(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 860 308 A1

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

(43) Date of publication:
04.08.2021 Bulletin 2021/31

(21) Application number: **18935439.2**

(22) Date of filing: **26.09.2018**

(51) Int Cl.:
H05B 6/12 *(2006.01)*

(86) International application number:
PCT/JP2018/035676

(87) International publication number:
WO 2020/065758 (02.04.2020 Gazette 2020/14)

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

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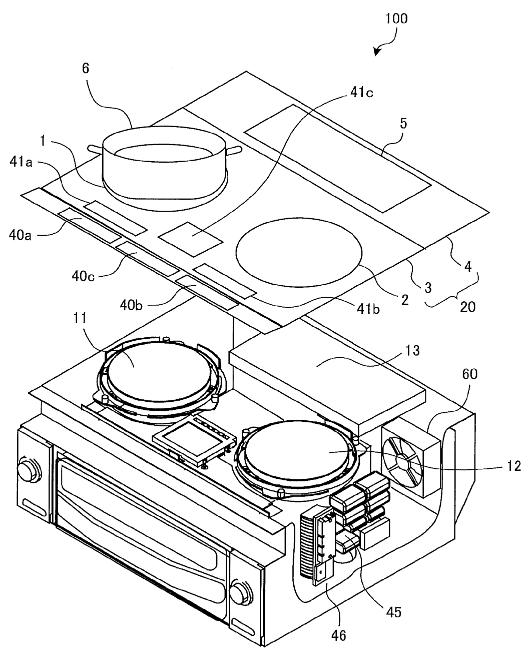
(54) INDUCTION HEATING COOKER

(57) An induction heating cooking apparatus includes a top plate having a tabular shape and including a first region and a second region having a higher thermal conductivity than does the first region, a heating coil provided below the first region included in the top plate and configured to inductively heat a cooking container placed on the first region, and a cooling device provided below the second region included in the top plate and configured to cool a cooking container placed on the second region.

FIG. 2



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Printed by Jouve, 75001 PARIS (FR)

Description

Technical Field

[0001] The present disclosure relates to an induction heating cooking apparatus including a top plate on which a cooking container is placed.

Background Art

[0002] Some electromagnetic cooking apparatus has been proposed, for example, that includes a placement part on which a cooking utensil is placed and a heating device that is disposed below the placement part and configured to heat the cooking utensil placed on the placement part by electromagnetic induction (see Patent Literature 1). The electromagnetic cooking apparatus includes a cooling device that is in contact with a face of the placement part opposite another face on which the cooking utensil is placed and that is configured to cool the cooking utensil placed on the placement part. The placement part is, for example, made of crystallized glass.

Citation List

Patent Literature

[0003] Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2008-287938

Summary of Invention

Technical Problem

[0004] The electromagnetic cooking apparatus described in Patent Literature 1 cools the cooking utensil by allowing the cooling device, which is in contact with a bottom face of the placement part, to remove heat transmitted from the cooking utensil to the placement part. As a result, a problem with the electromagnetic cooking apparatus is that cooling the cooking container by the cooling device requires time as compared with heating the cooking container by electromagnetic induction.

[0005] An object of the present disclosure, which has been accomplished to solve the problem described above, is to provide an induction heating cooking apparatus designed to cool a cooking container placed on a top plate with increased speed. Solution to Problem

[0006] An induction heating cooking apparatus according to an embodiment of the present disclosure includes a top plate having a tabular shape and including a first region and a second region having a higher thermal conductivity than does the first region, a heating coil provided below the first region included in the top plate and configured to inductively heat a cooking container placed on the first region, and a cooling device provided below the second region included in the top plate and configured to cool a cooking container placed on the second region.

Advantageous Effects of Invention

[0007] The induction heating cooking apparatus according to an embodiment of the present disclosure includes the heating coil configured to inductively heat the cooking container placed on the first region included in the top plate and the cooling device configured to cool the cooking container placed on the second region included in the top plate. In the top plate, the second region has a higher thermal conductivity than does the first region. This configuration allows the cooling device to cool the cooking container with increased speed as compared with a case in which the thermal conductivity of a region of the top plate above the cooling device is equal to the thermal conductivity of the first region.

Brief Description of Drawings

[0008]

[Fig. 1] Fig. 1 is a plan view showing an induction heating cooking apparatus according to Embodiment 1.

[Fig. 2] Fig. 2 is an exploded perspective view showing the induction heating cooking apparatus according to Embodiment 1.

[Fig. 3] Fig. 3 is a plan view illustrating a first region and a second region in the induction heating cooking apparatus according to Embodiment 1.

[Fig. 4] Fig. 4 is a block diagram showing a configuration of the induction heating cooking apparatus according to Embodiment 1.

[Fig. 5] Fig. 5 is a plan view showing a cooling device in the induction heating cooking apparatus according to Embodiment 1.

[Fig. 6] Fig. 6 is a schematic side view showing a configuration of the cooling device in the induction heating cooking apparatus according to Embodiment 1.

[Fig. 7] Fig. 7 is a schematic side view showing how the cooling device is placed in the induction heating cooking apparatus according to Embodiment 1.

[Fig. 8] Fig. 8 is a schematic side view showing how the cooling device is placed in an induction heating cooking apparatus according to a first modification example of Embodiment 1.

[Fig. 9] Fig. 9 is an exploded perspective view showing an induction heating cooking apparatus according to a second modification example of Embodiment 1.

[Fig. 10] Fig. 10 is a plan view showing an induction heating cooking apparatus according to Embodiment 2.

[Fig. 11] Fig. 11 is a plan view showing an induction heating cooking apparatus according to a first modification example of Embodiment 2.

[Fig. 12] Fig. 12 is a plan view showing an induction heating cooking apparatus according to a second modification example of Embodiment 2.

[Fig. 13] Fig. 13 is a longitudinal cross-sectional view showing a top plate of an induction heating cooking apparatus according to Embodiment 3.

[Fig. 14] Fig. 14 is a longitudinal cross-sectional view showing a top plate of an induction heating cooking apparatus according to Embodiment 4.

[Fig. 15] Fig. 15 is a longitudinal cross-sectional view showing a top plate of an induction heating cooking apparatus according to a modification example of Embodiment 4.

[Fig. 16] Fig. 16 is an exploded perspective view showing an induction heating cooking apparatus according to Embodiment 5.

[Fig. 17] Fig. 17 is a longitudinal cross-sectional view showing a top plate of the induction heating cooking apparatus according to Embodiment 5.

[Fig. 18] Fig. 18 is a schematic longitudinal cross-sectional view showing an internal configuration of an induction heating cooking apparatus according to Embodiment 6.

[Fig. 19] Fig. 19 is a drawing showing a cooling device and a refrigerant circuit in an induction heating cooking apparatus according to Embodiment 7. Description of Embodiments

Embodiment 1

(Configuration)

[0009] Fig. 1 is a plan view showing an induction heating cooking apparatus according to Embodiment 1.

[0010] Fig. 2 is an exploded perspective view showing the induction heating cooking apparatus according to Embodiment 1.

[0011] As shown in Figs. 1 and 2, an induction heating cooking apparatus 100 includes a top plate 20 in an upper part of the induction heating cooking apparatus 100. The top plate 20 has a tabular shape, and a cooking container 6 such as a pan and a pot is placed on the top plate 20. The top plate 20 includes a first top plate 3 and a second top plate 4. The first top plate 3 is adjacent to the second top plate 4. The first top plate 3 is provided at a front portion of the top plate 20. The second top plate 4 is provided at a rear portion of the top plate 20. The first top plate 3 and the second top plate 4 are joined together to be flush with each other.

