supplied from the outside into a substantially direct current, a choke coil 43 and a smoothing capacitor 44 connected to an output end of the converter 42, and the power detecting unit 45 detecting the electric power consumed in the power source 40. As described above, the power source 40 applies direct currents to the first and second inverter circuits 14, 34, and the power detecting unit 45 detects the electric power consumed in the power source 40.

[0041] The first inverter circuit 14 is connected to the power source 40 in parallel, has a drive arm made up of a semiconductor switching element pair such as an IGBT and a resonance capacitor 11, and converts the direct current from the power source 40 into a high-frequency current to supply the high-frequency current to the heating coil 12.

[0042] The heating coil 12 is shown as an equivalent circuit of an inductance L and a resistance R thereof, and the heated body 110 such as a pan placed above the heating coil 12 (facing the heating coil 12) via the top plate 3 is also shown as an object having an inductance component and a resistance component. When a high-frequency current is supplied to the heating coil 12, a high-frequency magnetic field is formed therearound, and the heated body 110 is interlinked with the high-frequency magnetic field and induction-heated.

[0043] The first inverter circuit 14 is provided with a pan detecting unit (first detecting unit) 15 detecting a drive voltage V applied to both ends of the heating coil 12 and a drive current I flowing through the heating coil 12 to detect the electric characteristics (including load characteristics such as a load resistance and a resonance frequency) of the heated body 110 based on the drive voltage V and the drive current I. The pan detecting unit 15 may have any known circuit configuration as long as the electric characteristics of the heated body 110 are detected, and preferably has the same circuit configuration as the load detecting unit disclosed in Japanese Laid-Open Patent Publication No. 2012-054179, for example.

[0044] Similarly, the second inverter circuit 34 is connected to the power source 40 in parallel, has a drive arm made up of a semiconductor switching element pair such as an IGBT and a resonance capacitor 31, and converts the direct current from the power source 40 into a high-frequency current to supply the high-frequency current to the power-feeding coil 32.

[0045] On the other hand, the power-feeding coil 32 is shown as an equivalent circuit of an inductance L' and a resistance R' thereof. The power-receiving coil 72 of the auxiliary cooker 70 shown in FIGS. 5(b) and 5(c) is a coil placed above the power-feeding coil 32 (facing the power-feeding coil 32) via the top plate 3 and, as described in detail later, a load part 74 such as a motor and a heater for supporting cooking is connected to both ends of the power-receiving coil 72 so that electric power is supplied thereto. Therefore, from the viewpoint of supplying electric power to the load part 74, the power-receiving coil 72 constitutes an electric generator, and in this description, the power-receiving coil 72 is also referred to as the "electric generator 72" according to a superordinate concept. The load part 74 such as a motor and a heater is also collectively referred to as the "cooking support unit 74" in this description in the context of being supplied with electric power to support cooking.

[0046] In FIG. 8, the auxiliary cooker 70 is shown as having the power-receiving coil (electric generator) 72 and the load part (cooking support unit) 74 having an inductance component. When a high-frequency current is supplied to the power-feeding coil 32, a high-frequency magnetic field is formed therearound so that an electromotive force is generated in the power-receiving coil (electric generator) 72, and the electric power is supplied to the load part (cooking support unit) 74 to support cooking of food such that the finish of the cooking is improved.

[0047] The load part (cooking support unit) 74 may include a converter (not shown) converting the electromotive force generated at both ends of the power-receiving coil 72 into a desired AC voltage or DC voltage and may further include, for example, a motor rotating a cutter of the blender shown in FIG. 5(b) or a resistance heating element such as a radiant heater of the fish roasting cooker 70 shown in FIG. 5(c).

[0048] The second inverter circuit 34 is provided with a coil detecting unit (second detecting unit) 35 detecting a drive voltage V applied to both ends of the power-feeding coil 32 and a drive current I flowing through the power-feeding coil 32 to detect the electric characteristics (including load characteristics such as a load resistance and a resonance frequency) of the load part 74 including the power-receiving coil 72 of the auxiliary cooker 70 placed above the power-feeding coil 32 based on the drive voltage V and the drive current I. The coil detecting unit 35 may have any known circuit configuration as long as the electric characteristics of the power-receiving coil 72 of the auxiliary cooker 70 are detected from the drive voltage V and the drive current I, and may have the same circuit configuration as the pan detecting unit 15.

[0049] The controller 50 is connected to the operation parts 7, 8 and the display 9 and controls the first and second inverter circuits 14, 34 so as to supply high-frequency currents corresponding to the heating power etc. desired by the user to the heating coil 12 and the power-feeding coil 32. The controller 50 is also connected to the pan detecting unit 15, the coil detecting unit 35, and the power detecting unit 45 and can control the drive frequency and the consumed electric power of each of the inverter circuits 14, 34 based on the electric characteristics of the objet to be heated 110 and the load part 74 including the power-receiving coil 72 of the auxiliary cooker 70 placed on the top plate 3.

[0050] The controller 50 can determine that the heated body 110 or the auxiliary cooker 70 is placed on the top plate

3 with a simple technique based on the load resistance detected by the pan detecting unit 15 and the coil detecting unit 35. FIG. 9 is a plot of load resistance detected by the pan detecting unit 15 and the coil detecting unit 35 at the time of sweeping (frequency sweeping) of the output voltages of the first and second inverter circuits 14, 34 changed by 1 kHz, for example.

[0051] As shown in FIG. 9, when the heated body 110 is placed on the top plate 3, the detected load resistance monotonically increases according to an increment in frequency and, when the auxiliary cooker 70 is placed on the top plate 3, the load resistance value changes such that a maximum value (peak value) is included at a certain resonance frequency. Therefore, by performing the frequency sweep and detecting the load, the controller 50 can instantaneously determine from the relationship of the frequency and the load characteristics shown in FIG. 9 that either the heated body 110 or the auxiliary cooker 70 is placed.

[0052] When the pan detecting unit 15 and the coil detecting unit 35 have the same circuit configuration, the controller 50 can easily recognize even the auxiliary cooker 70 placed on the induction heating area 10 and the heated body 110 placed on the cooking device area 30, from the relationship of the frequency and the load characteristics shown in FIG. 9, and can perform the induction heating of the heated body 110 and the electromagnetic induction of the power-receiving coil 72 of the auxiliary cooker 70 under proper conditions. In other words, although the induction heating area 10 and the cooking device area 30 are described by using different names in the above description, since both the heating coil 12 and the power-feeding coil 32 generate a magnetic field and both the pan detecting unit 15 and the coil detecting unit 35 detect the electric characteristics (including load characteristics) of the heated body 110 and the power-receiving coil 72, the areas 10, 30 can be utilized as areas providing the induction heating of the heated body 110 and the electromagnetic induction of the power-receiving coil 72 of the auxiliary cooker 70 in a compatible manner.

[0053] On the other hand, if the pan detecting unit 15 detects the electric characteristics of the placed object on the induction heating area 10 and it is determined that the power-receiving coil 72 is placed on the induction heating area 10, or if the coil detecting unit 35 detects the electric characteristics of the placed object on the cooking device area 30 and it is determined that the heated body 110 is placed on the cooking device area 30, the controller 50 may determine that a placed object other than the combined cooker 101 is placed or that the combined cooker 101 is not placed in the correct position, and may control the first and second inverter circuits 14, 34 so as not to supply a high-frequency current to the power-feeding coil 32 or the heating coil 12.

C. Combined Cooking Apparatus

[0054] FIG. 10 is a partially cutaway perspective view of the combined cooker 101 according to the present invention, and FIG. 11 is a perspective view of the combined cooker 101 placed on the top plate 3 of the IH cooker 1. FIG. 12 is a block circuit diagram of an electric circuit configuration of the induction-heating cooking system 100 made up of the IH cooker 1 and the combined cooker 101. The combined cooker 101 shown in FIG. 10 comprises the heated body 110 (induction-heated part) placed on the induction heating area 10 of the top plate 3 and the electric generator 72 including the power-receiving coil 72 placed on the cooking device area 30.

[0055] The combined cooker 101 of FIG. 10 is configured as a fish roaster for grilling a food such as fish, for example, and the heated body 110 is formed by bending a metal plate made of magnetic metal such as copper and iron into a rectangular dish member 110 having a concave portion. A grill net 116 may be disposed on the dish member 110 so that the food F is browned along mesh-like stripes. As shown in FIG. 10, when a high-frequency current is supplied to the heating coil 12 disposed under the induction heating area 10, the dish member (heated body) 110 is induction-heated by the heating coil 12 (first magnetic field generator) so that the food F is heated and cooked with the radiant heat thereof.

[0056] As shown in FIG. 12, the combined cooker 101 according to the present invention has the power-receiving coil 72. Similar to the power-feeding coil 32, the power-receiving coil 72 may be made up of an induction heating coil formed by winding a litz wire or a portion of an endless metal plate or metal thin film. When a high-frequency current is supplied to the power-feeding coil 32 disposed under the cooking device area 30 of the top plate 3, the power-receiving coil 72 is electromagnetically induced by the power-feeding coil 32 (second magnetic field generator) and generates an electromotive force.

[0057] Therefore, similar to the power-receiving coil 72 of the auxiliary cooker 70, when a high-frequency magnetic field is formed around the power-feeding coil 32 supplied with the high-frequency current, the power-receiving coil 72 of the combined cooker 101 has the electromotive force generated at both ends of the power-receiving coil 72 and functions as an electric generator supplying an electric power to the load part (cooking support unit) 74.

[0058] The cooking support unit 74 shown in FIGS. 10 and 11 comprises, for example, a converter (not shown) converting the high-frequency power from the power-receiving coil, i.e., the electric generator 72, into appropriate voltage and current, and a resistance heating element 76 such as a radiant heater or a sheath heater. The cooking support unit 74 shown in FIGS. 10 and 11 is disposed on the upper side of the combined cooker 101 to cook and heat the food F from above.

[0059] Therefore, when the high-frequency current is supplied to the heating coil 12 and the power-feeding coil 32

(first and second magnetic field generators) of the IH cooker 1, the combined cooker 101 according to the present invention can induction-heat the dish member (heated body) 110 for placing the food F thereon to cook and heat the food F from below and can supply an appropriate electric power acquired from the electromagnetic induction to the resistance heating element 76 disposed above the food F to cook and heat the food F from above.

[0060] Therefore, according to the combined cooker 101 of the present invention, the food F can be heated from below by using the dish member (heated body) 110, and the food F can efficiently be heated from above by using the resistance heating element 76 constituting the cooking support unit 74. The combined cooker 101 according to the present invention can perform grill cooking even when the IH cooker 1 is not equipped with the cooking oven 4, and is extremely convenient and easy to use.

[0061] Furthermore, the dish member 110 for placing the food F thereon is configured to be detachable from the combined cooker 101 and therefore can easily be cleaned to maintain cleanliness. The combined cooker 101 can not only cook grilled fish as shown in FIGS. 10 and 11, but also cook a meat dish such as roast beef and toast a slice of bread such as white bread from both sides.

[0062] While the combined cooker 101 supplies appropriate electric power to both the heated body 110 and the cooking support unit 74 to heat and cook the food F, the maximum electric power supplied to the heated body 110 is equal to a maximum supply electric power Pih of the induction heating area 10, and the maximum electric power supplied to the cooking support unit 74 is equal to a maximum supply electric power Pwpt of the cooking device area 30.

[0063] Therefore, the combined cooker 101 can supply a total electric power of the maximum supply electric power Pih of the induction heating area 10 and the maximum supply electric power Pwpt of the cooking device area 30 to quickly and efficiently perform heating. Generally, the maximum supply electric power Pih of the induction heating area 10 is about 3000 W as an electric power that can be supplied through induction heating, and the maximum supply electric power Pwpt of the cooking device area 30 is about 1500 W as an electric power transmittable without contact (scheduled to be standardized in the future). Therefore, the combined cooker 101 can cook with the total electric power of 4500 W and can shorten the cooking time so that convenience is improved.

[0064] The heated body 110 and the cooking support unit 74 of the combined cooker 101 according to the present invention may have various forms. FIG. 13(a) is an end view parallel to an XZ plane of the combined cooker 101 of FIG. 11, and FIG. 13(b) is a cross-sectional view parallel to a YZ plane of the combined cooker 101 of FIG. 11. In FIGS. 13(a) and 13(b), the dish member (heated body) 110 is made up of a half-cylindrical member 112 made of a hollow half-cylindrical metal and has a pair of end portions 114.

[0065] A grill net 116 may be disposed on the half-cylindrical member 112 so that the food F is browned along mesh-like stripes. As shown in the figures, when a high-frequency current is supplied to the heating coil 12 disposed under the induction heating area 10, the hemi-cylindrical member 112 is induction-heated by the heating coil 12 (first magnetic field generator) so that the food F is heated and cooked with the radiant heat thereof.

[0066] As shown in FIG. 13(a), a slit 115 is disposed at one of the end portions 114 of the half-cylindrical member (heated body) 112. On the other hand, the cooking support unit 74 shown in FIGS. 13(a) and 13(b) comprises, for example, a converter (not shown) converting the high-frequency power from the electric generator (power-receiving coil) 72 into appropriate voltage and current, and a rotation mechanism (cooking support unit) 75 configured to swing an arm 118 inserted in the slit 115 in directions of both arrows.

[0067] Therefore, according to the cooking support unit 74 of the combined cooker 101, when a high-frequency current is supplied to the heating coil 12 (first magnetic field generator) to induction-heat the half-cylindrical member 112 on which the food F is placed, the power-feeding coil 32 (second magnetic field generator) is supplied with a high-frequency current so as to supply an electric power to the electric generator 72, and the rotation mechanism 75 is thereby driven and used for continuously moving (shifting) an induction-heated portion of the half-cylindrical member 112, so that the food F can more uniformly be heated.

[0068] Although not particularly shown, the cooking support unit 74 comprises a (e.g., cylindrical- or drum-shaped) fixing member fixing the food F to the heated body 110 in the combined cooker 101 and the rotation mechanism 75 rotating the fixing member 360 degrees around a center axis thereof by using the electric power acquired by the electric generator 72. The cooking support unit 74 as described above can more uniformly heat the food F at the time of cooking a meat dish such as roast beef.

[0069] As shown in FIG. 13(c), the cooking support unit 74 may have both the resistance heating element 76 of FIG. 10 etc. and the rotation mechanism 75 of FIG. 13(a) etc.

[0070] The cooking support unit 74 may also have a converter converting the high-frequency power from the power-receiving coil 72 into appropriate voltage and current, and an illumination part (not shown) illuminating the inside of a housing 102 of the combined cooker 101. When the whole or a portion (a window portion) of the housing 102 of the combined cooker 101 is made up of a transparent member such as a heat resistant glass, illuminating the inside of the housing 102 by using the illumination part allows the user to visually check the progress of cooking of the food F and can make the food F look delicious during cooking.

[0071] The illumination part of the cooking support unit 74 may be made up of a series of red, green, and blue LED

lamps capable of achieving various color tones.

[0072] As described above, the heating coil 12 and the power-feeding coil 32 disposed under the induction heating area 10 and the cooking device area 30 both generate a high-frequency magnetic field, and the pan detecting unit 15 and the coil detecting unit 35 both detect the electric characteristics (including load characteristics) of the heated body 110 and the power-receiving coil 72, so that based on a circuit configuration (theoretically), the heating coil 12 and the power-feeding coil 32 can provide the induction heating and the electromagnetic induction of the heated body 110 and the power-receiving coil 72 in a compatible manner.

[0073] Therefore, with regard to the combined cooker 101 according to the present invention, even when the IH cooker 1 is not equipped with the cooking device area 30, for example, the combined cooker 101 may be placed on the top plate 3 with the dish member (heated body) 110 placed on the left induction heating area 10a shown in FIG. 1 and the power-receiving coil 72 placed on the right induction heating area 10c (not shown). Therefore, the combined cooker 101 according to the present invention can achieve efficient cooking as described above by using the induction-heating cooker 1 having the at least two magnetic field generators 12, 32.

Modification Example 1: Misplacement Detection 1

[0074] On the other hand, the heating coil 12 and the power-feeding coil 32 (the first and second magnetic field generators) both generate a magnetic field, and therefore, based on the circuit configuration (theoretically), the power-feeding coil 32 can induction-heat the heated body 110 and the heating coil 12 can electromagnetically induce the receiving coil 72 of the auxiliary cooker 70 etc. However, since the electric energy required for induction heating of the heated body 110 with the power-feeding coil 32 is generally larger than the electric energy required for electromagnetic induction of the power-receiving coil 72 of the auxiliary cooker 70 etc., it is preferable that the semiconductor switching elements etc. constituting the second inverter circuit 34 for the auxiliary cooker 70 etc. have a maximum rated current smaller than those constituting the first inverter circuit 14 for induction heating of the heated body 110 and are expensive.