[0012] The first top plate 3 is made of a material that allows a flow of eddy currents into the cooking container 6 to inductively heat the cooking container 6 without blocking a high-frequency magnetic field from a heating coil 11 described later. The first top plate 3 is, for example, made of a material such as heat-resistant tempered glass and crystallized glass.

[0013] The second top plate 4 is made of a material having a higher thermal conductivity than does the material of the first top plate 3. The second top plate 4 is, for example, made of a material such as aluminum, copper, aluminum nitride, silicon, stainless steel, and alumina. For instance, the thermal conductivity of crystallized glass is 1 [W/mK]. The thermal conductivity of aluminum is 236 [W/mK]. The thermal conductivity of copper is 398 [W/mK]. The thermal conductivity of aluminum nitride is 285 [W/mK]. The thermal conductivity of silicon is 168 [W/mK]. The thermal conductivity of stainless steel ranges from 16.7 to 20.9 [W/mK]. The thermal conductivity of alumina is 30 [W/mK]. In other words, the second top plate 4 has, for example, approximately 16 times to 400 times higher thermal conductivity as compared with the first top plate 3.

[0014] The heating coil 11 and a heating coil 12 are disposed below the first top plate 3 and configured to inductively heat the cooking container 6 placed on the first top plate 3. The heating coil 11 and the heating coil 12 are arranged laterally in a front portion of the induction heating cooking apparatus 100. The first top plate 3 has a first heating zone 1 and a second heating zone 2, which correspond to respective heating zones of the heating coil 11 and the heating coil 12 to roughly show sites on which the cooking container 6 is placed. The first heating zone 1 and the second heating zone 2 are, for example, circular marks corresponding to outlines of the heating coil 11 and the heating coil 12. The first heating zone 1 and the second heating zone 2 are formed by a method such as applying paint to the first top plate 3 and printing the marks on the first top plate 3.

[0015] The heating coil 11 and the heating coil 12 each include a lead wire that is made up of a metal coated for insulation and that is wound into circles. A core of the lead wire is, for example, made of any metal such as copper and aluminum. When a high-frequency current is supplied to the heating coil 11 and the heating coil 12, the heating coils each generate a high-frequency magnetic field. As a result, the cooking container 6 placed on the first top plate 3 directly above the heating coil 11 and the heating coil 12 is inductively heated.

[0016] A cooling device 13 is disposed below the second top plate 4 and configured to cool the cooking container 6 placed on the second top plate 4. The cooling device 13 is disposed at a substantially lateral middle place below the second top plate 4 in a rear portion of the induction heating cooking apparatus 100. The second top plate 4 has a cooling zone 5, which corresponds to a cooling zone of the cooling device 13 to roughly show a site on which the cooking container 6 is placed. The cooling zone 5 is, for example, formed above the cooling device 13 and is a mark of a rectangle corresponding to an outline of the cooling device 13. The cooling zone 5 is formed by a method such as applying paint to the second top plate 4 and printing the mark on the second top plate 4.

[0017] A shape of the cooling zone 5 is not limited to the rectangle. The cooling zone 5 may have any shape that roughly shows a zone within which the cooking container 6 placed on the second top plate 4 is allowed to be cooled by the cooling device 13. For instance, the shape of the cooling zone 5 may be circular, elliptical, or square. A plurality of the cooling zones 5 may be formed for one unit of the cooling device 13. Alternatively, a plurality of the cooling devices 13 may be disposed such that a plurality of the cooling zones 5 corresponding to cooling zones of the respective cooling devices 13 are formed. One piece of the cooling zone 5 may be formed for a plurality of the cooling devices 13.

[0018] The cooling device 13, for example, includes a Peltier element. The cooling device 13 cools a bottom face of the second top plate 4 to cool the cooking container 6 placed on the second top plate 4. The cooling device 13 will be detailed later.

[0019] Fig. 3 is a plan view illustrating a first region and a second region in the induction heating cooking apparatus according to Embodiment 1.

[0020] As shown in Fig. 3, the top plate 20 includes a first region 21 and a second region 22. The second region 22 is a region having a higher thermal conductivity than does the first region 21. In other words, the second top plate 4 made of the material having a higher thermal conductivity than does the material of the first top plate 3 includes the second region 22 of the top plate 20. The first top plate 3 includes the first region 21 of the top plate 20. The heating coil 11 and the heating coil 12 each inductively heat the cooking container 6 placed on the first region 21 of the top plate 20. The cooling device 13 cools the cooking container 6 placed on the second region 22 of the top plate 20.

[0021] Figs. 1 and 2 will be referenced again.

[0022] An operation unit 40a and an operation unit 40b are disposed as input devices at a front portion of the top plate 20 to supply electric power and choose a cooking menu or other settings when the cooking container 6 or other utensil is heated by either of the heating coil 11 and the heating coil 12. A display 41a and a display 41b are disposed as informing units in the vicinity of the operation unit 40a and the operation unit 40b and configured to display operating states of the heating coils and command details or other information input from the operation unit 40a and the operation unit 40b.

[0023] An operation unit 40c is disposed as an input device at a middle place at a front portion of the top plate 20 to supply electric power and choose a cooking menu or other settings when the cooking container 6 or other utensil is cooled by the cooling device 13. A display 41c is disposed as an informing unit in the vicinity of the operation unit 40c and configured to display an operating state of the cooling device 13 and command details or other information input from the operation unit 40c.

[0024] The operation units 40a to 40c are mechanical switches, such as push switches and tact switches, or touch switches used to detect an input operation by a change in electrode static capacitance. The displays 41a to 41c are, for example, devices such as LCDs and LEDs. The operation unit 40a and the display 41a may be integrated together to be used as an operation display unit. The operation unit 40b and the display 41b may be integrated together to be used as an operation display unit. The operation unit 40c and the display 41c may be integrated together to be used as an operation display unit. The operation display unit is, for example, a device such as a touch screen that includes a touch switch disposed on a top face of an LCD. The LCD is an acronym for "liquid crystal device". The LED is an acronym for "light emitting diode".

[0025] The operation units 40a, 40b, 40c and the displays 41a, 41b, 41c are provided for the heating coil 11, the heating coil 12, and the cooling device 13, respectively, as described above. However, this example does not place a limitation on the numbers of the units and the displays provided for the coils and the device. For instance, one operation unit 40 and one display 41 may be shared by the heating coil 11, the heating coil 12, and the cooling device 13.

[0026] In the induction heating cooking apparatus 100, drive circuits 46 are disposed to drive the heating coil 11, the heating coil 12, and the cooling device 13, and a controller 45 is disposed to control overall operation of the induction heating cooking apparatus 100 including the drive circuits 46.

[0027] The controller 45 includes dedicated hardware or a CPU that executes programs stored in a memory. The CPU is an acronym for "central processing unit". The CPU is also called a central processor, a processor unit, an arithmetic unit, a microprocessor, a microcomputer, or a processor.

[0028] When the controller 45 is dedicated hardware, the controller 45, for example, represents a single circuit, a composite circuit, an ASIC, an FPGA, or a combination of any of these parts. The controller 45 may include pieces of hardware configured to be used as respective functional units or may be one piece of hardware configured to be used as functional units. The ASIC is an acronym for "application specific integrated circuit". The FPGA is an acronym for "field-programmable gate array".

[0029] When the controller 45 is a CPU, the controller 45 implements functions by software, firmware, or a combination of software and firmware. The software and the firmware are written as programs and are stored in a memory. The CPU reads programs stored in the memory and executes the programs, so that the controller 45 implements functions. The memory described herein is, for example, a non-volatile or volatile semiconductor memory such as a RAM, a ROM, a flash memory, an EPROM, and an EEPROM.

[0030] The controller 45 may implement the functions partly by dedicated hardware and may implement the functions partly by software or firmware. The RAM is an acronym for "random access memory". The ROM is an acronym for "read only memory". The EPROM is an acronym for "erasable programmable read only memory". The EEPROM is an acronym for "electrically erasable programmable read-only memory".

[0031] A temperature sensor 42 (shown by a broken line in Fig. 1) is disposed on the bottom face of the second top plate 4. The temperature sensor 42 is, for example, a thermistor. The temperature sensor 42 is, for example, provided in the vicinity of the cooling device 13. The temperature sensor 42 detects temperature by heat transmitted from the cooking container 6 to the second top plate 4. The controller 45 controls the cooling device 13 in response to the temperature detected by the temperature sensor 42.

[0032] A fan 60 is disposed inside the induction heating cooking apparatus 100. The fan 60 is used to suction air from an exterior of a body of the induction heating cooking apparatus 100 into an interior of the body via an air inlet (not shown) to supply cooling air to the interior of the body. The cooling air supplied into the body cools parts and the cooling device 13 in the interior of the body and is then discharged to the exterior of the body via an air outlet (not shown).

[0033] Fig. 4 is a block diagram showing a configuration of the induction heating cooking apparatus according to Embodiment 1.

[0034] As shown in Fig. 4, the heating coil 11 is driven and controlled by a drive circuit 46a. The heating coil 12 is driven and controlled by a drive circuit 46b. The cooling device 13 is driven and controlled by a drive circuit 46c. The drive circuit 46a and the drive circuit 46b each include an inverter circuit. The drive circuit 46a and the drive circuit 46b each convert alternating-current (AC) power supplied from an AC power source into AC power having a high frequency ranging approximately from 20 kHz to 100 kHz and output the AC power to the corresponding one of the heating coil 11 and the heating coil 12. The drive circuit 46c includes a direct-current (DC) power supply circuit. The drive circuit 46c converts AC power supplied from the AC power source into DC power of any given wattage and outputs the DC power to the cooling device 13. In response to input from the operation units 40a to 40c and the temperature sensor 42, the controller 45 controls operation of the drive circuits 46a to 46c and the fan 60.

[0035] Fig. 5 is a plan view showing the cooling device in the induction heating cooking apparatus according to Embodiment 1.

[0036] Fig. 6 is a schematic side view showing a configuration of the cooling device in the induction heating cooking apparatus according to Embodiment 1.

[0037] As shown in Figs. 5 and 6, the cooling device 13 includes a plurality of p-type thermoelectric semiconductors 13a, a plurality of n-type thermoelectric semiconductors 13b, a plurality of electrodes 13c, and a pair of insulating parts 13d. The pair of the insulating parts 13d are, for example, each made of an insulating material such as ceramics. The pair of the insulating parts 13d have a tabular shape. The pair of the insulating parts 13d are provided opposite to each other.

[0038] The plurality of the p-type thermoelectric semiconductors 13a and the plurality of the n-type thermoelectric semiconductors 13b are provided between the pair of the insulating parts 13d. The p-type thermoelectric semiconductors 13a and the n-type thermoelectric semiconductors 13b are provided in an alternate order. The electrode 13c electrically connects the p-type thermoelectric semiconductor 13a and the n-type thermoelectric semiconductor 13b provided adjacent to each other. One end of a lead wire 13e is connected to an end of the electrode 13c. The other end of the lead wire 13e is connected to the drive circuit 46c, and a DC voltage from the drive circuit 46c is applied to the cooling device 13.

[0039] The p-type thermoelectric semiconductors 13a, the n-type thermoelectric semiconductors 13b, and the electrodes 13c compose a Peltier element. A DC current flowing into the electrodes 13c causes heat generation or heat removal at a face of the electrode 13c where the p-type thermoelectric semiconductor 13a and the n-type thermoelectric semiconductor 13b touch the electrode 13c. Thus, one of the pair of the insulating parts 13d that represents a cold side is cooled, and the other of the pair of the insulating parts 13d that represents a hot side is heated.

[0040] Fig. 7 is a schematic side view showing how the cooling device is placed in the induction heating cooking apparatus according to Embodiment 1.

[0041] As shown in Fig. 7, the cooling device 13 is firmly attached to the bottom face of the second top plate 4 such that the insulating part 13d representing the cold side faces the second top plate 4. A heat radiation unit 61 is firmly attached to the other of the pair of the insulating parts 13d representing the hot side. The heat radiation unit 61, for example, includes radiating fins. Cooling air is supplied from the fan 60 to the heat radiation unit 61 to radiate heat from the insulating part 13d representing the hot side.

[0042] A fan may be further provided beside or below the heat radiation unit 61 and configured to send cooling air to the heat radiation unit 61. Preferably, a substance such as thermal grease and an adhesive is applied to an interface between the cooling device 13 and the second top plate 4 and an interface between the cooling device 13 and the heat radiation unit 61 so that firm attachment is achieved without interposition of air.

(Operation)

[0043] Next, operation of the induction heating cooking apparatus according to Embodiment 1 will be described such that description is separately given of heat cooking involving inductively heating the cooking container 6 and of cool cooking involving cooling the cooking container 6.

[Heat cooking]

[0044] A user places the cooking container 6 such as a pan and a pot on the first heating zone 1 or the second heating zone 2 of the first top plate 3. A case in which the cooking container 6 is placed on the first heating zone 1 will be described below.

[0045] The user inputs a command via the operation unit 40a to start heating. In response to a level of electric power specified by the command input from the operation unit 40a, the controller 45 controls operation of the drive circuit 46a. For instance, the controller 45 allows frequency at which a high-frequency current is supplied from the drive circuit 46a to the heating coil 11 to vary depending on the specified electric power level.

[0046] When a high-frequency current flows into the heating coil 11, the heating coil 11 generates a high-frequency magnetic field, causing an eddy current to flow through a bottom of the cooking container 6 placed on the first heating zone 1 in a direction in which to cancel a flux change. Because of a loss of the flowing eddy current, the cooking container 6 is heated.

[Cool cooking]

[0047] A user places the cooking container 6 such as a pan and a pot on the cooling zone 5 of the second top plate 4. Then, the user inputs a command via the operation unit 40c to start cooling. In response to a level of electric power specified by the command input from the operation unit 40c, the controller 45 controls operation of the drive circuit 46c. The command input from the operation unit 40c is, for example, a command input to set a cooling temperature in three levels "Low", "Medium", and "High" or a command input to set a value of temperature for the cooking container 6.