[0075] Therefore, regardless of the theoretically possibility, it is extremely preferable for the IH cooker 1 according to this embodiment to use the heating coil 12 for the induction heating of the heated body 110 such as a pan and to use the power-receiving coil 72 for operating the auxiliary cooker 70 etc., from the viewpoint of miniaturization of constituent components and manufacturing costs.

[0076] In particular, if the user mistakenly places the heated body 110 on the cooking device area 30 or places the auxiliary cooker 70 (the power-receiving coil 72) on the induction heating area 10, it is extremely desirable to stop the induction heating or electromagnetic induction thereof. Detection of misplacement of the heated body 110 or the auxiliary cooker 70 by the user will hereinafter be described with reference to FIGS. 14 to 16.

[0077] FIG. 14 is a plan view of the IH cooker 1 similar to FIG. 2, showing the heated body 110 such as a pan placed on the left cooking device area 30a, the auxiliary cooker 70 placed on the left induction heating area 10a, and the other auxiliary cooker 70 placed over portions of the right cooking device area 30b, the center induction heating area 10b, and the right induction heating area 10c. Description will be made of a method of controlling the IH cooker 1 when the user does not place the heated body 110 or the auxiliary cooker 70 in a proper position on the induction heating area 10 or the cooking device area 30 (including the case of misplacement).

[0078] FIG. 15 is a flowchart of a control technique for providing the electromagnetic induction of the power-receiving coil 72 for power feeding (electromagnetic induction mode or power feeding mode) only when the auxiliary cooker 70 is properly placed on the cooking device area 30, while the second inverter circuit 34 does not supply a high-frequency current to the power-feeding coil 32 (stops the operation) when no load is placed or when the heated body 110 such as a pan is mistakenly placed on the cooking device area 30.

[0079] First, the user operates the operation parts 7, 8 such that the power-receiving coil 72 of the auxiliary cooker 70 is electromagnetically induced (start power feeding operation). As described above, the auxiliary cooker 70 and the heated body 100 such as a pan have the relationship of frequency and load resistance as shown in FIG. 9, and the load resistance of the auxiliary cooker 70 has the maximum value (peak value) at the resonance frequency (e.g., 20 kHz).

[0080] At step ST01 of the flowchart shown in FIG. 15, when a load resistance value detected by the coil detecting unit 35 is equal to or greater than a predetermined first threshold value, the controller 50 determines that some kind of load is placed on the cooking device area 30 (YES), and goes to step ST02. On the other hand, when the load resistance value detected by the coil detecting unit 35 is less than the predetermined first threshold value, the controller 50 determines that no load is placed, visually or audibly gives the user a warning thereof (step ST05), and stops the operation of the second inverter circuit 34 supplying a high-frequency current to the power-feeding coil 32 (step ST06).

[0081] When the coil detecting unit 35 detects that the load resistance value detected at a predetermined drive frequency (e.g., 20 kHz) is equal to or greater than a second threshold value larger than the first threshold value, the controller 50 determines that the auxiliary cooker 70 is placed on the cooking device area 30 (YES), and goes to step ST03.

[0082] On the other hand, when the load resistance value detected at the predetermined driving frequency is less than the second threshold value, the controller 50 determines that the auxiliary cooker 70 is not placed on the cooking device

area 30 (NO), visually or audibly gives the user a warning thereof (step ST05), and stops the operation of the second inverter circuit 34 supplying a high-frequency current to the power-feeding coil 32 (step ST06).

[0083] For example, as shown in FIG. 14, if the auxiliary cooker 70 is placed over portions of the right cooking device area 30b, the center induction heating area 10b, and the right induction heating area 10c, the pan detecting unit 15 corresponding to the center induction heating area 10b and the right induction heating area 10c adjacent to the right cooking device area 30b also detects the load. Therefore, when the pan detecting unit 15 corresponding to the other adjacent induction heating areas 10b, 10c detects the same load characteristics as the coil detecting unit 35 at step ST03, the controller 50 determines that the auxiliary cooker 70 is not properly placed on the right side cooking device 30b (NO), visually or audibly gives the user a warning thereof (step ST05), and stops the operation of the second inverter circuit 34 supplying a high-frequency current to the power-feeding coil 32 (step ST06).

[0084] Therefore, when only the coil detecting unit 35 corresponding to the right cooking device area 30b detects the load at step ST03 (YES), the controller 50 controls the second inverter circuit 34 to supply a high-frequency current to the power-feeding coil 32 at step ST04 (electromagnetic induction mode).

[0085] FIG. 16 is a flowchart of a control technique for providing the induction heating of the heated body 110 (induction heating mode) only when the heated body 110 such as a pan is properly placed on the induction heating area 10, while the first inverter circuit 14 does not supply a high-frequency current (stops the operation) when no load is placed, when a placed load is a small object not to be heated such as a spoon, and when the power-receiving coil 72 of the auxiliary cooker 70 is mistakenly placed on the induction heating area 10.

[0086] First, the user operates the operation parts 7, 8 such that the heated body 110 is induction-heated (start heating operation). At step ST07 of the flowchart shown in FIG. 16, when the load resistance value detected by the pan detecting unit 15 is equal to or greater than the first threshold value, the controller 50 determines that some kind of load is placed on the induction heating area 10 (YES), and goes to step ST08.

[0087] On the other hand, when the load resistance value detected by the pan detecting unit 15 is less than the predetermined first threshold value, the controller 50 determines that no load is placed, visually or audibly gives the user a warning thereof (step ST11), and stops the operation of the first inverter circuit 14 supplying a high-frequency current to the heating coil 12 (step ST12).

[0088] When the pan detecting unit 15 detects that the load resistance value detected at a predetermined drive frequency (e.g., 20 kHz) is greater than the first threshold value and less than the second threshold value or when the pan detecting unit 15 detects a load resistance value increasing according to the frequency, the controller 50 determines that the heated body 110 is placed on the induction heating area 10 (YES), and goes to step ST09. On the other hand, when the load resistance value detected at the predetermined drive frequency is greater than the second threshold value or has the maximum value (peak value) at the resonance frequency at step ST08, the controller 50 determines that the auxiliary cooker 70 is placed on the induction heating area 10 as shown in FIG. 14 (NO).

[0089] The controller 50 visually or audibly gives the user a warning in the same way, or more preferably, notifies the user of the placement of the receiving coil 72 of the auxiliary cooker 70 etc. on the induction heating area 10 (step ST11) and stops the operation of the first inverter circuit 14 supplying a high-frequency current to the heating coil 12 (step ST12).

[0090] Furthermore, although not particularly shown, if the heated body 110 is placed over portions of the left cooking device area 30a and the left induction heating area 10a, the coil detecting unit 35 corresponding to the left induction heating area 10a and the left cooking device area 30a detects the same load as the pan detecting unit 15. Therefore, when the coil detecting unit 35 corresponding to the different adjacent cooking device area 30 detects the same load characteristics as the pan detecting unit 15 at step ST09, the controller 50 determines that the heated body 110 is not properly placed on the left induction heating area 10a (NO), gives the user a warning thereof (step ST11), and stops the operation of the first inverter circuit 14 supplying a high-frequency current to the heating coil 12 (step ST12). Thus, when only the pan detecting unit 15 corresponding to the left induction heating area 10a detects the load at step ST09 (YES), the controller 50 controls the first inverter circuit 14 to supply a high-frequency current to the heating coil 12 at step ST10 (induction heating mode).

[0091] Therefore, according to the misplacement detection according to Modification Example 1 described above, when the user mistakenly places the heated body 110 on the cooking device area 30, when the auxiliary cooker 70 (the power-receiving coil 72) is placed on the induction heating area 10, or when the heated body 110 or the auxiliary cooker 70 is placed over the induction heating area 10 and the cooking device area 30 adjacent to each other, the controller 50 can provide control to stop the operation of the first or second inverter circuit 14, 34. In this way, the heating coil 12 can be prevented from supplying an excessive electric power to the power-receiving coil 72 and destroying the load part 74, or the power-feeding coil 32 can be prevented from being supplied with an excessive current for acquiring an electric power required for induction heating so that an excessive burden is applied to the inverter circuit 34. Furthermore, since the load is reliably determined, the constituent components such as semiconductor switching elements constituting the first and second inverter circuits 14, 34 can properly be selected.

Modification Example 2: Misplacement Detection 2

[0092] FIGS. 17 and 18 are plan views of the induction-heating cooker 1 similar to FIG. 2, showing the combined cooker 101 placed at an improper position (a back-to-front position or a position shifted in a left-right direction) on the top plate 3. Therefore, the heated bodies 110 and the power-receiving coils 72 of these combined cookers 101 are not placed at proper positions above the induction heating area 10 and the cooking device area 30, respectively.

[0093] Description will hereinafter be made of a method of controlling the induction-heating cooker 1 when the heated body 110 of the combined cooker 101 is placed on the cooking device area 30 and the power-receiving coil 72 is placed on the induction heating area 10 as shown in FIG. 17.

[0094] First, the user operates the operation parts 7, 8 to start cooking with the combined cooker 101 (start cooking). As described above, the heated body 110 and the power-receiving coil 72 have a relationship of the frequency and the load resistance as shown in FIG. 9. At step ST13 of a flowchart shown in FIG. 19, when the load resistance values detected by the pan detecting unit 15 and the coil detecting unit 35 are equal to or greater than the predetermined first threshold value, the controller 50 determines that some kind of load (placed object) is placed on the induction heating area 10 and the cooking device area 30 (YES), and goes to step ST 14.

[0095] When it is determined that no load is placed (NO), the controller goes to step ST17, and the induction-heating cooker 1 stops the cooking operation. Although not shown in this figure, before the stop of the operation (step ST17), the user may be given a warning of improper placement of the combined cooker 110 on the top plate 3 as shown in FIGS. 15 and 16 of Modification Example 1.

[0096] The pan detecting unit 15 detects the relationship of the frequency and the load resistance of the placed load as described above and it is determined whether the load placed on the induction heating area 10 is the heated body 110 (step ST14). When determining that the placed load is not the heated body 110, the controller 50 goes to step ST17 and stops the cooking operation.

[0097] If it is determined at step ST14 that the placed load is the heated body 110 (YES), the controller 50 goes to step ST15 to detect the relationship of the frequency and the load resistance of the load placed on the cooking device area 30 with the coil detecting unit 35 and determine whether the load placed on the cooking device area 30 is the power-receiving coil 72 (the cooking support unit 74). If it is determined at step ST15 that the load placed on the cooking device area 30 is not the power-receiving coil 72 (the cooking support unit 74) (NO), the controller 50 goes to step ST17 and stops the cooking operation.

[0098] On the other hand, when determining that the load placed on the cooking device area 30 is the power-receiving coil 72 (the cooking support unit 74) at step ST 15 (YES), the controller 50 goes to step ST16 to permit the operation of the combined cooker 101 and start cooking. Therefore, when the heated body 110 is placed on the induction heating area 10 and the power-receiving coil 72 (the cooking support portion 74) is placed on the cooking device area 30, the controller 50 controls the first and second inverter circuits 14, 34 so as to permit the cooking operation by the combined cooker.

[0099] As described above, FIG. 18 is a view of a placement state of the heated body 110 and the power-receiving coil 72 of the combined cooker 101 shifted in a left-right direction from the induction heating area 10 and the cooking device area 30, respectively, as in Modification Example 1. Since the operation of the controller 50 in this case is the same as Modification Example 1 and therefore will not be described in detail.

[0100] As described above, the induction-heating cooker 1 is configured to permit the operation of the combined cooker 101 when it is determined that the heated body 110 and the power-receiving coil 72 of the combined cooker 101 are placed at appropriate positions, and therefore, when the user mistakenly places the combined cooker 101 back to front on the top plate 3 and starts the cooking operation, the heating coil 12 can be prevented from supplying an excessive electric power to the power-receiving coil 72 and destroying the load part 74, or the power-feeding coil 32 can be prevented from being supplied with an excessive current for acquiring an electric power required for induction heating so that an excessive burden is applied to the inverter circuit 34. Furthermore, since the load is reliably determined, the constituent components such as semiconductor switching elements constituting the first and second inverter circuits 14, 34 can properly be selected.

[0101] According to the induction-heating cooker 1, the auxiliary cooker 70, and the combined cooker 101 configured as described above, the following effects can be achieved.

a) Since drive parts (the first and second inverter circuits 14, 34) are independently provided, respective electric powers (first and second electric powers) can individually be controlled. As a result, if it is desired to increase an amount of heating from an upper surface according to a progress (finish) of cooking, the electric power supplied to the resistance heating element 76 constituting the cooking support portion 74 of the combined cooker 101 can be made larger to increase the electric power (heating power) of the resistance heating body 76. If it is desired to prevent or suppress overcooking on the lower surface of the food F, the electric power supplied to the heated body 110 of the combined cooker 101 can be made smaller to reduce the electric power (heating power) of the induction

heating. Since the electric power supplied to the cooking support unit 74 from the upper side and the heated body 110 from the lower side can individually be controlled in this way, the finish state of cooking can further be improved.
b) Since the induction heating area 10 and the cooking device area 30 are independently disposed, the induction heating and the power feeding (power receiving) can be performed at the same time, and since the induction heating area 10 and the cooking device area 30 are dividedly (separately) arranged, magnetic interference can be suppressed between the respective areas so that the efficient heating operation can be achieved.
c) Since the induction heating area 10 and the cooking device area 30 are independently disposed, the combined cooker 101 can output a maximum of 3 kW (the maximum value of the first electric power) in the induction heating area 10, a maximum of 1.5 kW (the maximum value of the second electric power) in the cooking device area 30, and the maximum total electric power of 4.5 kW, and can shorten a cooking time according to cooking contents.
d) Furthermore, since the induction heating area 10 and the cooking device area 30 are independently disposed, when the combined cooker 101 is not used, normal cooking can be performed in the induction heating area 10, while the different auxiliary cooker (power receiving apparatus) 70 can be placed and used on the cooking device area 30, so that the users convenience is improved.
e) Since the induction heating area 10 and the cooking device area 30 have the magnetic field generators and the first and second magnetic field generators can be controlled and operated as the induction heating parts, the induction heating can be performed in a wider area by placing a large heating load, for example, an iron plate, extending over these areas 10, 30, so that the convenience is improved.
f) By disposing the pan detecting unit 15 in the induction heating area 10 and the coil detecting unit 35 in the cooking device area 30, the induction-heating cooker 1 is configured to operate when an appropriate load is placed on each of the areas 10, 30, and therefore, a proper electric power can be supplied and the induction-heating cooker 1 can be prevented from being broken due to misplacement.

(Modification Example 3: Electric power demand)

[0102] The IH cooker 1 shown in FIG. 1 comprises the three heating coils 12 (the induction heating areas 10) for induction heating of the heated body 110 and the two power-feeding coils 32 (the cooking device areas 30) for electromagnetic induction of the power-receiving coil 72 of the auxiliary cooker 70 etc., and also arbitrarily has the cooking oven 4. Therefore, when high-frequency currents are simultaneously supplied to the pluralities of the heating coils 12 and the power-feeding coils 32 in the IH cooker 1 of FIG. 1, a sum of respective heating powers (consumed electric powers) thereof desired by the user may exceed a maximum supply electric power (maximum allowable electric power) Pmax (e.g., 5.8 kW) of the whole IH cooker 1. In this case, the electric power consumed by at least one of the heating coils 12 or the power-feeding coils 32 must be suppressed so that the total electric power consumed by the pluralities of the heating coils 12 and the power-feeding coils 32 does not exceed the maximum rated electric power Pmax. A control technique of suppressing the electric power consumed by the heating coils 12 or the power-feeding coils 32 in this way is referred to as "electric power demand".