[0048] In response to the command input from the operation unit 40c, the controller 45 controls the operation of the drive circuit 46c. For instance, in response to the level of cooling temperature, the controller 45 controls activation and deactivation of the supply of DC power to the cooling device 13. Specifically, when the level set by the input command is "High", the controller 45 activates and keeps the supply of DC power from the drive circuit 46c to the cooling device 13. When the level set by the input command is "Medium", the controller 45 switches periodically between activation and deactivation of the supply of DC power from the drive circuit 46c to the cooling device 13. When the level set by the input command is "Low", the controller 45 switches periodically between activation and deactivation of the supply of DC power from the drive circuit 46c to the cooling device 13 such that a length of time for which the supply is deactivated is long compared with that when the level set by the input command is "Medium".

[0049] For instance, the controller 45 controls the cooling device 13 to cause the temperature detected by the temperature sensor 42 to reach the set temperature. Specifically, when the temperature detected by the temperature sensor 42 is lower than the set temperature, the controller 45 activates the supply of DC power from the drive circuit 46c to the cooling device 13. When the temperature detected by the temperature sensor 42 is higher than or equal to the set temperature, the controller 45 deactivates the supply of DC power from the drive circuit 46c to the cooling device 13. The control of the cooling device 13 exercised by the controller 45 is not limited to the control described above, and the controller 45 may use any other temperature control. The controller 45 may, for example, control the cooling device 13 to increase the on-duty ratio for the drive circuit 46c in response to an increase in difference between the set temperature and the temperature detected by the temperature sensor 42.

[0050] When DC power is supplied to the cooling device 13, the second top plate 4 to which the insulating part 13d representing the cold side is firmly attached is cooled, and the cooking container 6 placed on the second top plate 4 is cooled.

[0051] The heat cooking and the cool cooking can be performed concurrently or can be performed in sequence. For instance, a user may place two respective cooking containers 6 on the first heating zone 1 and the cooling zone 5 to perform concurrently the heat cooking by the heating coil 11 and the cool cooking by the cooling device 13. For instance, a user may place one cooking container 6 on the first heating zone 1 to perform the heat cooking by the heating coil 11 and may then move the cooking container 6 placed on the first heating zone 1 to the cooling zone 5 to perform the cool cooking by the cooling device 13.

(Effects)

[0052] As described above, the induction heating cooking apparatus according to Embodiment 1 includes the heating coil 11 provided below the first region 21 included in the top plate 20 and the cooling device 13 provided below the second region 22 included in the top plate 20. In the top plate 20, the second region 22 has a higher thermal conductivity than does the first region 21. This configuration allows the cooling device 13 to cool the cooking container 6 with increased speed as compared with a case in which the thermal conductivity of the second region 22 of the top plate 20 is equal to the thermal conductivity of the first region 21. This shortens cooking time required for cool cooking of the cooking container 6. This also shortens time required until temperature of cooked stuff in the cooking container 6, after heat cooking, falls to a temperature suitable for preservation of food in a refrigerator. As a result, the induction heating cooking apparatus is configured to hinder the propagation of bacteria in cooked stuff compared with a case of natural cooling.

[0053] The induction heating cooking apparatus enables the user to perform the heat cooking and the cool cooking concurrently or in sequence. Thus, stuff in the cooking container 6 can be cooked through coordination between cooling and heating. The cool cooking performed after the heat cooking allows improved infiltration of seasonings into cooked stuff in the cooking container 6, enhancing a fine flavor of the cooked stuff.

[0054] The top plate 20 has a tabular shape. Thus, after heat cooking with the cooking container 6 placed on the first region 21 of the top plate 20, the cooking container 6 can be readily moved from the first region 21 to the second region 22 of the top plate 20 by sliding the cooking container 6 without holding up the cooking container 6. This facilitates coordination between the heat cooking and the cool cooking.

[0055] In Embodiment 1, the top plate 20 includes the first top plate 3 including the first region 21 and the second top plate 4 including the second region 22. The second top plate 4 is made of a material having a higher thermal conductivity than does the material of the first top plate 3. This configuration allows the cooking container 6 placed on the second top plate 4 to be cooled with increased speed as compared with a case in which the thermal conductivity of the second top plate 4 is equal to the thermal conductivity of the first top plate 3. This shortens cooking time required for cool cooking of the cooking container 6.

[0056] The first top plate 3 and the second top plate 4 are joined together to be flush with each other. Thus, after heat cooking with the cooking container 6 placed on the first top plate 3, the cooking container 6 can be readily moved from the first top plate 3 to the second top plate 4 by sliding the cooking container 6 without holding up the cooking container 6. This facilitates coordination between the heat cooking and the cool cooking.

[0057] The first top plate 3 is, for example, made of a material such as heat-resistant tempered glass and crystallized glass. The second top plate 4 is, for example, made of a material such as aluminum, copper, aluminum nitride, silicon, stainless steel, and alumina. In most cases, heat-resistant tempered glass and crystallized glass each are expensive compared with any of aluminum, copper, aluminum nitride, silicon, stainless steel, and alumina. Thus, this configuration provides a decrease in amount of usage of a material such as heat-resistant tempered glass and crystallized glass and contributes to a reduction in manufacturing costs as compared with a case in which the top plate 20 is completely made of a material such as heat-resistant tempered glass and crystallized glass.

[0058] In Embodiment 1, the second top plate 4 is provided adjacent to the first top plate 3. Thus, after heat cooking with the cooking container 6 placed on the first top plate 3, the cooking container 6 can be readily moved from the first top plate 3 to the second top plate 4. This facilitates coordination between the heat cooking and the cool cooking.

[0059] In Embodiment 1, the top plate 20 has the cooling zone 5 above the cooling device 13 to show a site on which the cooking container 6 is placed. This allows the user to readily locate the site on which the cooking container 6 is to be placed to perform the cool cooking. Thus, the cooking container 6 can be readily placed on the site where the cool cooking is enabled with the cooling device 13. This provides efficient cooling of the cooking container 6.

[0060] In Embodiment 1, the induction heating cooking apparatus includes the temperature sensor 42 provided on a bottom face of the second region 22 included in the top plate 20 and the controller 45 configured to control the cooling device 13 in response to the temperature detected by the temperature sensor 42. This configuration can reduce both an error in detection of temperature of and a time delay before detection of a change in temperature of the cooking container 6 as compared with a case in which the thermal conductivity of the second region 22 of the top plate 20 is equal to the thermal conductivity of the first region 21. This enables quick and accurate detection of the temperature of the cooking container 6 and temperature control with high accuracy based on detected signals from the temperature sensor 42 during cool cooking.

[0061] In Embodiment 1, the induction heating cooking apparatus includes the controller 45 configured to control the cooling device 13 in response to a command input from any of the operation units 40. This configuration allows the user to readily set the operation of the cooling device 13, such as starting and stopping of the cool cooking.

[0062] The induction heating cooking apparatus includes the controller 45 configured to control the cooling device 13 to cause the temperature detected by the temperature sensor 42 to reach the set temperature. This enables temperature control with high accuracy based on detected signals from the temperature sensor 42 during cool cooking.

(First modification example)

[0063] Fig. 8 is a schematic side view showing how the cooling device is placed in an induction heating cooking apparatus according to a first modification example of Embodiment 1.

[0064] As shown in Fig. 8, the cooling device 13 may be firmly attached to a bottom face of the top plate 20 with an elastic body 62. In other words, the elastic body 62 is interposed between the insulating part 13d representing the cold side of the cooling device 13 and the second top plate 4. The elastic body 62 is made of a material having a higher thermal conductivity than does the material of the first top plate 3. The elastic body 62 is, for example, made of silicon or other material.

[0065] This configuration allows the cooling device 13 and the second top plate 4 to be firmly attached to each other such that an air layer is not interposed between the cooling device 13 and the second top plate 4. This provides improved efficiency in the cooling of the cooking container 6 by the cooling device 13 and allows the cooling of the cooking container 6 with increased speed.

(Second modification example)

[0066] Fig. 9 is an exploded perspective view showing an induction heating cooking apparatus according to a second modification example of Embodiment 1.

[0067] As shown in Fig. 9, the first top plate 3 and the second top plate 4 may be arranged laterally. The first top plate 3 is provided at a left portion of the top plate 20. The second top plate 4 is provided at a right portion of the top plate 20. The first top plate 3 is provided adjacent to the second top plate 4. The first top plate 3 and the second top plate 4 are joined together to be flush with each other.

[0068] The heating coil 11 is disposed below the first top plate 3. The heating coil 11 is provided in a front left portion of the induction heating cooking apparatus 100. The first top plate 3 has the first heating zone 1 corresponding to a heating zone of the heating coil 11. The cooling device 13 is disposed below the second top plate 4. The cooling device 13 is disposed in a right portion of the induction heating cooking apparatus 100. The second top plate 4 has the cooling zone 5 corresponding to a cooling zone of the cooling device 13. Lateral positions of the first heating zone 1 and the cooling zone 5 are not limited as shown.

[0069] This configuration can also produce effects similar to those in Embodiment 1 described above.

Embodiment 2

[0070] A configuration of an induction heating cooking apparatus 100 according to Embodiment 2, in particular, differences between Embodiment 2 and Embodiment 1 described above, will be described below. In the following description, components identical to those in Embodiment 1 are assigned with the same reference signs, and descriptions of the components will be omitted.

[0071] Fig. 10 is a plan view showing an induction heating cooking apparatus according to Embodiment 2.

[0072] As shown in Fig. 10, a first top plate 3 has an opening portion 31. A second top plate 4 is provided in the opening portion 31 formed in the first top plate 3. The first top plate 3 and the second top plate 4 are joined together to be flush with each other.

[0073] The opening portion 31 in the first top plate 3 is, for example, formed above a cooling device 13 and has a shape of a rectangle corresponding to an outline of the cooling device 13. In Embodiment 2, a mark of a cooling zone 5 may be omitted.

[0074] In Embodiment 2, as described above, the second top plate 4 is provided in the opening portion 31 formed in the first top plate 3. This configuration can also produce effects similar to those in Embodiment 1 described above. As the first top plate 3 and the second top plate 4 are made of different materials, the top plates differ in color in most cases. Thus, even if the mark of the cooling zone 5 is omitted, a color of the second top plate 4 enables the user to identify a cooling zone of the cooling device 13.

(First modification example)

[0075] Fig. 11 is a plan view showing an induction heating cooking apparatus according to a first modification example of Embodiment 2.

[0076] As shown in Fig. 11, the first top plate 3 may have a cutout 32. The second top plate 4 is provided in the cutout 32 formed in the first top plate 3. The first top plate 3 and the second top plate 4 are joined together to be flush with each other.

[0077] This configuration can also produce effects similar to those in the first modification example described above.

[0078] The shapes of the opening portion 31 and the cutout 32 described above may be any shapes, such as circular, square, and elliptical, other than the rectangular shapes.

(Second modification example)

[0079] Fig. 12 is a plan view showing an induction heating cooking apparatus according to a second modification example of Embodiment 2.

[0080] As shown in Fig. 12, the first top plate 3 may have two pieces of an opening portion 33a and an opening portion 33b. The opening portion 33a and the opening portion 33b are, for example, elliptical. A second top plate 4a is provided in the opening portion 33a formed in the first top plate 3, and a second top plate 4b is provided in the opening portion 33b formed in the first top plate 3. Respective cooling devices 13 are provided below the opening portion 33a and the opening portion 33b.

[0081] This configuration can also produce effects similar to those in the first modification example described above.

[0082] The shapes of the opening portion 33a and the opening portion 33b described above may be any shapes, such as circular, square, and rectangular, other than the elliptical shapes. The number of the opening portions may be any other than the two. An operation unit 40c may be used to select any of the opening portion 33a and the opening portion 33b to control operation of the cooling device 13 provided below the selected one of the opening portion 33a and the opening portion 33b.

Embodiment 3

[0083] A configuration of an induction heating cooking apparatus 100 according to Embodiment 3, in particular, differences between Embodiment 3 and Embodiments 1 and 2 described above, will be described below. In the following description, components identical to those in Embodiments 1 and 2 are assigned with the same reference signs, and descriptions of the components will be omitted.

[0084] Fig. 13 is a longitudinal cross-sectional view showing a top plate of an induction heating cooking apparatus according to Embodiment 3.

[0085] As shown in Fig. 13, a heat insulator 70 is provided between a first top plate 3 and a second top plate 4. The heat insulator 70 is made of a material having a lower thermal conductivity than does the material of the first top plate 3. The heat insulator 70 is, for example, made of an epoxy resin or other material. The thermal conductivity of epoxy resin ranges from 0.15 to 0.21 [W/mK].

[0086] A rest of the configuration is similar to that in Embodiment 1 or 2 described above. In other words, a top plate 20 in Embodiment 3 is equivalent to the top plate in Embodiment 1 that includes a heat insulator 70 disposed at a location where the first top plate 3 and the second top plate 4 are joined together. The top plate 20 in Embodiment 3 is equivalent to the top plate in Embodiment 2 that includes a heat insulator 70 at a location where the opening portion 31 in the first top plate 3 and the second top plate 4 are joined together.

[0087] In Embodiment 3, as described above, the induction heating cooking apparatus includes the heat insulator 70, which is provided between the first top plate 3 and the second top plate 4 and is made of a material having a lower thermal conductivity than does the material of the first top plate 3. This configuration hinders transfer of heat between the first top plate 3 and the second top plate 4. In other words, when the heat cooking and the cool cooking are performed concurrently or in sequence, this configuration can prevent the first top plate 3 and the second top plate 4 from thermally interfering with each other. This prevents the heat cooking from increasing the temperature of the second top plate 4 and the cool cooking from decreasing the temperature of the first top plate 3. As a result, the induction heating cooking apparatus enables efficient heat cooking and cool cooking.

Embodiment 4

[0088] A configuration of an induction heating cooking apparatus 100 according to Embodiment 4, in particular, differences between Embodiment 4 and Embodiments 1 to 3 described above, will be described below. In the following description, components identical to those in Embodiments 1 to 3 are assigned with the same reference signs, and descriptions of the components will be omitted.

[0089] Fig. 14 is a longitudinal cross-sectional view showing a top plate of an induction heating cooking apparatus according to Embodiment 4.

[0090] As shown in Fig. 14, a middle of a side end of a first top plate 3 has a protrusion 71a. An end of a second top plate 4 has a recess 71b into which the protrusion 71 a of the first top plate 3 is fit. The protrusion 71a and the recess 71b are fit together and hence the first top plate 3 and the second top plate 4 are joined together in a watertight manner.