[0103] For simplification of description, it is assumed that electric powers required for the left and center heating coils 12a, 12b through the operation parts 7, 8 by the user are heating electric powers Pa, Pb and that an electric power required for the power-feeding coil 32 is a feeding electric power Pc. When determining that the sum of the heating electric powers Pa, Pb and the feeding electric power Pc, i.e., an electric power P (=Pa+Pb+Pc) requested by the user, exceeds the maximum supply electric power Pmax, the controller 50 suppresses at least one of the heating electric powers Pa, Pb and the feeding electric power Pc (Pa→Pa', Pb→Pb', Pc→Pc') to provide control such that the electric power P (=Pa'+Pb'+Pc') consumed by the whole IH cooker 1 becomes equal to or less than the maximum supply electric power Pmax (P≤Pmax).

[0104] FIG. 20 is a chart of change in electric power before and after electric power demand according to one form. In the electric power demand shown in FIG. 20, when a consumed electric power P requested by the user exceeds the maximum supply electric power Pmax, the controller 50 calculates a ratio t (=Pmax/P) of the consumed electric power P to the maximum supply electric power Pmax and controls the first and second inverter circuits 14, 34 so as to supply the electric powers (Pa', Pb', Pc') obtained by multiplying the heating electric powers Pa, Pb and the feeding electric power Pc by the ratio t. This is referred to as "electric power demand in a ratio distribution mode (adjustment)".

[Mathematical 1]

$$Pa' = t \times Pa$$

$$Pb' = t \times Pb$$

$$Pc' = t \times Pc$$

therefore, Pmax = Pa' + Pb' + Pc'

[0105] When performing the electric power demand, desirably, the controller 50 displays to the user the induction heating areas 10a, 10b or the cooking device area 30 corresponding to the heating coils 12a, 12b or the power-feeding coil 32 to be suppressed in the consumed electric power, displays to what extent the suppression is performed (e.g., the ratio t) on the display 9, and makes a notification through sound or other notification means etc.

[0106] FIG. 21 is a chart of change in electric power before and after electric power demand according to another form. In the electric power demand shown in FIG. 21, when the consumed electric power P requested by the user exceeds the maximum supply electric power Pmax, the controller 50 suppresses only the heating electric power Pb required for the heating coil 12b of the center induction heating area 10b (Pb') and controls the first and second inverter circuits 14, 34 such that the sum of the heating electric powers Pa, Pb' and the feeding electric power Pc does not exceed the maximum supply electric power Pmax. This is referred to as "electric power demand in an induction heating mode (adjustment)".

[Mathematical 2]

$$Pa' = Pa$$

$$Pb' < Pb$$

$$Pc' = Pc$$

therefore, Pmax = Pa + Pb' + Pc

[0107] FIG. 22 is a chart of change in electric power before and after electric power demand according to another form. In the electric power demand shown in FIG. 22, when the consumed electric power P requested by the user exceeds the maximum supply electric power Pmax, the controller 50 suppresses only the feeding electric power Pc required for the power-feeding coil 32 (Pc') and controls the first and second inverter circuits 14, 34 such that the sum of the heating electric power Pa, Pb and the feeding electric power Pc' does not exceed the maximum supply electric power Pmax. This is referred to as "electric power demand in a feeding electric power mode (adjustment)".

[Mathematical 3]

$$Pa' = Pa$$

$$Pb' = Pb$$

$$Pc' < Pc$$

therefore, Pmax = Pa + Pb + Pc'

[0108] In the electric power demand shown in FIG. 22, although the heating power is maintained in the induction heating areas 10a, 10b, the feeding electric power is suppressed in the cooking device area 30, and therefore, for example, if the power-receiving coil 72 of the auxiliary cooker 70 etc. rotates a rotation mechanism such as a motor, the rotating force thereof is reduced. Thus, when performing the electric power demand, desirably, the controller 50 displays to the user the induction heating area 10 and the cooking device area 30 corresponding to the heating coils 12a, 12b and the power-feeding coil 32 to be suppressed in the consumed electric power, displays the consumed electric power (Pc') for the apparatus 70 etc. on the display 9, and makes a notification through sound or other notification means etc.

[0109] As described above, the controller 50 can suppress the electric power of an arbitrary combination out of the heating electric powers Pa, Pb and the feeding electric power Pc. The controller 50 may determine the priority and the electric power suppression amount of the heating coils 12a, 12b and the power-feeding coil 32 to be suppressed in electric power depending on a cooking mode (stewing, baking, boiling, etc.) in the induction heating areas 10a, 10b and the operating state of the auxiliary cooker 70 etc. or may make the determination according to the priority and the electric power suppression amount set in advance. Alternatively, the user may use the operating parts 7, 8 to determine the priority and the electric power suppression amount of the heating coils 12a, 12b and the power-feeding coil 32 to be suppressed in electric power. Similarly, when performing the electric power demand, the controller 50 preferably displays the priority and the power suppression amount of the heating coils 12a, 12b and the power-feeding coil 32 to be suppressed on the display 9 etc.

[0110] If the cooking with the heating coil 12a is stopped (the heating electric power Pa is set to zero) although the consumed electric power P requested by the user has initially exceeded the maximum supply electric power Pmax, as shown in FIG. 23, the controller 50 may control the first and second inverter circuits 14, 34 such that the user supplies the heating electric power Pb and the feeding electric power Pc required for the second heating coil 12 and the power-feeding coil 32 via the operation parts 7, 8 within a range in which the sum of the heating electric power Pb and the

feeding electric power Pc does not exceed the maximum supply electric power Pmax.

[0111] FIG. 24 is a flowchart for more specifically explaining the electric power demands in the "ratio distribution mode" and the "induction heating mode". At step ST 21, when the controller 50 determines that the total electric power P (=Pa+Pb+Pc) of the heating electric powers Pa, Pb and the feeding electric power Pc does not exceed the maximum supply electric power Pmax (NO) as a result of operation of the IH cooker 1 by the user, the first and second inverter circuits 14, 34 supply the high-frequency currents to the heating coils 12a, 12b and the power-feeding coil 32 so that the electric power desired by the user can be acquired at step ST26 (continue operation).

[0112] On the other hand, when determining that the total electric power P exceeds the maximum supply electric power Pmax (YES), the controller 50 determines at step ST22 whether the electric power is being supplied to the power-feeding coil 32 (power-feeding coil is in operation). If the power-feeding coil is not in operation (NO), the controller 50 notifies the user of the total electric power P exceeding the maximum supply electric power Pmax at step ST27. In this case, for example, the user may temporarily stop the operation of the auxiliary cooker 70 so as to voluntarily reduce the feeding electric power Pc. When determining that the power feeding operation is in progress (YES), the controller 50 subsequently determines at step ST23 whether the electric power is being supplied to the heating coils 12a, 12b (heating coil is in operation). If the heating coil is not in operation (NO), the controller 50 notifies the user of the total electric power P exceeding the maximum supply electric power Pmax at step ST28. In this case, for example, the user may temporarily weaken the heating power of the one heating coil 12b corresponding to the center induction heating area 10b (e.g., having a pan placed thereon for stewing food) so as to voluntarily reduce the heating electric power Pb.

[0113] When determining that the heating coils 12a, 12b and the power-feeding coil 32 are supplied with power, the controller 50 determines at step ST24 whether the mode is preliminarily set to the ratio distribution mode. If the mode is preliminarily set to the ratio distribution mode (YES), the controller 50 calculates the ratio t (= Pmax/P) of the consumed electric power P to the maximum supply electric power Pmax at step ST25 and controls the first and second inverter circuits 14, 34 so as to supply the electric powers (Pa', Pb', Pc') obtained by multiplying the heating electric powers Pa, Pb and the feeding electric power Pc by the ratio t. On the other hand, if the mode is not set to the ratio distribution mode (NO), the heating electric powers Pa, Pb are suppressed according to the priority set in advance by the user at step ST29 (induction heating mode).

[0114] FIG. 25 is a flowchart for more specifically explaining the electric power demands in the "induction heating mode" and the "feeding electric power mode". At step ST31, when the controller 50 determines that the total electric power P (= Pa + Pb + Pc) of the heating electric powers Pa, Pb and the feeding electric power Pc does not exceed the maximum supply electric power Pmax (NO) as a result of operation of the IH cooker 1 by the user, the first and second inverter circuits 14, 34 supply the high-frequency currents to the heating coils 12a, 12b and the power-feeding coil 32 so that the electric power desired by the user can be acquired at step ST26 (continue operation).

[0115] On the other hand, when determining that the total electric power P exceeds the maximum supply electric power Pmax (YES), the controller 50 determines at step ST32 whether the electric power is being supplied to the power-feeding coil 32 (power-feeding coil is in operation). If the power-feeding coil is not in operation (NO), the controller 50 notifies the user of the total electric power P exceeding the maximum supply electric power Pmax at step ST37. In this case, for example, the user may temporarily stop the operation of the auxiliary cooker 70 so as to voluntarily reduce the feeding electric power Pc. When determining that the power feeding operation is in progress (YES), the controller 50 subsequently determines at step ST33 whether the electric power is being supplied to the heating coils 12a, 12b (heating coil is in operation). If the heating coil is not in operation (NO), the controller 50 notifies the user of the total electric power P exceeding the maximum supply electric power Pmax at step ST38. In this case, for example, the user may temporarily weaken the heating power of the one heating coil 12b corresponding to the center induction heating area 10b (e.g., having a pan placed thereon for stewing food) so as to voluntarily reduce the heating electric power Pb.

[0116] When determining that the heating coils 12a, 12b and the power-feeding coil 32 are supplied with power, the controller 50 determines at step ST34 whether the mode is preliminarily set to the power feeding mode. If setting is preliminarily made to prioritize the power feeding mode (YES), the first inverter circuit 14 is controlled at step ST35 so as to maintain the feeding power Pc and suppress one of the heating powers Pa, Pb. On the other hand, if setting is not made to prioritize the power feeding mode (NO), the feeding power Pc is suppressed at step ST39.

EXPLANATIONS OF REFERENCE SIGNS

[0117]

1 induction-heating cooker (IH cooker)
2 main body
3 top plate
4 cooking oven
5 intake window

6 exhaust window
7 console (console panel)
8 console (heating-power adjustment dial)
9 display
10 induction heating area
11 resonance capacitor
12 heating coil (first magnetic field generator)
13 center coil
14 first inverter circuit
15 pan detecting unit (first detecting unit)
16 peripheral coil
30 cooking device area
31 resonance capacitor
32 power-feeding coil (second magnetic field generator)
34 second inverter circuit
35 coil detecting unit (second detecting unit)
40 power source
41 single-phase AC power source
42 converter (diode bridge)
43 choke coil
44 smoothing capacitor
45 power detecting unit
50 controller
63 excitation part
64 power-receiving part
65 transformer
66 opening
68 wall
69 coil
70 auxiliary cooker (power receiving apparatus)
72 electric generator (power-receiving coil)
74 cooking support unit (load part)
75 rotation mechanism
76 resistance heating element
100 induction-heating cooking system
101 combined cooker
110 heated body (pan, dish member)
112 half-cylindrical member
114 end portion
115 slit
116 grill net
118 arm
F food.

Claims

1. An induction-heating cooking system comprising: an induction-heating cooker and a combined cooker, wherein the induction-heating cooker comprises:

a top plate having an induction heating area and a cooking device area;
first and second magnetic field generators disposed under the induction heating area and the cooking device area;
first and second inverter circuits respectively supplying high-frequency currents to the first and second magnetic field generators so as to generate high-frequency magnetic fields; and
a controller controlling the first and second inverter circuits, wherein

the combined cooker comprises:

an induction-heated part inductively heated with a first electric power by the high-frequency magnetic field generated by the first magnetic field generator;
an electric generator electromagnetically induced by the high-frequency magnetic field generated by the second magnetic field generator to generate a second electric power; and
a cooking support unit operating by using the second electric power acquired by the electric generator, and wherein

when the induction-heated part of the combined cooker is placed on the induction heating area and the electric generator of the combined cooker is placed on the cooking device area, the controller controls the first and second inverter circuits independently of each other such that a food cooked by the combined cooker is heated by the induction-heated part while cooking of the food on the induction-heated part is supported by the cooking support unit.

2. An induction-heating cooker used together with a combined cooker, comprising:

a top plate having an induction heating area and a cooking device area; first and second magnetic field generators disposed under the induction heating area and the cooking device area;
first and second inverter circuits respectively supplying high-frequency currents to the first and second magnetic field generators so as to generate high-frequency magnetic fields; and
a controller controlling the first and second inverter circuits, wherein the combined cooker comprises:

an induction-heated part inductively heated with a first electric power by the high-frequency magnetic field generated by the first magnetic field generator;
an electric generator electromagnetically induced by the high-frequency magnetic field generated by the second magnetic field generator to generate a second electric power; and
a cooking support unit operating by using the second electric power acquired by the electric generator, and wherein

when the induction-heated part of the combined cooker is placed on the induction heating area and the electric generator of the combined cooker is placed on the cooking device area, the controller controls the first and second inverter circuits independently of each other such that a food cooked by the combined cooker is heated by the induction-heated part while cooking of the food on the induction-heated part is supported by the cooking support unit.

3. A combined cooker used together with an induction-heating cooker, wherein the induction-heating cooker comprises:

a top plate having an induction heating area and a cooking device area;
first and second magnetic field generators disposed under the induction heating area and the cooking device area;
first and second inverter circuits respectively supplying high-frequency currents to the first and second magnetic field generators so as to generate high-frequency magnetic fields; and
a controller controlling the first and second inverter circuits, wherein

the combined cooker comprises:

an induction-heated part inductively heated with a first electric power by the high-frequency magnetic field generated by the first magnetic field generator;
an electric generator electromagnetically induced by the high-frequency magnetic field generated by the second magnetic field generator to generate a second electric power; and
a cooking support unit operating by using the second electric power acquired by the electric generator, and wherein

when the induction-heated part of the combined cooker is placed on the induction heating area and the electric generator of the combined cooker is placed on the cooking device area, the controller controls the first and second inverter circuits independently of each other such that a food cooked by the combined cooker is heated by the induction-heated part while cooking of the food on the induction-heated part is supported by the cooking support unit.

4. The induction-heating cooking system according to claim 1, the induction-heating cooker according to claim 2, or the combined cooker according to claim 3,

wherein the induction heating area is disposed in a first region, and wherein the cooking device area is disposed in a second region different from the first region.

5. The induction-heating cooking system according to claim 1, the induction-heating cooker according to claim 2, or the combined cooker according to claim 3,
wherein the cooking support unit heats the food in a direction different from the induction-heated part.

6. The induction-heating cooking system, the induction-heating cooker, or the combined cooker according to claim 5, wherein the cooking support unit is a resistance heating element heating the food by using the second electric power acquired by the electric generator.

7. The induction-heating cooking system according to claim 1, the induction-heating cooker according to claim 2, or the combined cooker according to claim 3,
wherein the induction heating area and the cooking device area on the top plate are dividedly arranged, wherein when an heated body made of a metal material is placed on the induction heating area, induction heating is performed by the first magnetic field generator, wherein
when an auxiliary cooker is placed on the cooking device area, electricity is supplied by the second magnetic field generator, and wherein
the controller selectively controls the first and second inverter circuits so as to supply a high-frequency current to the first and second magnetic field generators.

8. The induction-heating cooking system according to claim 1, the induction-heating cooker according to claim 2, or the combined cooker according to claim 3,
wherein the cooking support unit moves an induction-heated portion of the induction-heated part.

9. The induction-heating cooking system, the induction-heating cooker, or the combined cooker according to claim 8, wherein the cooking support unit has a fixing component fixing the food in the combined cooker and a rotation mechanism rotating the fixing component around a predetermined axis by using the second electric power acquired by the electric generator.

10. The induction-heating cooking system according to claim 1,
the induction-heating cooker according to claim 2, or the combined cooker according to claim 3, wherein the cooking support unit has an illumination part illuminating the food by using the second electric power acquired by the electric generator.

11. The induction-heating cooking system, the induction-heating cooker, or the combined cooker according to claim 7, wherein the induction-heating cooker further comprises a first detecting unit detecting an electric characteristic of the induction-heated part of the combined cooker or the heated body placed on the induction heating area, and
a second detecting unit detecting an electric characteristic of the electric generator of the combined cooker or the auxiliary cooker placed on the cooking device area, and wherein
the controller controls the first and second inverter circuits based on the electric characteristics detected by the first and second detecting units.

12. The induction-heating cooking system, the induction-heating cooker, or the combined cooker according to claim 11, wherein the first detecting unit detects a load resistance of the induction-heated part of the combined cooker or the heated body, wherein the second detecting unit detects a load resistance of the electric generator of the combined cooker or the auxiliary cooker, and wherein based on frequency characteristics of the load resistances detected by the first and second detecting units, the controller determines whether the induction-heated part of the combined cooker or the heated body is placed on the induction heating area and whether the electric generator of the combined cooker or the auxiliary cooker is placed on the cooking device area.

13. The induction-heating cooking system, the induction-heating cooker, or the combined cooker according to claim 11, wherein when the first detecting unit detects that the induction-heated part of the combined cooker is placed on the induction heating area and the second detecting unit detects that the electric generator of the combined cooker is placed on the cooking device area, the controller controls the first and second inverter circuits so as to respectively supply high-frequency currents to the first and second magnetic field generators for providing induction-heating of the induction-heated part and causing the electric generator to generate electricity.

14. The induction-heating cooking system, the induction-heating cooker, or the combined cooker according to claim 12, wherein when the load resistances detected by the first and second detecting units are within a predetermined load threshold range thereof, the controller controls the first and second inverters so as to supply high-frequency currents.

15. The induction-heating cooking system, the induction-heating cooker, or the combined cooker according to claim 12, wherein when the load resistances detected by the first and second detecting units are not within a predetermined load threshold range thereof, the controller controls the first and second inverters so as not to supply high-frequency currents.

16. The induction-heating cooking system according to claim 1, the induction-heating cooker according to claim 2, or the combined cooker according to claim 3,
wherein the induction-heating cooker further comprises first and second power detecting units detecting first and second consumed electric powers consumed by the first and second magnetic field generators, and wherein
when determining that a total electric power of the first and second consumed electric powers detected by the first and second power detecting units exceeds a maximum supply electric power of the induction-heating cooker, the controller controls the first and second inverter circuits so as to supply electric powers obtained by multiplying the first and second consumed electric powers by a ratio of the total electric power to the maximum supply electric power.

17. The induction-heating cooking system according to claim 1, the induction-heating cooker according to claim 2, or the combined cooker according to claim 3,
wherein when determining that a total electric power of the first and second consumed electric powers detected by the first and second detecting units exceeds a maximum supply electric power of the induction-heating cooker, the controller controls the first and second inverter circuits so as to output an electric power according to a priority set in advance.

18. The induction-heating cooking system according to claim 1,
the induction-heating cooker according to claim 2, or the combined cooker according to claim 3,
wherein the first and second magnetic field generators are made up of an induction heating coil formed by winding a litz wire or a portion of an endless metal plate or metal thin film.

19. The induction-heating cooking system according to claim 1, the induction-heating cooker according to claim 2, or the combined cooker according to claim 3,
wherein the maximum value of the first electric power is greater than the maximum value of the second electric power, and
wherein the controller controls the first and second inverter circuits independently of each other so as to supply the first electric power to the induction-heated part of the combined cooker and supply the second electric power to the electric generator of the combined cooker.

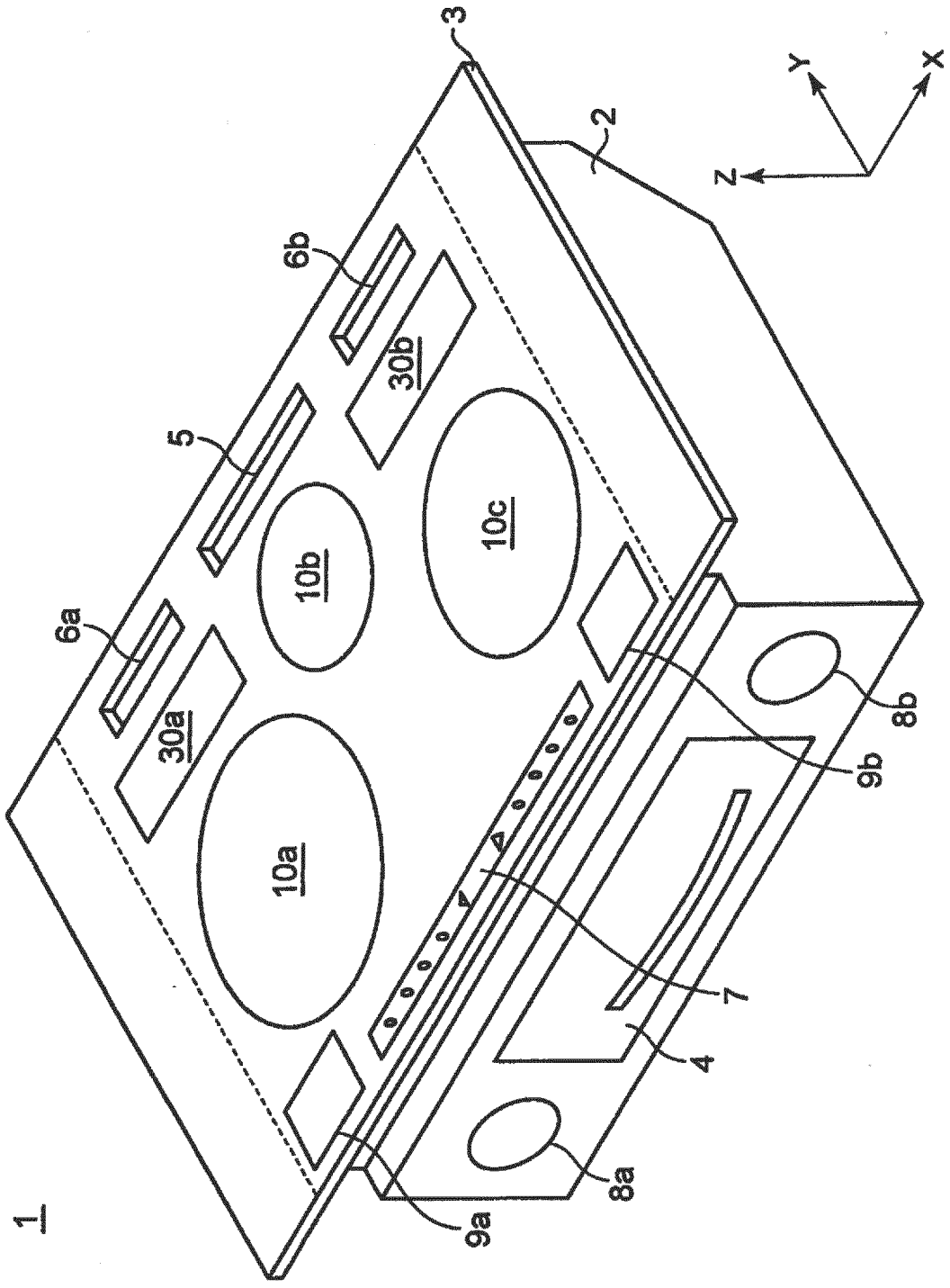
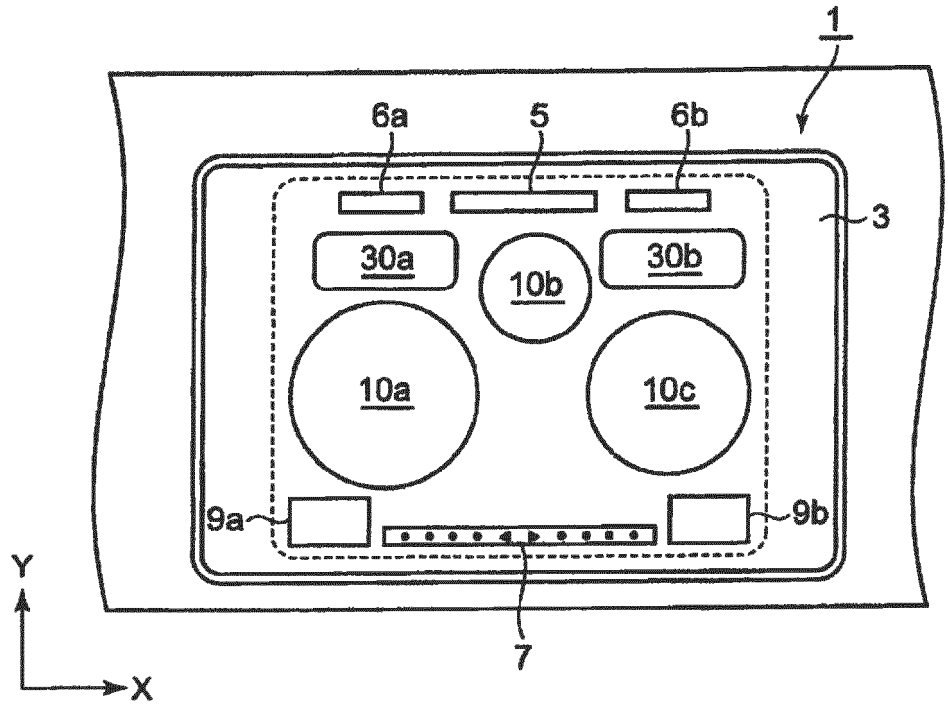


Fig.1

Fig.2



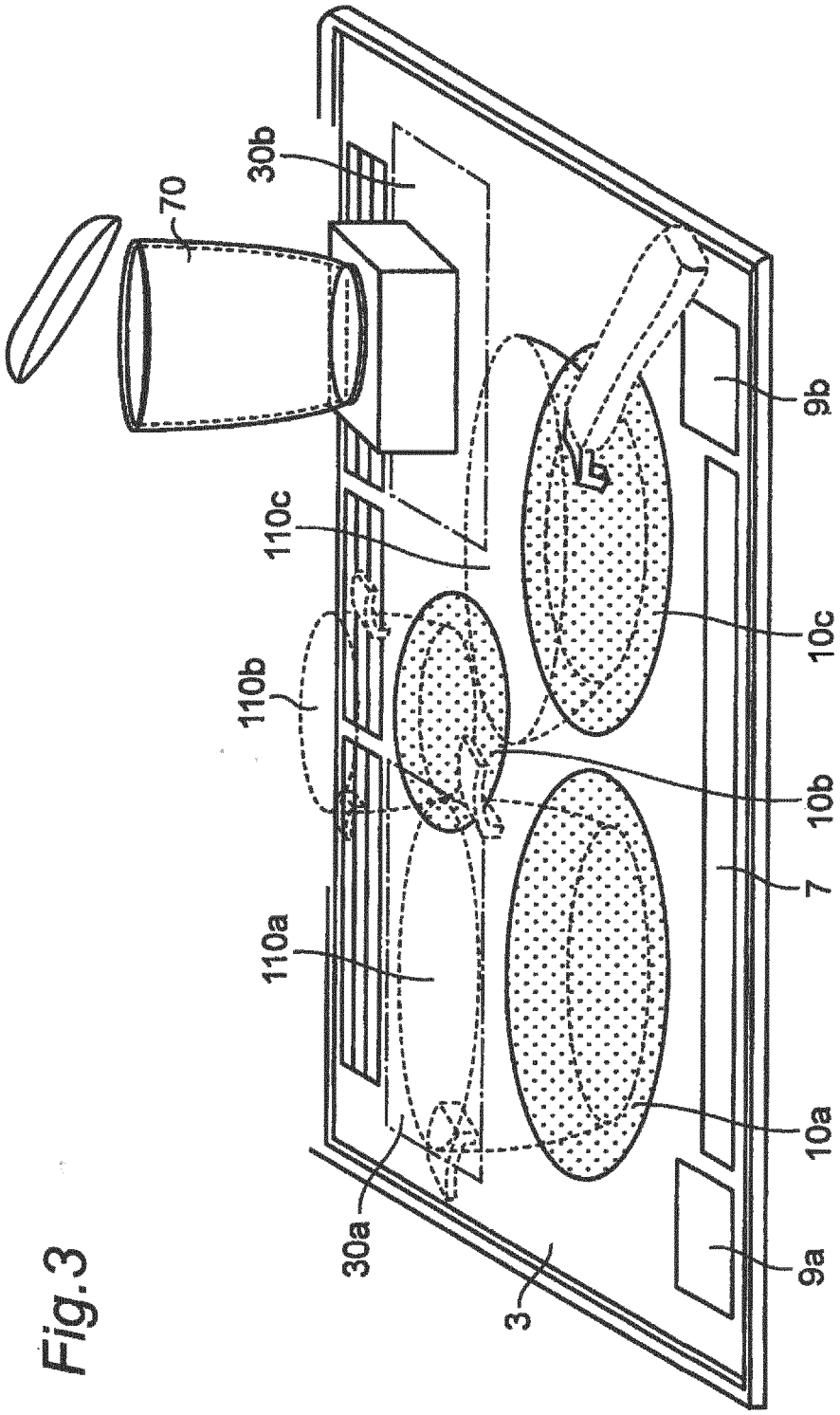
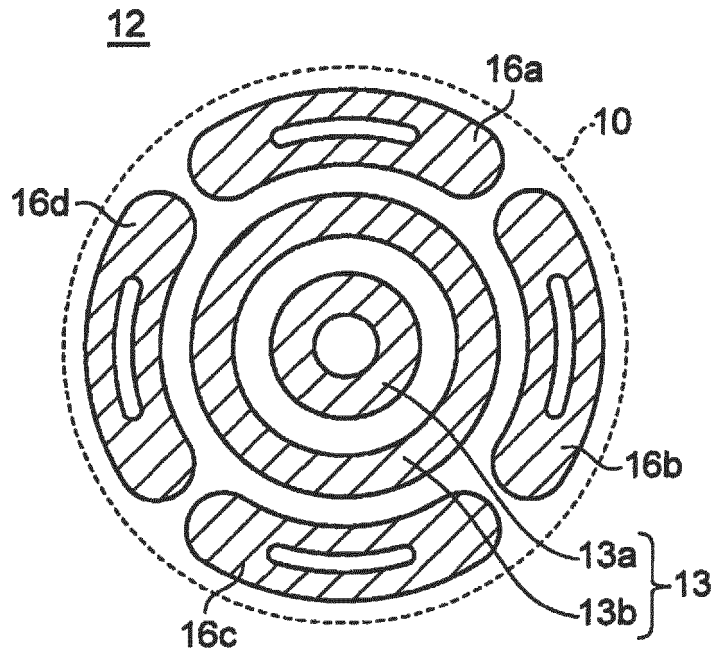


Fig.3

Fig.4

(a)



(b)