[0091] A rest of the configuration is similar to that in Embodiment 1 or 2 described above. In other words, a top plate 20 in Embodiment 4 is equivalent to a top plate formed such that the first top plate 3 and the second top plate 4 in Embodiment 1 that are joined together in a watertight manner. The top plate 20 in Embodiment 4 is equivalent to a structure of the opening portion 31 in the first top plate 3 and the second top plate 4 in Embodiment 2 that are joined together in a watertight manner. In Embodiment 4, similarly to Embodiment 3 described above, a heat insulator 70 may be disposed in an interface between the first top plate 3 and the second top plate 4, which are joined together.

[0092] In Embodiment 4, as described above, the first top plate 3 and the second top plate 4 are joined together in a watertight manner. This configuration hinders ingress of moisture into the induction heating cooking apparatus 100 through a gap at a location where the first top plate 3 and the second top plate 4 are joined together. For instance, even if broth or other liquid in a cooking container 6 has boiled over during hot cooking, this configuration obstructs ingress of the moisture of the broth or other liquid into the induction heating cooking apparatus 100. This prevents malfunction and deterioration of a device caused by moisture ingress into the induction heating cooking apparatus 100.

[0093] With the structure described above, the protrusion 71a and the recess 71b are fit together. This example, however, does not place a limitation on the scope of the present disclosure. The joint structure may form any configuration as long as the first top plate 3 and the second top plate 4 are joined together in a watertight manner. For instance, the first top plate 3 and the second top plate 4 may be joined together by being firmly attached to each other with a sealing material interposed between the first top plate 3 and the second top plate 4. The sealing material may be a material having a lower thermal conductivity than does the material of the first top plate 3 to be used as both a heat insulator 70 in Embodiment 3 and a watertight joint structure.

(Modification example)

[0094] Fig. 15 is a longitudinal cross-sectional view showing a top plate of an induction heating cooking apparatus according to a modification example of Embodiment 4.

[0095] As shown in Fig. 15, a lower part of a side end of the first top plate 3 has a protrusion 72a. The protrusion 72a has a recess 72b depressed downward. An upper part of a side end of the second top plate 4 has a protrusion 73a. The protrusion 73a has a protrusion 73b projecting downward. The top plates are provided such that the protrusion 72a of the first top plate 3 and the protrusion 73a of the second top plate 4 are arranged vertically and the protrusion 73b and the recess 72b are fit together. As a result, the first top plate 3 and the second top plate 4 are joined together in a watertight manner.

[0096] In this manner, the interface between the first top plate 3 and the second top plate 4 is provided with a plurality of the recesses and the protrusions. This configuration provides improved waterproofness between the first top plate 3 and the second top plate 4.

Embodiment 5

[0097] A configuration of an induction heating cooking apparatus 100 according to Embodiment 5, in particular, differences between Embodiment 5 and Embodiment 1 described above, will be described below. In the following description, components identical to those in Embodiment 1 are assigned with the same reference signs, and descriptions of the components will be omitted.

[0098] Fig. 16 is an exploded perspective view showing an induction heating cooking apparatus according to Embodiment 5.

[0099] Fig. 17 is a longitudinal cross-sectional view showing a top plate of the induction heating cooking apparatus according to Embodiment 5.

[0100] As shown in Figs. 16 and 17, an induction heating cooking apparatus 100 according to Embodiment 5 includes a top plate 80 in an upper part of the induction heating cooking apparatus 100. The top plate 80 has a tabular shape, and a cooking container 6 such as a pan and a pot is placed on the top plate 80. A first region 21 included in the top plate 80 is occupied by a first material 81. A second region 22 included in the top plate 80 is occupied by a mixture of the first material 81 and a second material 82. The second material 82 has a higher thermal conductivity than does the first material 81. The first material 81 is, for example, a material such as heat-resistant tempered glass and crystallized glass. The second material 82 is, for example, a material such as aluminum, copper, aluminum nitride, silicon, stainless steel, and alumina. The second material 82 is, for example, formed as particles.

[0101] A rest of the configuration is similar to that in Embodiment 1 described above.

[0102] In Embodiment 5, as described above, the top plate 80 includes the first region 21 occupied by the first material 81 and the second region 22 occupied by a mixture of the first material 81 and the second material 82 having a higher thermal conductivity than does the first material 81. This configuration allows a cooling device 13 to cool the cooking container 6 with increased speed as compared with a case in which the first material 81 is not mixed as the material of the second region 22 of the top plate 80. This shortens cooking time required for cool cooking of the cooking container 6. This also shortens time required until temperature of cooked stuff in the cooking container 6, after heat cooking, falls to a temperature suitable for preservation of food in a refrigerator. As a result, the induction heating cooking apparatus is configured to hinder the propagation of bacteria in cooked stuff compared with a case of natural cooling.

[0103] The top plate 80 has a tabular shape. Thus, after heat cooking with the cooking container 6 placed on the first region 21 of the top plate 20, the cooking container 6 can be readily moved from the first region 21 to the second region 22 of the top plate 80 by sliding the cooking container 6 without holding up the cooking container 6. This facilitates coordination between the heat cooking and the cool cooking.

[0104] The first region 21 and the second region 22 of the top plate 80 are integrated together. This prevents ingress of moisture into the induction heating cooking apparatus 100.

Embodiment 6

[0105] A configuration of an induction heating cooking apparatus 100 according to Embodiment 6, in particular, differences between Embodiment 6 and Embodiments 1 to 5 described above, will be described below. In the following description, components identical to those in Embodiments 1 to 5 are assigned with the same reference signs, and descriptions of the components will be omitted.

[0106] Fig. 18 is a schematic longitudinal cross-sectional view showing an internal configuration of an induction heating cooking apparatus according to Embodiment 6.

[0107] As shown in Fig. 18, an induction heating cooking apparatus 100 according to Embodiment 6 includes a drain pan 90 and a discharge unit 93. A rest of the configuration is similar to that in Embodiment 1 described above. In Fig. 17, illustration of some components is omitted.

[0108] The drain pan 90 is provided below a cooling device 13 to receive condensed water generated on a bottom face of a second top plate 4. The discharge unit 93 discharges the condensed water stored in the drain pan 90. The discharge unit 93 includes a water pipe 91 connected to a bottom of the drain pan 90 and a drain container 92 that stores condensed water drained through the water pipe 91. An upper part of the drain container 92, which is detachable, is locked to the second top plate 4 with a lock piece 92a. The second top plate 4 includes an openable lid 94 disposed above the drain container 92.

[0109] A process for storing and discarding the condensed water will be described.

[0110] Cool cooking performed with the cooling device 13 causes moisture in the air to condense (dew condensation) on the second top plate 4 around the cooling device 13 and thus generates condensed water. The condensed water adhering to the bottom face of the second top plate 4 drips downward and is stored in the drain pan 90. The condensed water stored in the drain pan 90 is stored into the drain container 92 via the water pipe 91. The user opens the openable lid 94 of the second top plate 4, removes the drain container 92 out from the apparatus body, and discards the condensed water in the drain container 92.

[0111] In Embodiment 6, as described above, the induction heating cooking apparatus includes the drain pan 90, which is provided below the cooling device 13 to receive condensed water generated on the bottom face of a top plate 20, and the discharge unit 93 configured to discharge the condensed water stored in the drain pan

90. This configuration prevents condensed water generated around the cooling device 13 by cool cooking from adhering to electrical parts and other structural components inside the induction heating cooking apparatus 100. This hinders the electrical parts inside the induction heating cooking apparatus 100 from having an electric short circuit. This configuration also prevents the electrical parts and other structural components inside the induction heating cooking apparatus 100 from deteriorating or corroding by moisture adhesion.

Embodiment 7

[0112] In Embodiments 1 to 6 described above, the cooling device includes a Peltier element. This example, however, does not place a limitation on the scope of the present disclosure. The cooling device may have any configuration as long as the cooling device cools the cooking container 6 placed on the second region 22. A cooling device according to Embodiment 7 will be described that is applied as an evaporator included in a refrigerant circuit.

[0113] Fig. 19 is a drawing showing a cooling device and a refrigerant circuit in an induction heating cooking apparatus according to Embodiment 7.

[0114] As shown in Fig. 19, a refrigerant circuit 200 includes a compressor 201, a condenser 202, an expansion valve 203, and a cooling device 204, which is an evaporator. The compressor 201, the condenser 202, the expansion valve 203, and the cooling device 204 are connected annularly in order by a refrigerant pipe.

[0115] The compressor 201 suctions refrigerant having low temperature and low pressure and discharges the refrigerant having high temperature and high pressure. The high-temperature and high-pressure refrigerant discharged from the compressor 201 flows into the condenser 202 to transfer heat. The refrigerant that has fallen in temperature turns into refrigerant in the form of liquid and flows out from the condenser 202. The refrigerant flowing out from the condenser 202 is decompressed by the expansion valve 203 to turn into two-phase gas-liquid refrigerant and flows into the cooling device 204, which is the evaporator. The refrigerant flowing into the cooling device 204 removes heat from the cooking container 6 and thereby evaporates to turn into refrigerant in the form of gas and flows out from the cooling device 204. The refrigerant flowing out from the cooling device 204 is suctioned into the compressor 201.

[0116] This configuration allows the induction heating cooking apparatus to cool the cooking container 6 placed on a top plate 20 and thus produce effects similar to those in Embodiments 1 to 6 described above.

Reference Signs List

[0117] 1 first heating zone 2 second heating zone 3 first top plate 4 second top plate 4a second top plate 4b second top plate 5 cooling zone 6 cooking container 11 heating coil 12 heating coil 13 cooling device 13a p-type thermoelectric semiconductor 13b n-type thermoelectric semiconductor 13c electrode 13d insulating part 13e lead wire 20 top plate 21 first region 22 second region 31 opening portion 32 cutout33a opening portion 33b opening portion 40 operation unit 40a operation unit 40b operation unit 40c operation unit 41 display 41a display 41b display 41c display 42 temperature sensor 45 controller 46 drive circuit 46a drive circuit 46b drive circuit 46c drive circuit 60 fan 61 heat radiation unit 62 elastic body 70 heat insulator 71a protrusion 71b recess72a protrusion 72b recess 73a protrusion 73b protrusion 80 top plate 81 first material 82 second material 90 drain pan 91 water pipe 92 drain container 92a lock piece 93 discharge unit 94 openable lid 100 induction heating cooking apparatus 200 refrigerant circuit 201 compressor 202 condenser 203 expansion valve 204 cooling device

Claims

1. An induction heating cooking apparatus, comprising:

   a top plate having a tabular shape and including a first region and a second region having a higher thermal conductivity than does the first region;
   a heating coil provided below the first region included in the top plate and configured to inductively heat a cooking container placed on the first region; and
   a cooling device provided below the second region included in the top plate and configured to cool a cooking container placed on the second region.

2. The induction heating cooking apparatus of claim 1, wherein the top plate includes
   a first top plate including the first region, and
   a second top plate including the second region and made of a material having a higher thermal conductivity than does a material of the first top plate, and
   wherein the first top plate and the second top plate are joined together to be flush with each other.

3. The induction heating cooking apparatus of claim 2, wherein the second top plate is provided adjacent to the first top plate.

4. The induction heating cooking apparatus of claim 2, wherein the second top plate is provided in an opening portion formed in the first top plate.

5. The induction heating cooking apparatus of any one of claims 2 to 4, further comprising a heat insulator that is provided between the first top plate and the second top plate and that is made of a material having a lower thermal conductivity than does the material of the first top plate.

6. The induction heating cooking apparatus of any one of claims 2 to 4, wherein the first top plate and the second top plate are joined together in a watertight manner.

7. The induction heating cooking apparatus of claim 1, wherein the top plate includes the first region occupied by a first material and the second region occupied by a mixture of the first material and a second material having a higher thermal conductivity than does the first material.

8. The induction heating cooking apparatus of any one of claims 1 to 7, wherein the top plate has a cooling zone above the cooling device to show a site on which the cooking container is placed.

9. The induction heating cooking apparatus of any one of claims 1 to 8, further comprising:

   a temperature sensor provided on a bottom face of the second region included in the top plate; and
   a controller configured to control the cooling device in response to a temperature detected by the temperature sensor.

10. The induction heating cooking apparatus of any one of claims 1 to 8, further comprising:

   an operation unit used to input a command to the cooling device; and
   a controller configured to control the cooling device in response to the command input from the operation unit.

11. The induction heating cooking apparatus of any one of claims 1 to 8, further comprising:

   a temperature sensor provided on a bottom face of the second region included in the top plate;
   an operation unit used to input a command about a set temperature of the cooling device; and
   a controller configured to control the cooling device to cause a temperature detected by the temperature sensor to reach the set temperature.

12. The induction heating cooking apparatus of any one of claims 1 to 11, wherein the cooling device includes a Peltier element.

13. The induction heating cooking apparatus of any one of claims 1 to 12, wherein the cooling device is firmly attached to a bottom face of the top plate directly or with an elastic body interposed between the cooling device and the bottom face of the top plate.

14. The induction heating cooking apparatus of any one of claims 1 to 13, further comprising:

   a drain pan provided below the cooling device to receive condensed water generated on a bottom face of the top plate; and
   a discharge unit configured to discharge the condensed water stored in the drain pan.