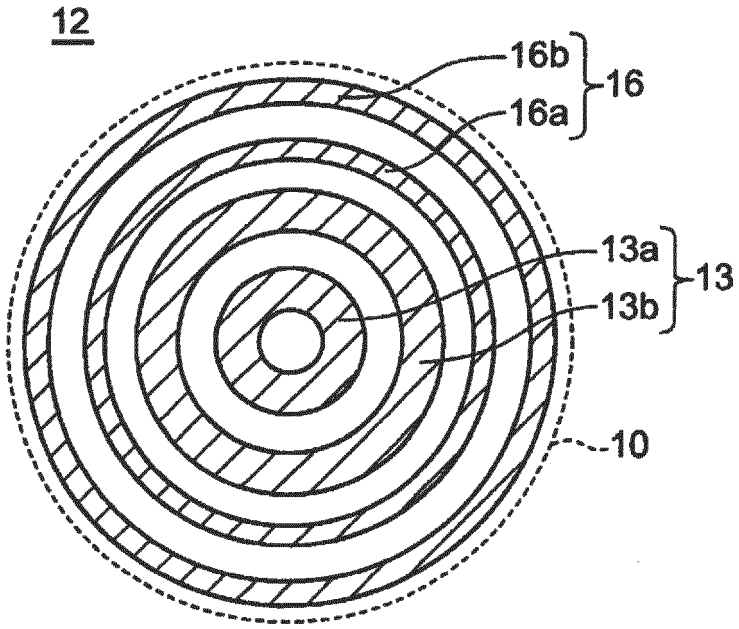


Fig.5

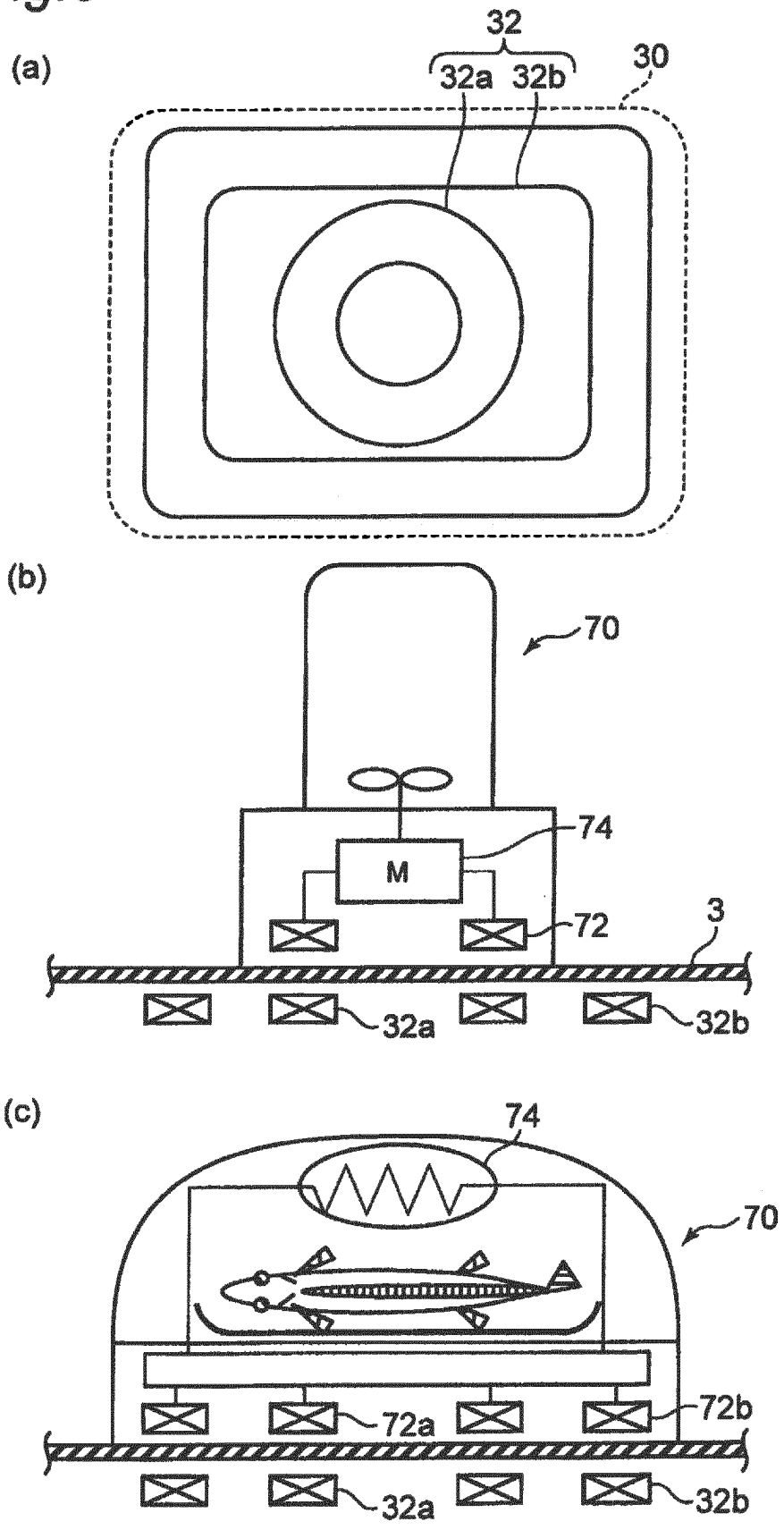
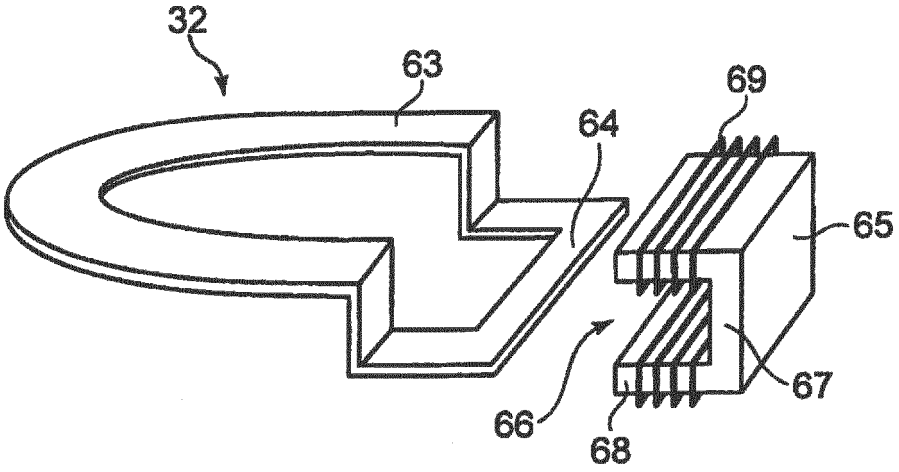


Fig.6

(a)



(b)

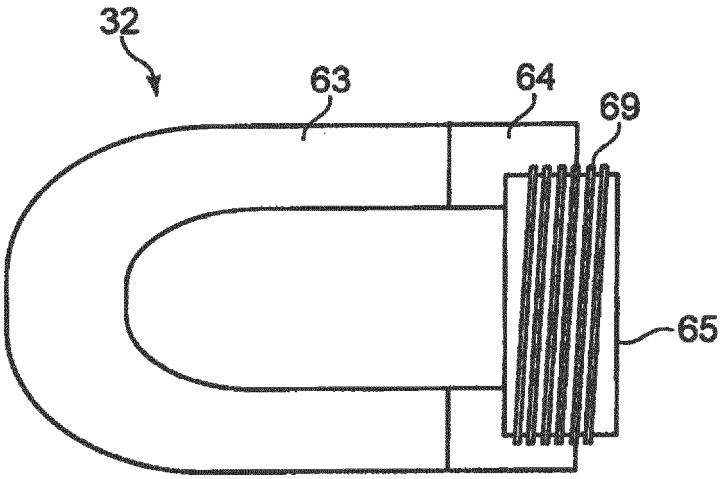
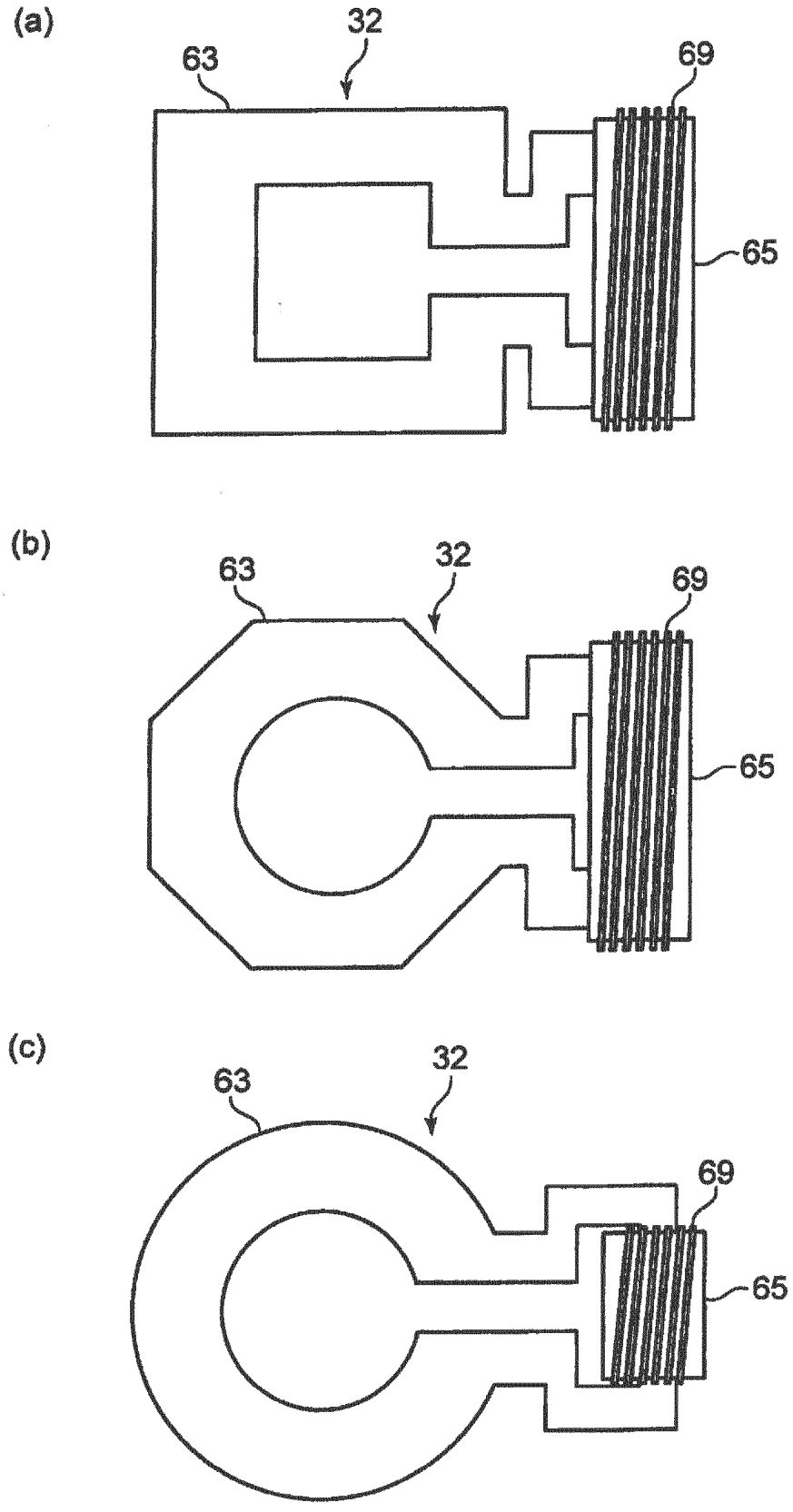


Fig.7



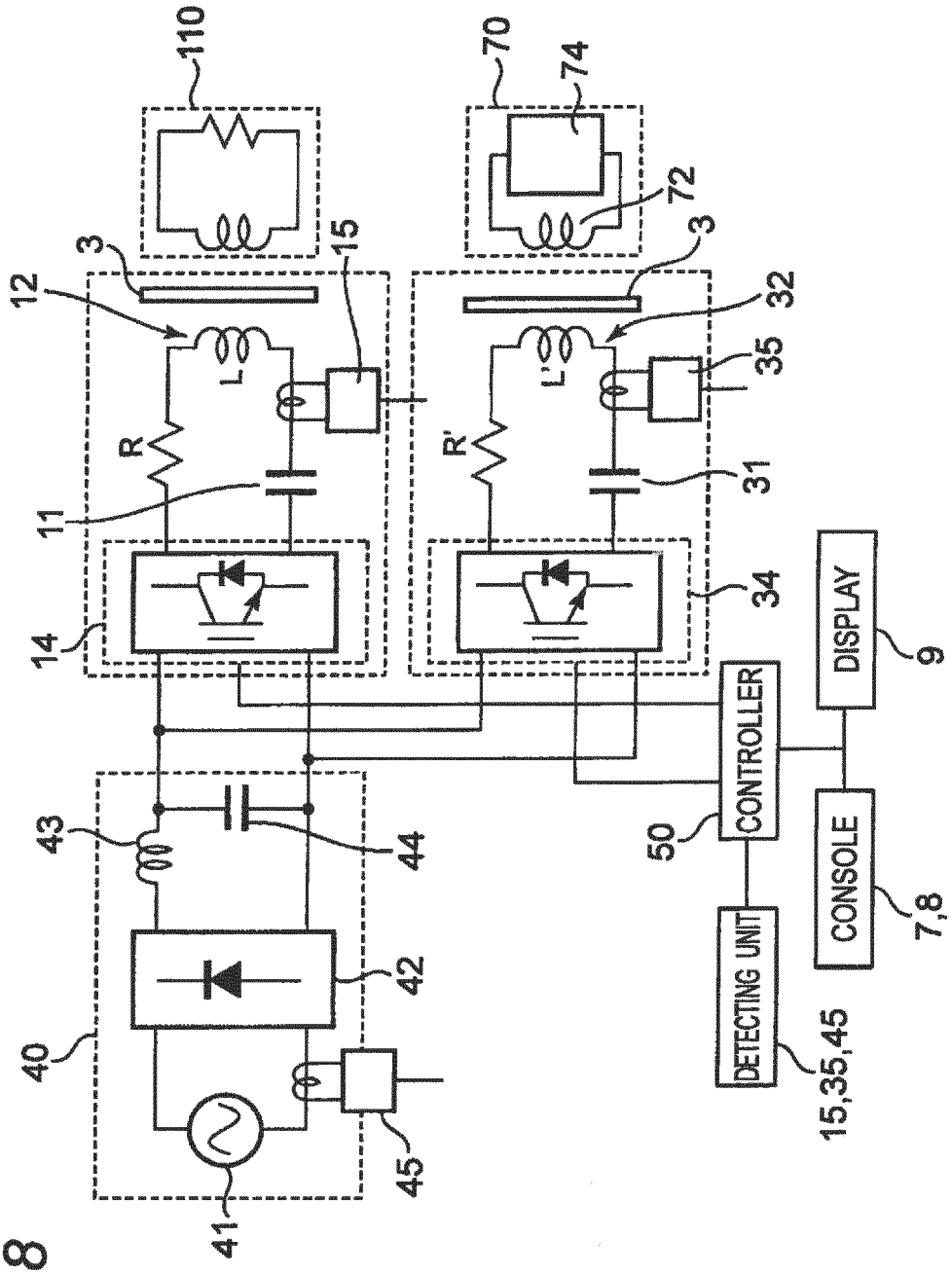

110
70
74
72
3
15
12
32
L
L'
R
R'
35
11
31
14
34
DISPLAY
9
CONTROLLER
43
44
50
CONSOLE
7,8
42
40
DETECTING UNIT
15,35,45
45
41

Fig.8

Fig.9

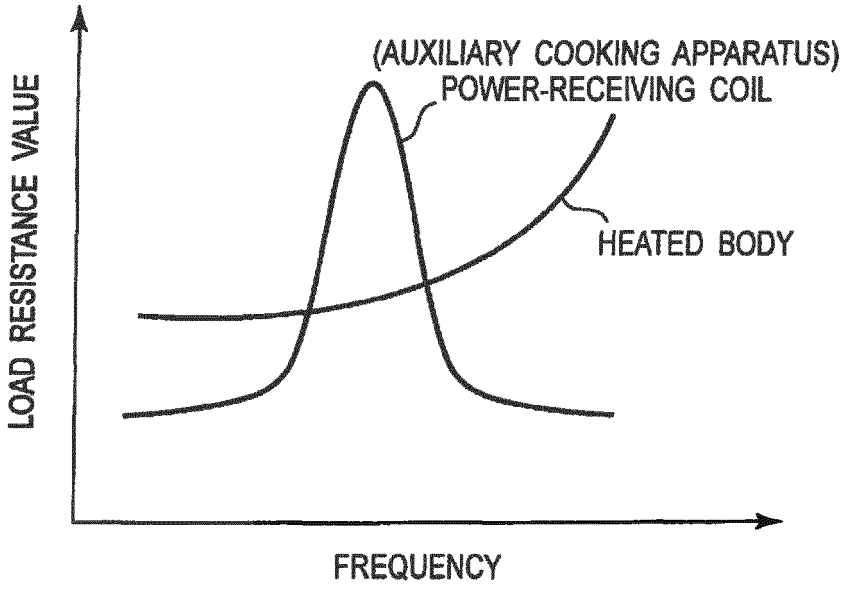
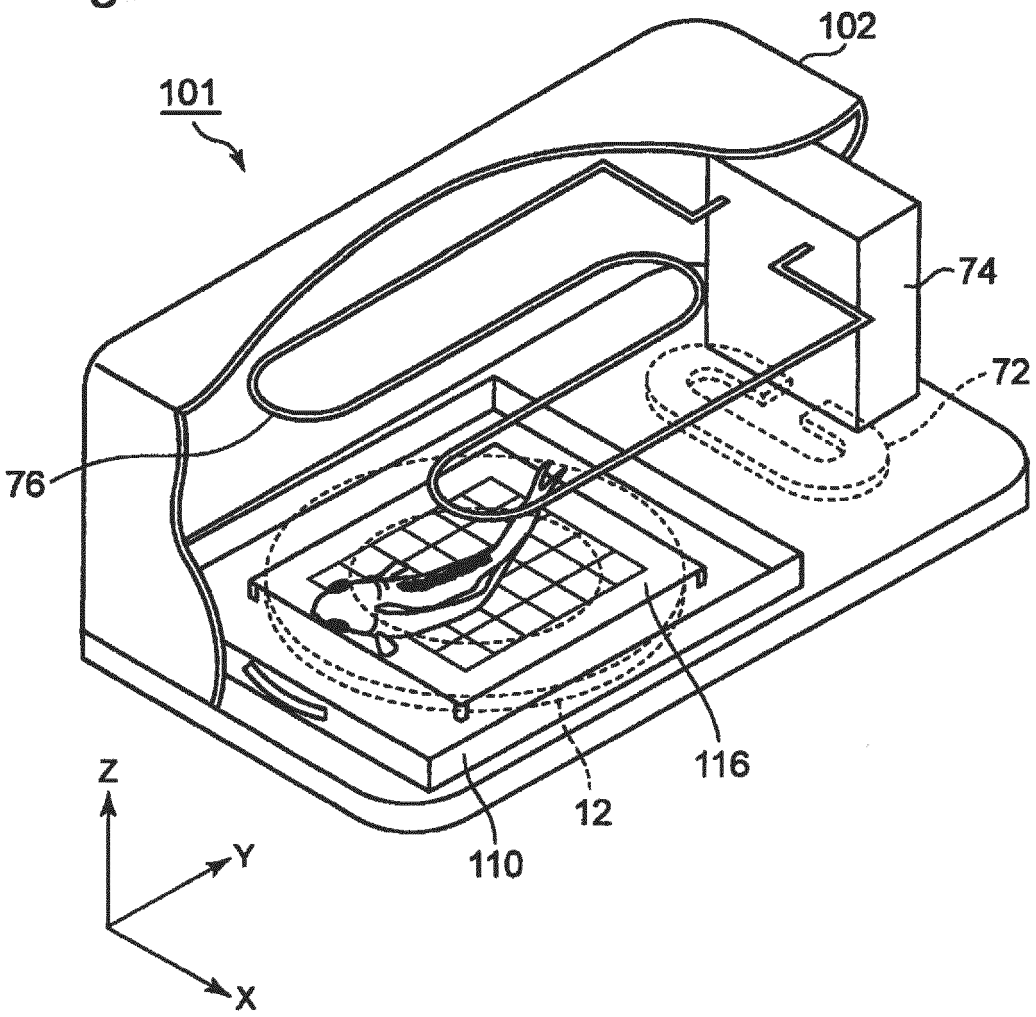

(AUXILIARY COOKING APPARATUS)
POWER-RECEIVING COIL
HEATED BODY
LOAD RESISTANCE VALUE
FREQUENCY

Fig.10



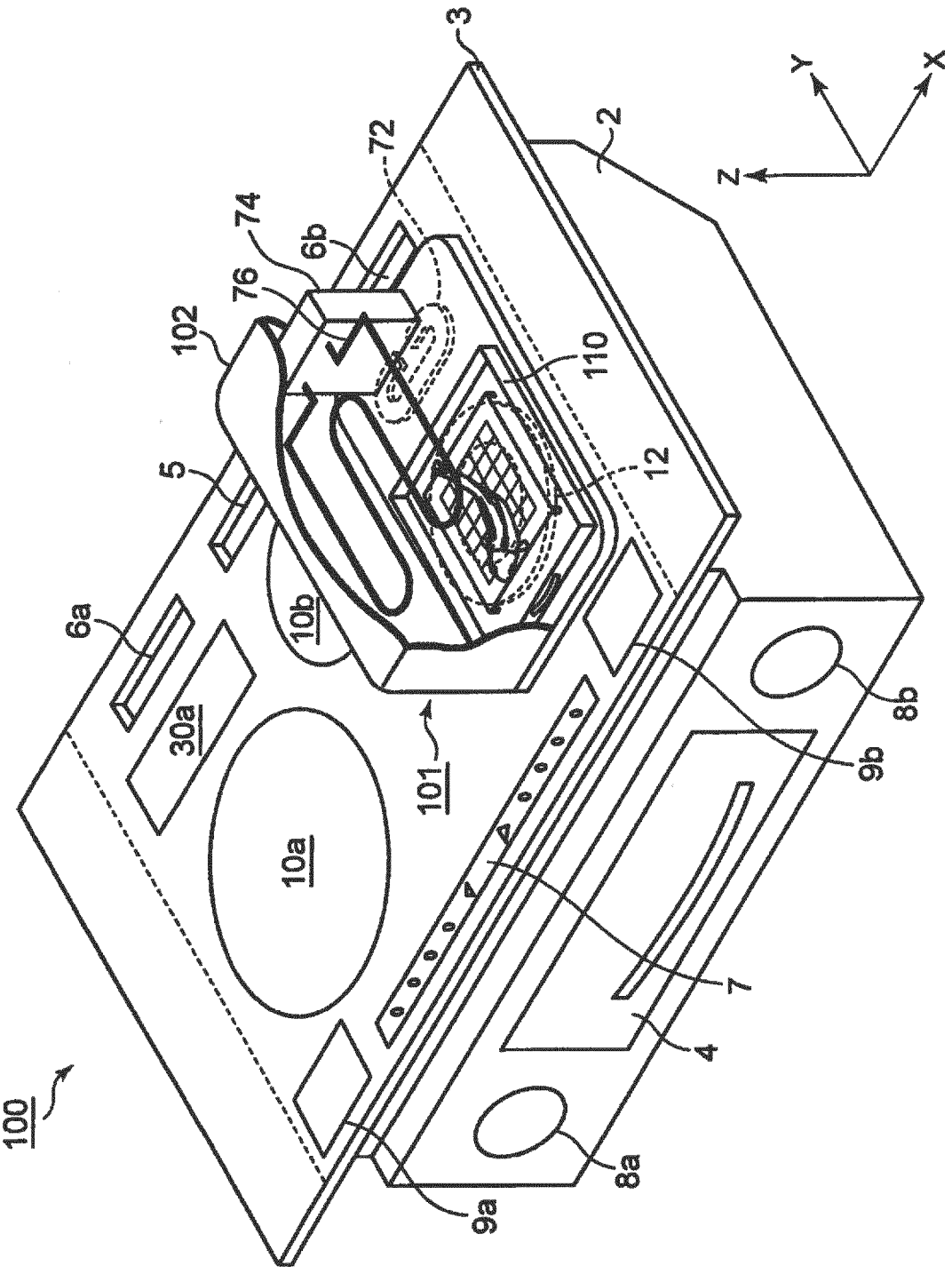


Fig. 11

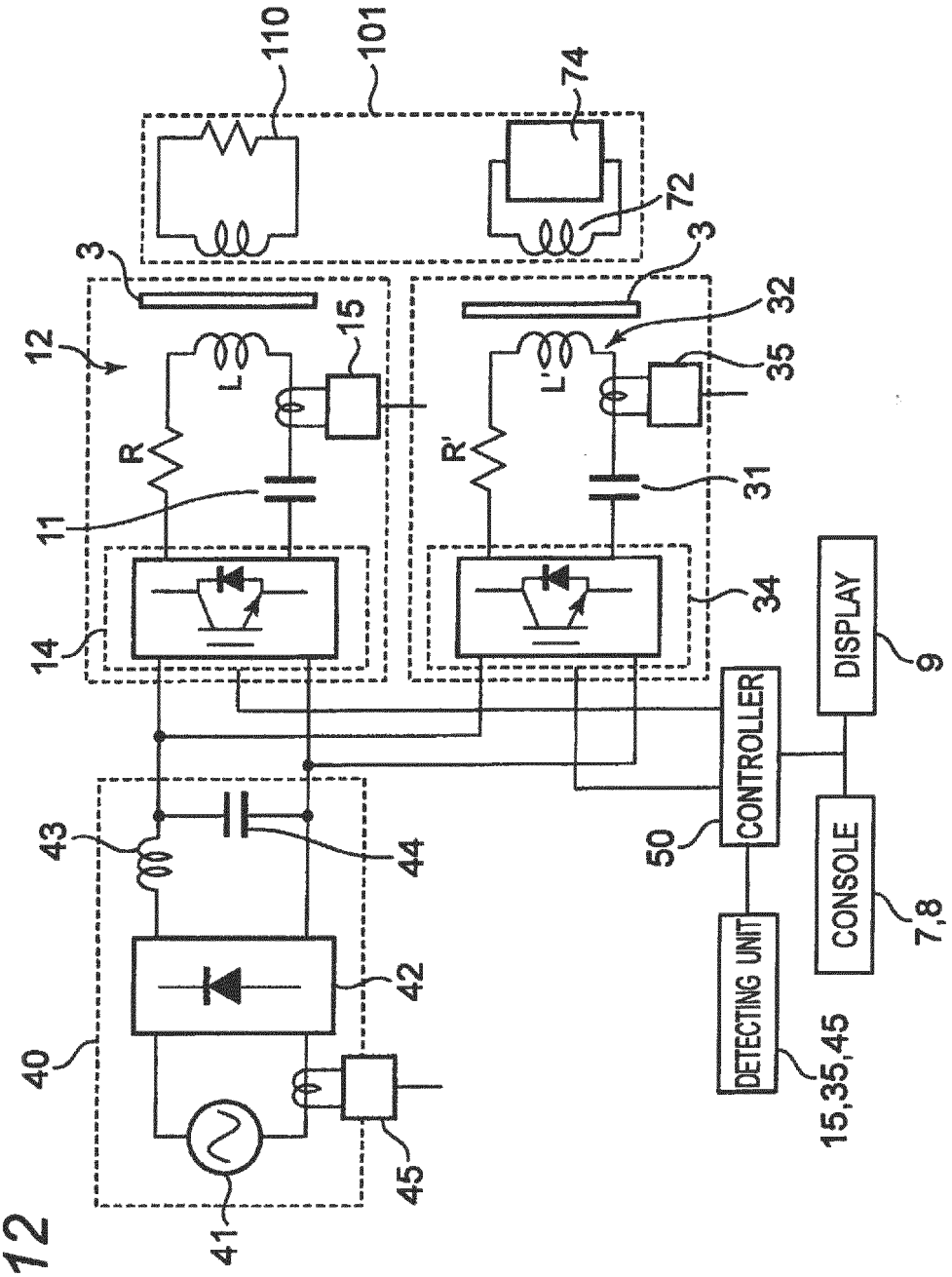
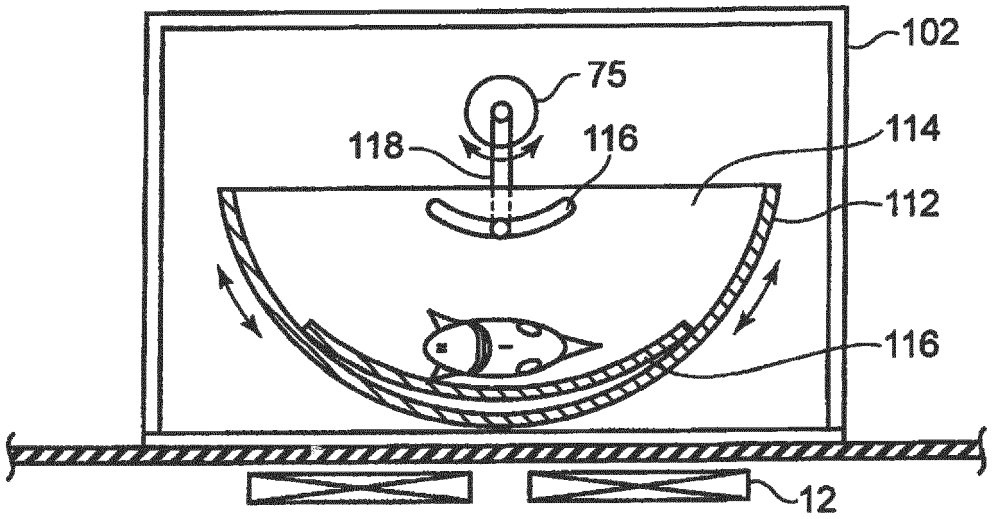

110
101
74
72
3
3
12
15
32
35
L
L'
R
R'
11
31
14
34
DISPLAY
9
CONTROLLER
50
43
44
42
40
CONSOLE
7,8
DETECTING UNIT
15,35,45
45
41

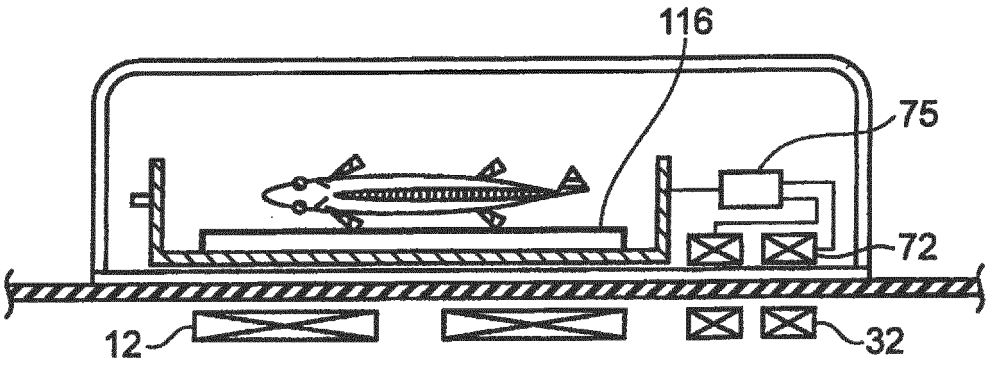
Fig.12

Fig.13

(a)


102
75
118
116
114
112
116
12

(b)


116
75
72
12
32

(c)

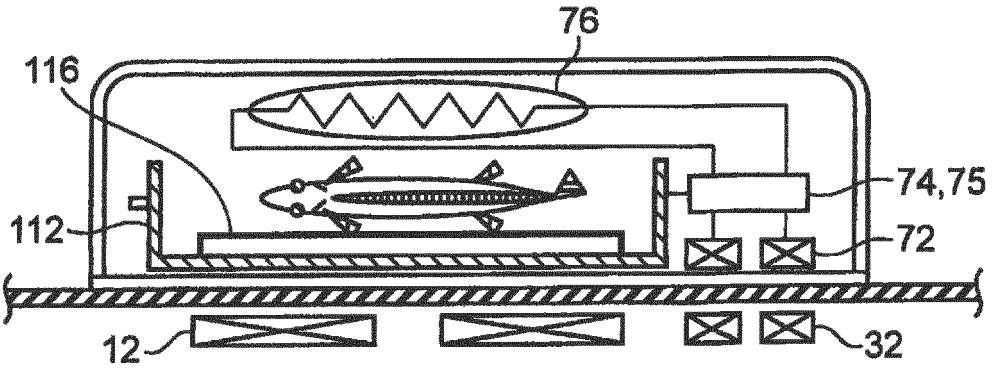

76
116
74,75
112
72
12
32

Fig.14

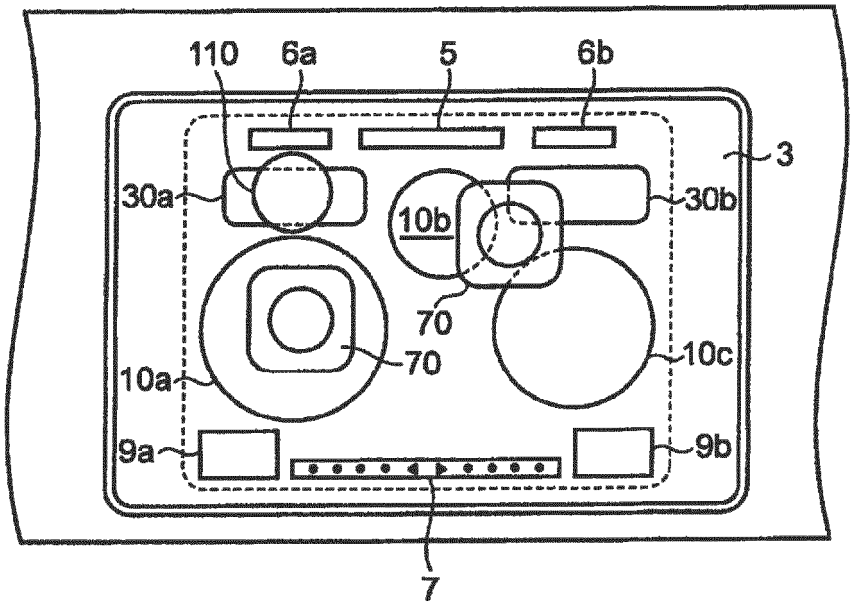


Fig.15

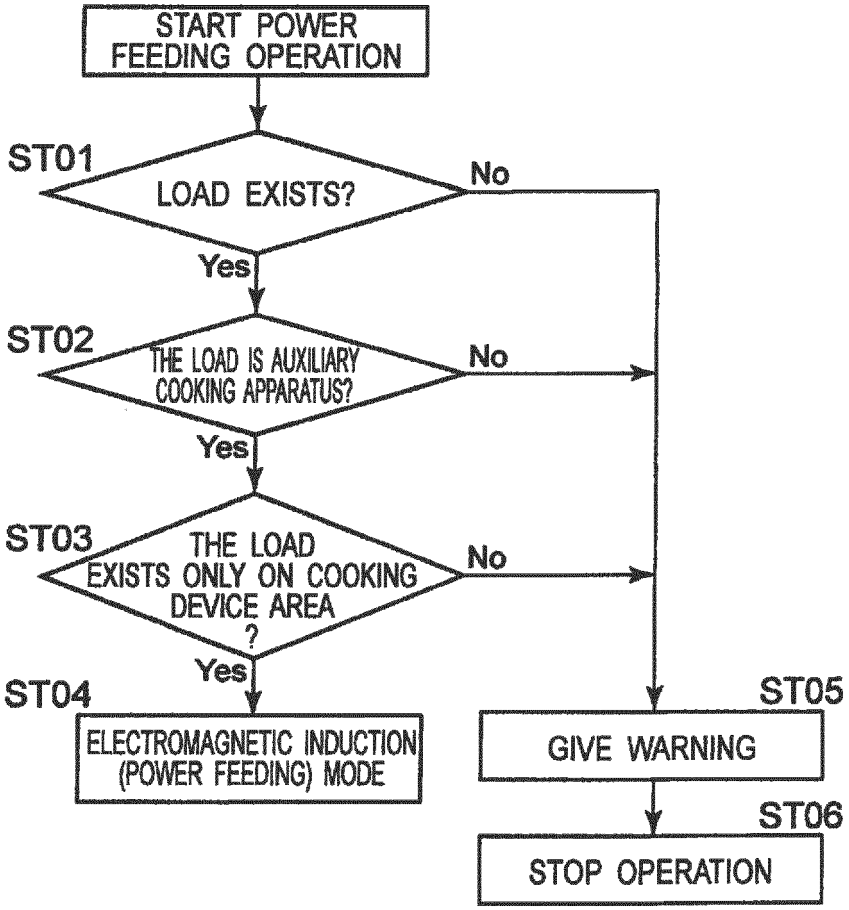

START POWER FEEDING OPERATION
ST01
LOAD EXISTS?
No
Yes
ST02
THE LOAD IS AUXILIARY COOKING APPARATUS?
No
Yes
ST03
THE LOAD EXISTS ONLY ON COOKING DEVICE AREA ?
No
Yes
ST04
ELECTROMAGNETIC INDUCTION (POWER FEEDING) MODE
ST05
GIVE WARNING
ST06
STOP OPERATION

Fig.16

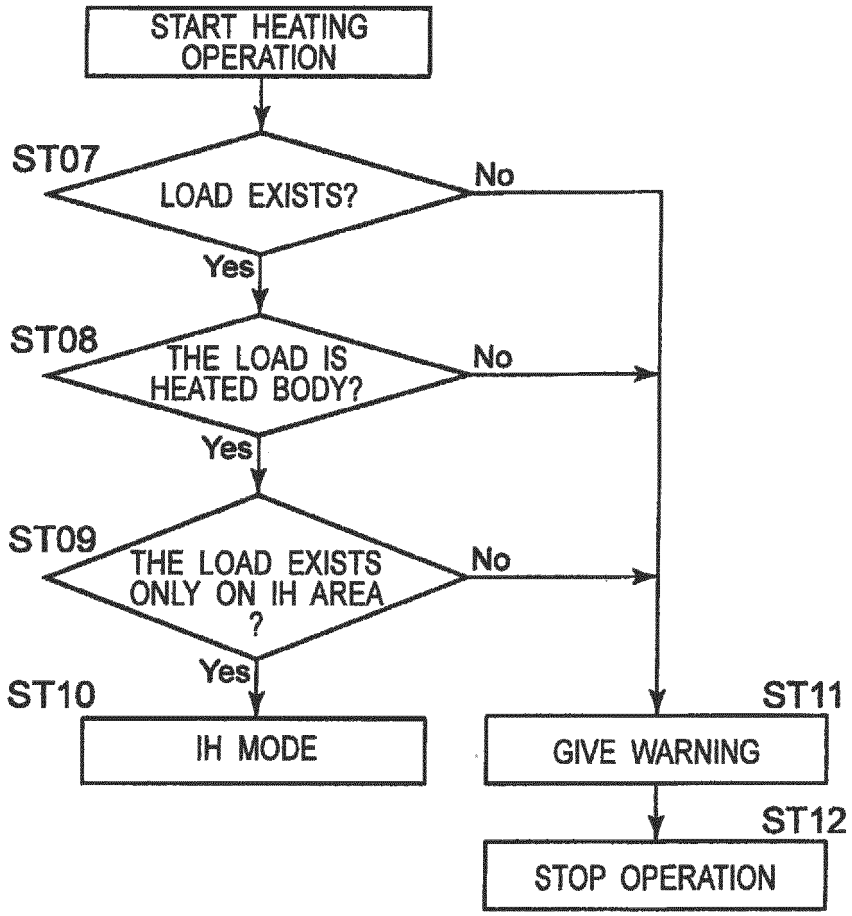

START HEATING OPERATION
ST07
LOAD EXISTS?
No
Yes
ST08
THE LOAD IS HEATED BODY?
No
Yes
ST09
THE LOAD EXISTS ONLY ON IH AREA ?
No
Yes
ST10
IH MODE
ST11
GIVE WARNING
ST12
STOP OPERATION

Fig.17

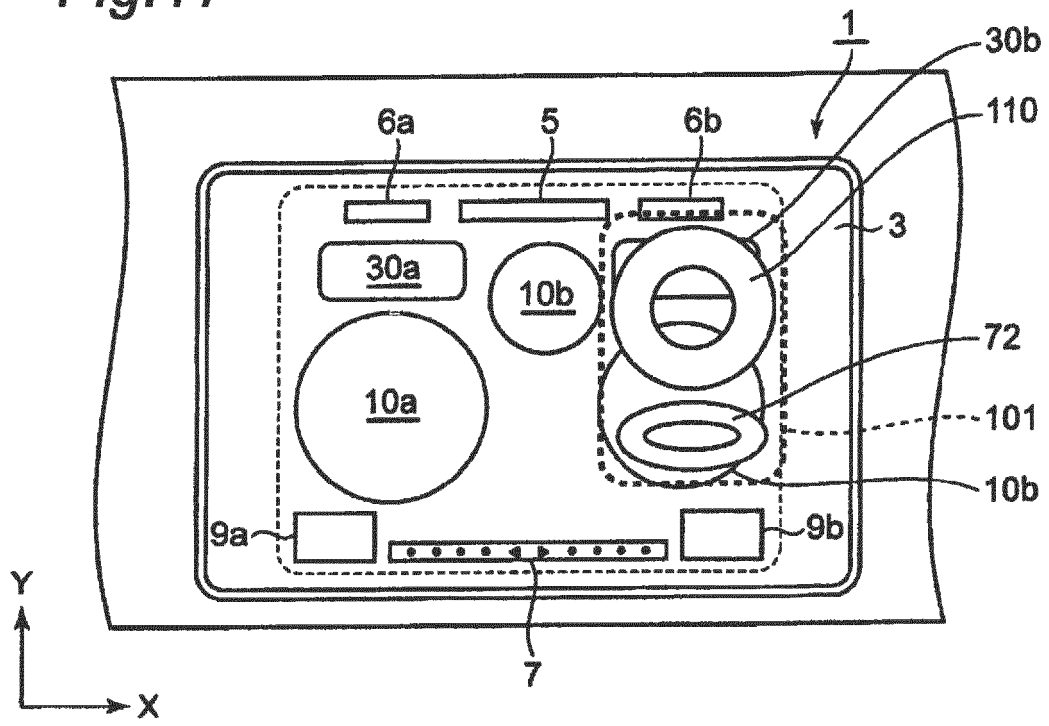

1
30b
110
6a
5
6b
3
30a
10b
72
10a
101
10b
9a
9b
7
Y
X

Fig.18

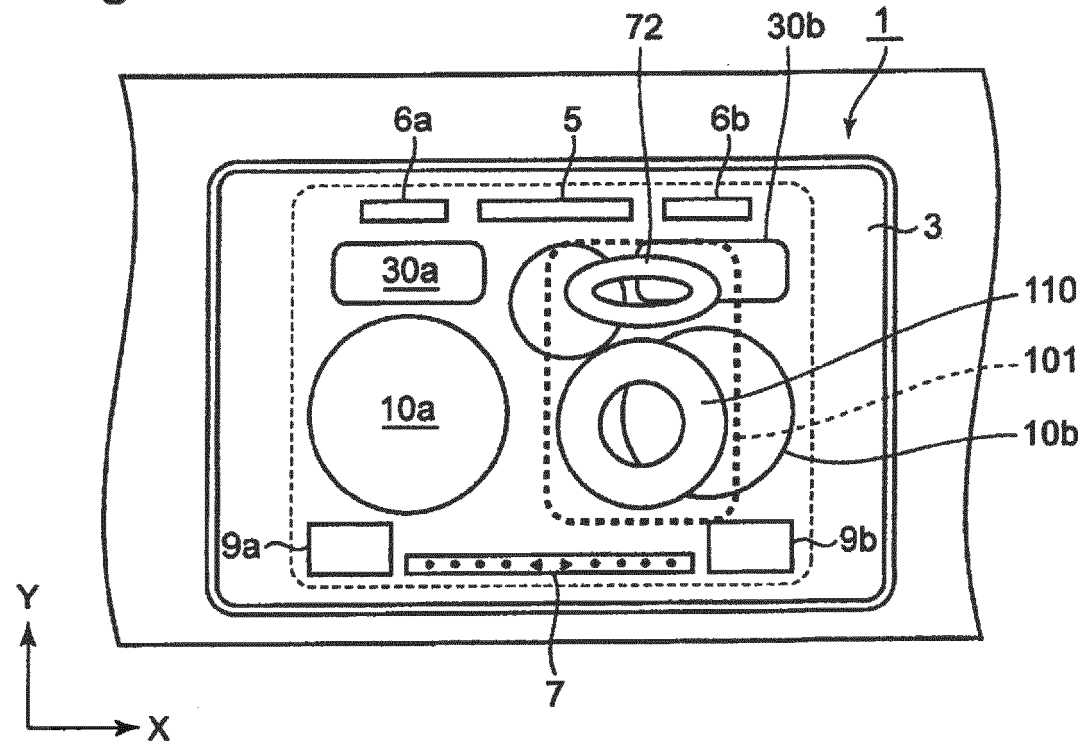

72
30b
1
6a
5
6b
3
30a
110
10a
101
10b
9a
9b
7
Y
X

Fig.19

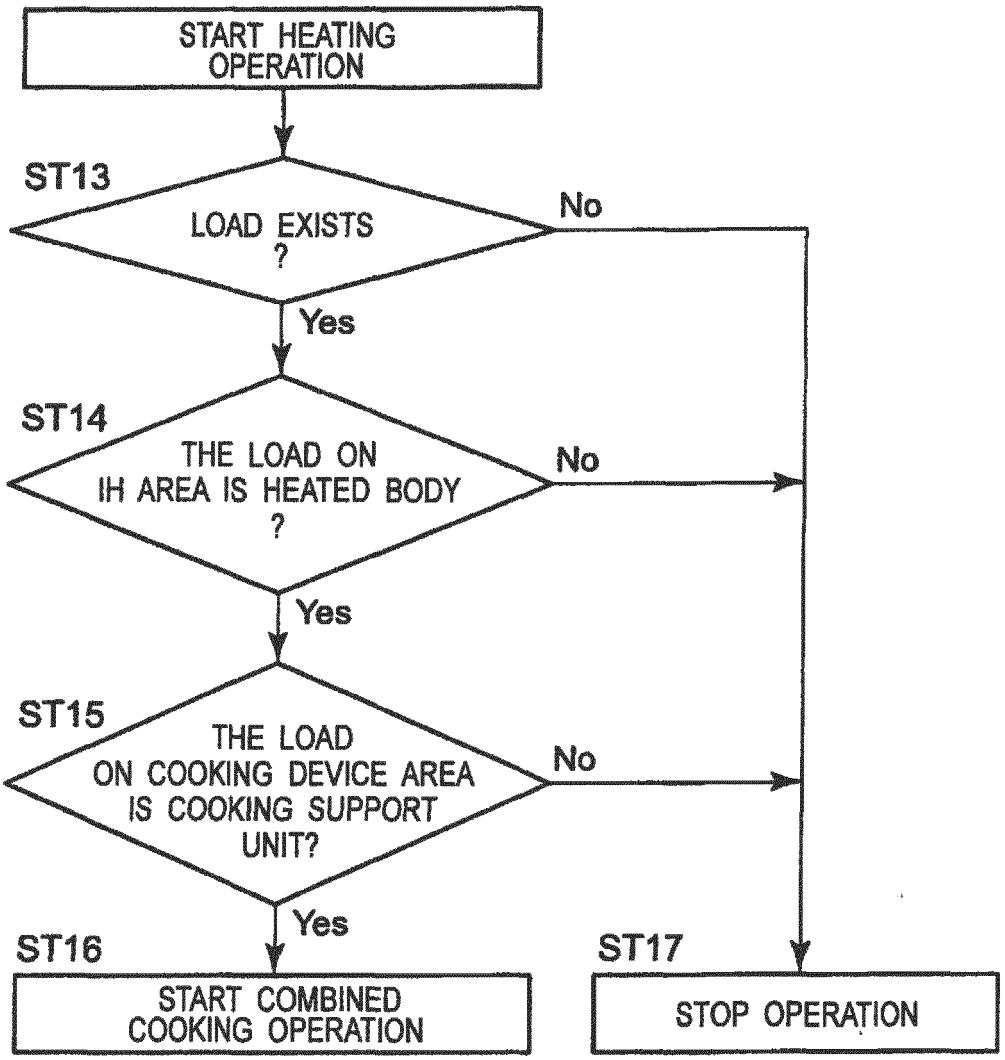

START HEATING OPERATION
ST13
LOAD EXISTS ?
No
Yes
ST14
THE LOAD ON IH AREA IS HEATED BODY ?
No
Yes
ST15
THE LOAD ON COOKING DEVICE AREA IS COOKING SUPPORT UNIT?
No
Yes
ST16
START COMBINED COOKING OPERATION
ST17
STOP OPERATION

Fig.20

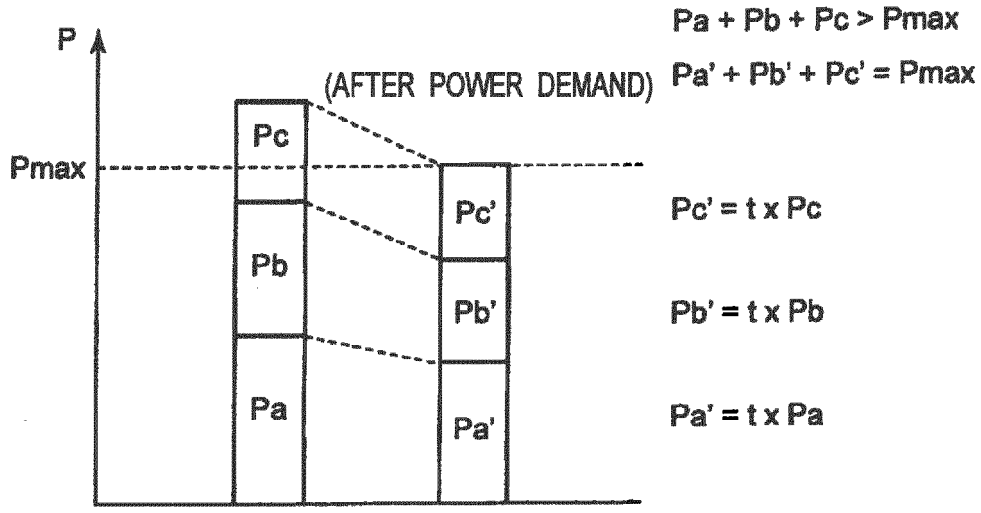

P
Pmax
(AFTER POWER DEMAND)
Pc
Pb
Pa
Pc'
Pb'
Pa'
Pa + Pb + Pc > Pmax
Pa' + Pb' + Pc' = Pmax
Pc' = t x Pc
Pb' = t x Pb
Pa' = t x Pa

Fig.21

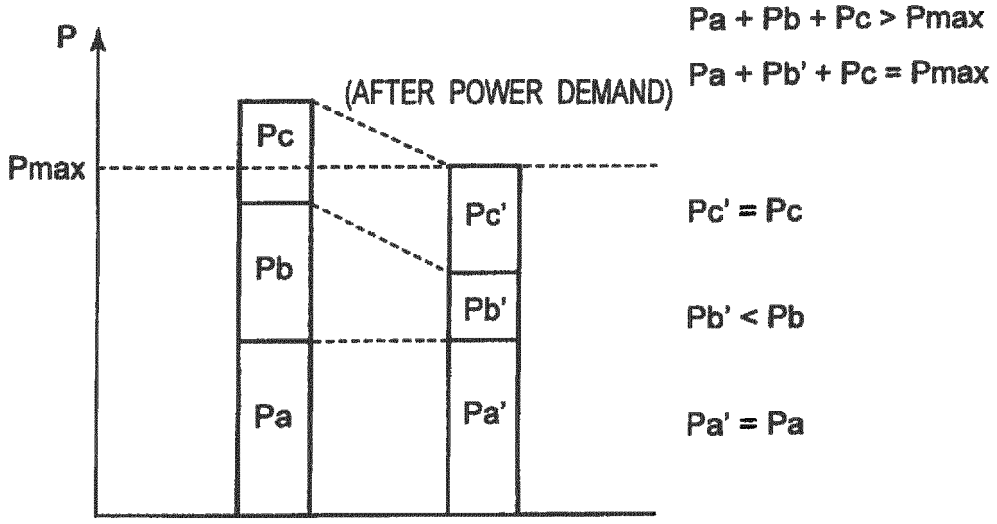

P
Pmax
(AFTER POWER DEMAND)
Pc
Pb
Pa
Pc'
Pb'
Pa'
Pa + Pb + Pc > Pmax
Pa + Pb' + Pc = Pmax
Pc' = Pc
Pb' < Pb
Pa' = Pa

Fig.22

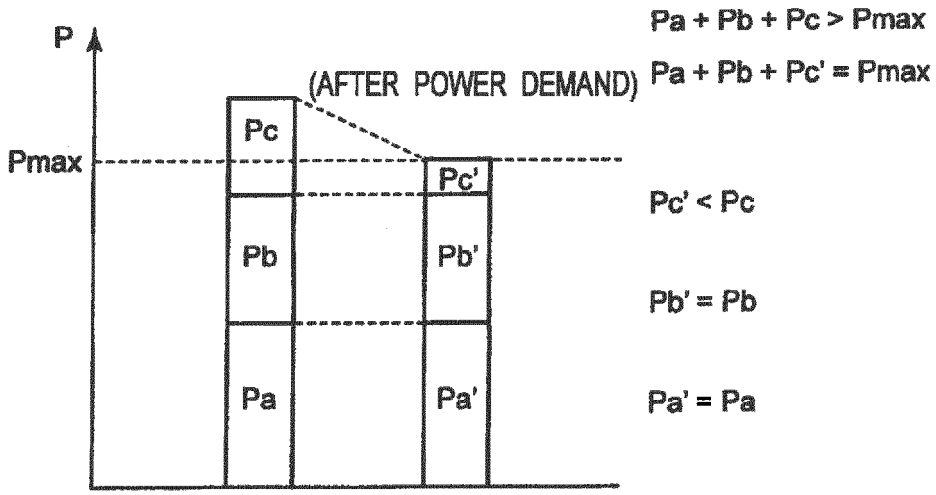

P
Pmax
(AFTER POWER DEMAND)
Pc
Pb
Pa
Pc'
Pb'
Pa'
Pa + Pb + Pc > Pmax
Pa + Pb + Pc' = Pmax
Pc' < Pc
Pb' = Pb
Pa' = Pa

Fig.23

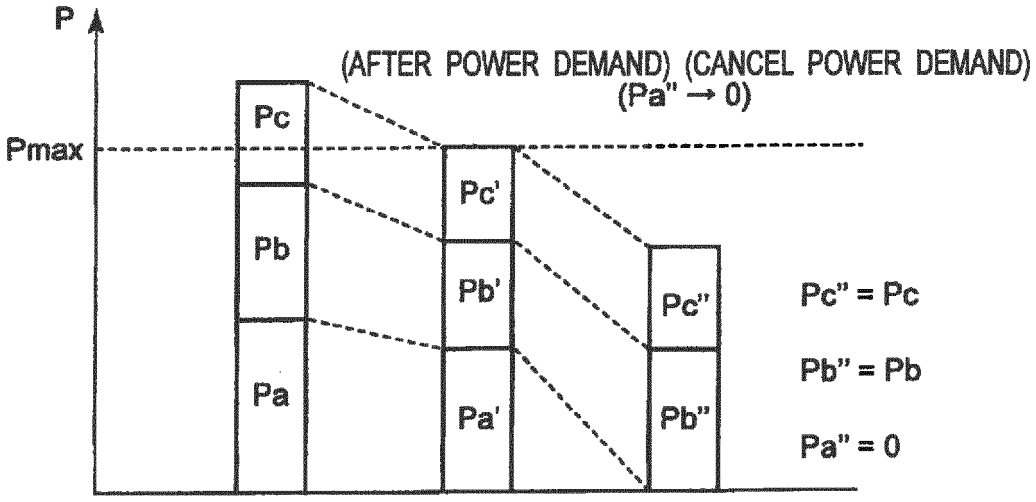

P
Pmax
(AFTER POWER DEMAND) (CANCEL POWER DEMAND)
(Pa" → 0)
Pc
Pb
Pa
Pc'
Pb'
Pa'
Pc"
Pb"
Pc" = Pc
Pb" = Pb
Pa" = 0

Fig.24

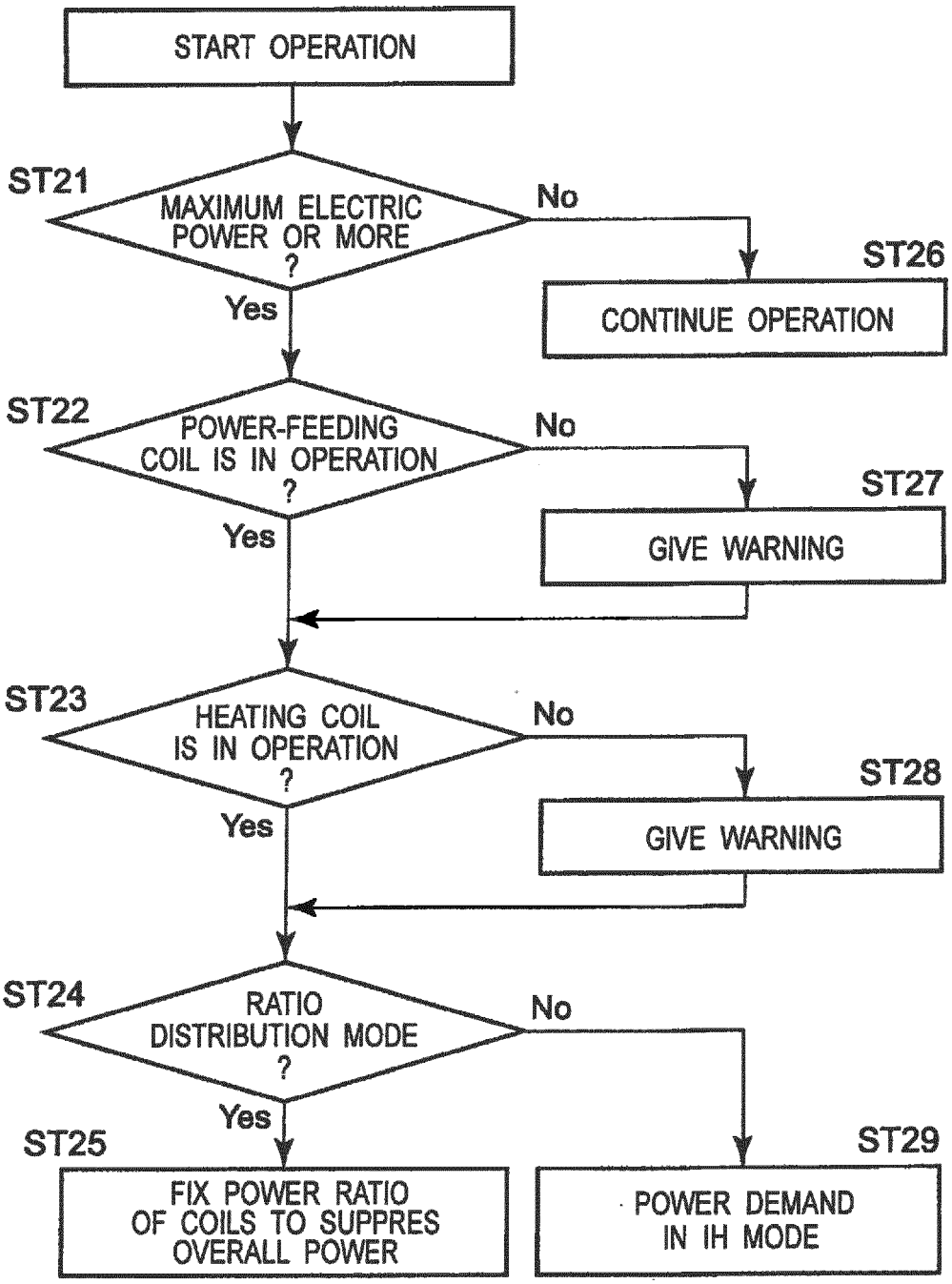
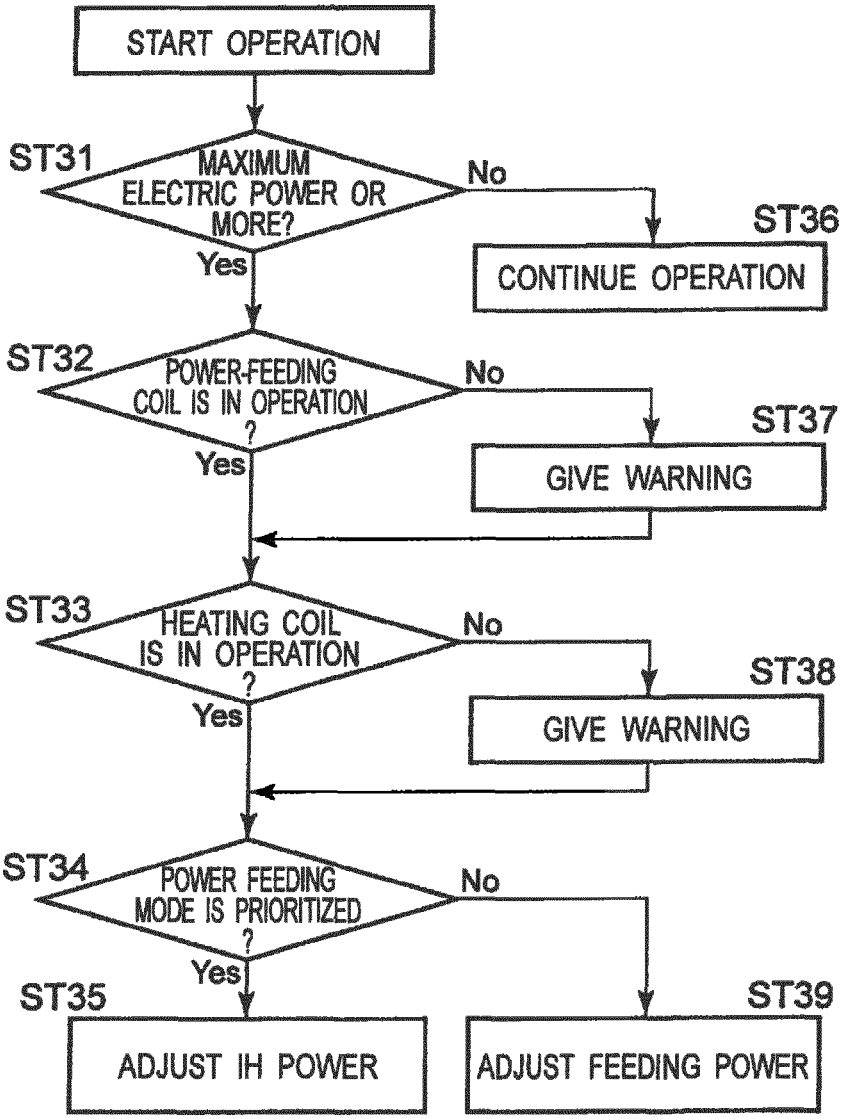

START OPERATION
ST21
MAXIMUM ELECTRIC POWER OR MORE ?
No
ST26
CONTINUE OPERATION
Yes
ST22
POWER-FEEDING COIL IS IN OPERATION ?
No
ST27
GIVE WARNING
Yes
ST23
HEATING COIL IS IN OPERATION ?
No
ST28
GIVE WARNING
Yes
ST24
RATIO DISTRIBUTION MODE ?
No
Yes
ST25
FIX POWER RATIO OF COILS TO SUPPRES OVERALL POWER
ST29
POWER DEMAND IN IH MODE

Fig.25


START OPERATION
ST31
MAXIMUM ELECTRIC POWER OR MORE?
No
ST36
CONTINUE OPERATION
Yes
ST32
POWER-FEEDING COIL IS IN OPERATION ?
No
ST37
GIVE WARNING
Yes
ST33
HEATING COIL IS IN OPERATION ?
No
ST38
GIVE WARNING
Yes
ST34
POWER FEEDING MODE IS PRIORITIZED ?
No
Yes
ST35
ADJUST IH POWER
ST39
ADJUST FEEDING POWER

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2015/079274

A. CLASSIFICATION OF SUBJECT MATTER
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)
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 1996-2016
Kokai Jitsuyo Shinan Koho 1971-2016 Toroku Jitsuyo Shinan Koho 1994-2016

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.
Y A	JP 7-263132 A (Mitsubishi Electric Corp.), 13 October 1995 (13.10.1995), paragraphs [0029] to [0045], [0049]; fig. 1 to 4, 13 to 14 (Family: none)	1-7,10-11, 16-19 8-9
Y A	JP 4-341790 A (Mitsubishi Electric Home Appliance Co., Ltd.), 27 November 1992 (27.11.1992), paragraphs [0013] to [0014]; fig. 1 to 2 (Family: none)	1-7,10-11, 16-19 8-9
Y A	JP 2011-4795 A (Mitsubishi Electric Corp.), 13 January 2011 (13.01.2011), paragraphs [0031] to [0033]; fig. 1 to 2 (Family: none)	1-7,10-11, 16-19 8-9

☒ 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	Date of mailing of the international search report
07 January 2016 (07.01.16)	19 January 2016 (19.01.16)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2015/079274

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2011-113948 A (Mitsubishi Electric Corp.), 09 June 2011 (09.06.2011), paragraphs [0002], [0009], [0016] to [0019], [0020] to [0021]; fig. 1 to 3 (Family: none)	1-7,10-11, 16-19 12-15
Y A	WO 2014/129208 A1 (Panasonic Corp.), 28 August 2014 (28.08.2014), paragraphs [0038] to [0070]; fig. 1 to 5 & CN 105007786 A	10 8-9
Y	JP 2011-55622 A (Panasonic Corp.), 17 March 2011 (17.03.2011), paragraphs [0002] to [0007], [0052] to [0069]; fig. 5 (Family: none)	16-17
Y	JP 2013-201073 A (Mitsubishi Electric Corp.), 03 October 2013 (03.10.2013), paragraphs [0005], [0037], [0052]; fig. 6 (Family: none)	18
Y	JP 2013-122932 A (Mitsubishi Electric Corp.), 20 June 2013 (20.06.2013), paragraphs [0014] to [0015]; fig. 1 to 3, 8, 17 & JP 2013-122933 A & JP 5622862 B2 & JP 2015-35424 A & WO 2012/056957 A1	18
Y	JP 2001-167864 A (Fuji Xerox Co., Ltd.), 22 June 2001 (22.06.2001), claim 9; paragraphs [0020], [0023]; fig. 3 to 5 (Family: none)	18

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2013094174 A1 **[0006]**
- JP 2014044819 A **[0006]**
- JP 2012054179 A **[0043]**