FIG. 1

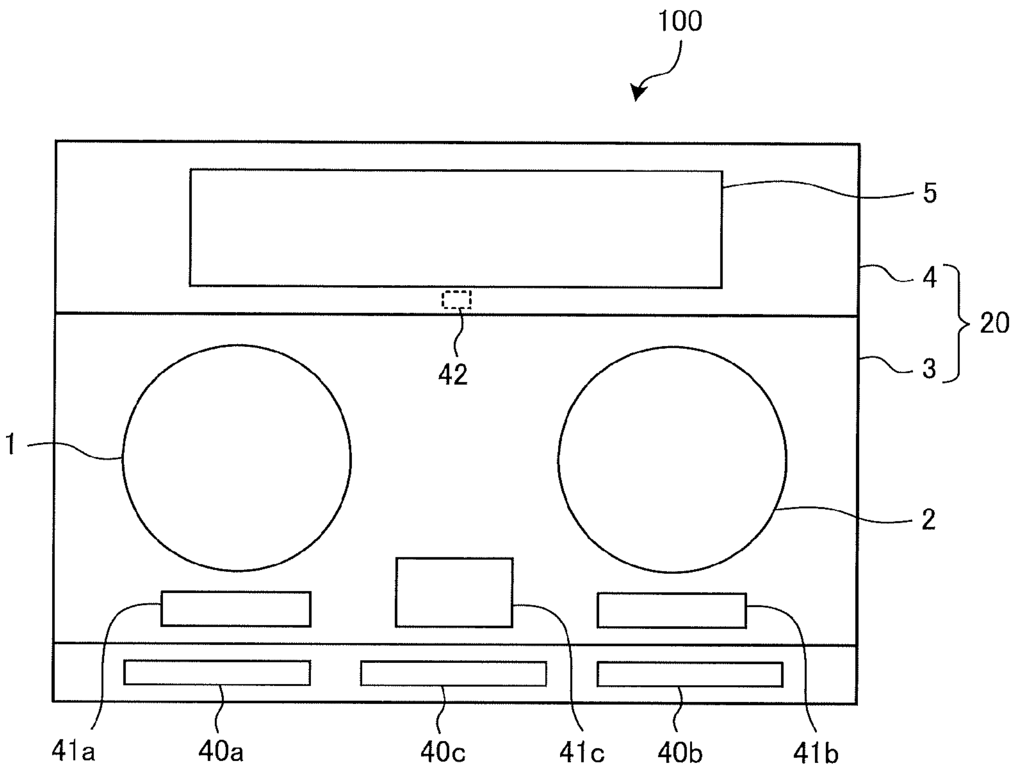


FIG. 2

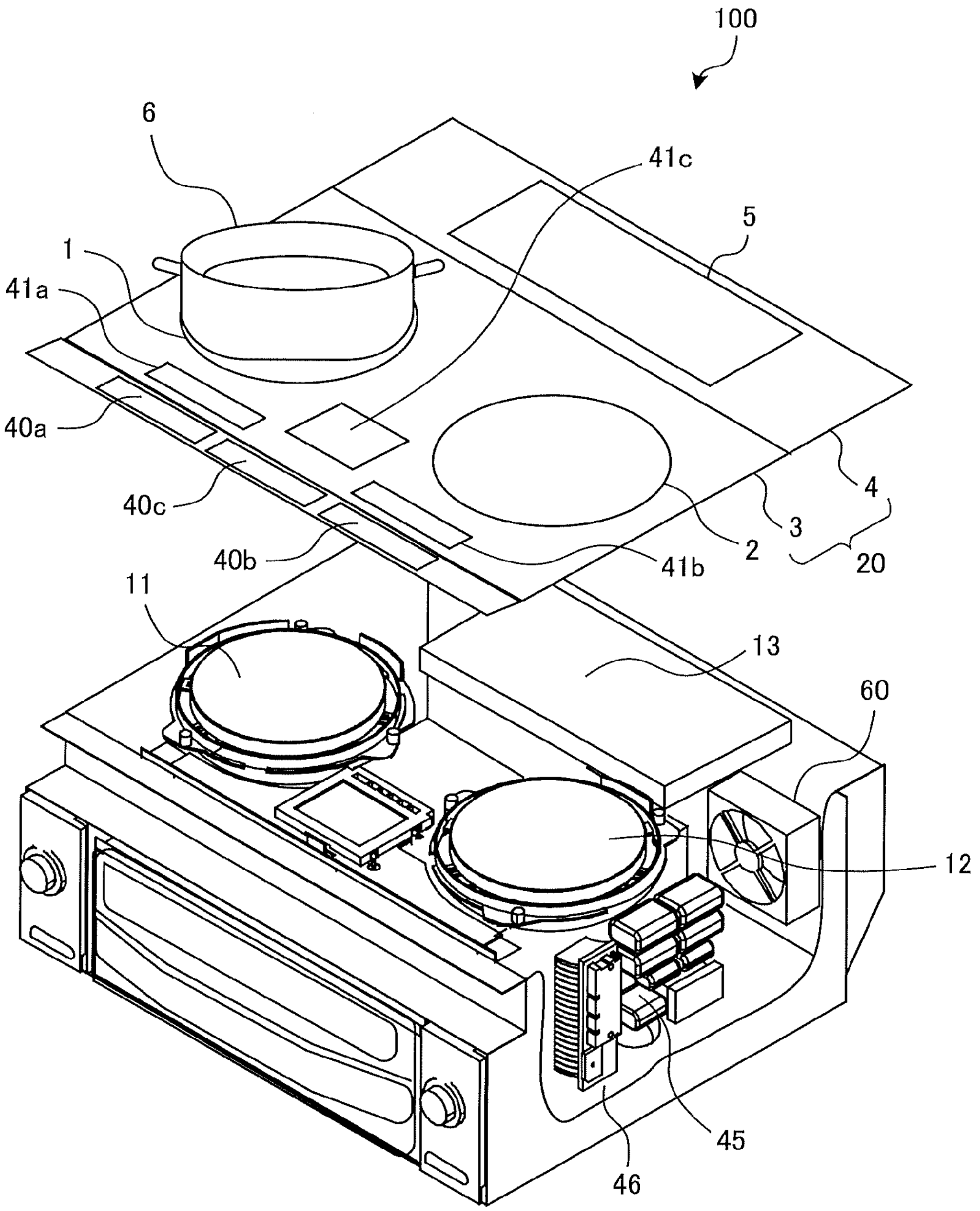
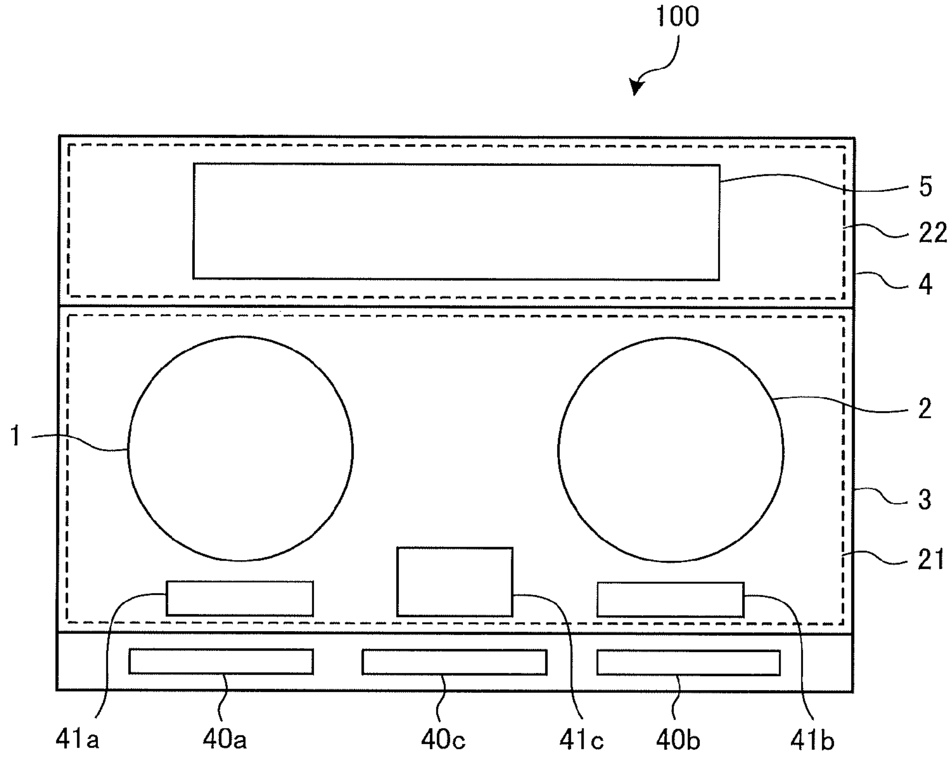


FIG. 3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2
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21
41a
40a
40c
41c
40b
41b

FIG. 4

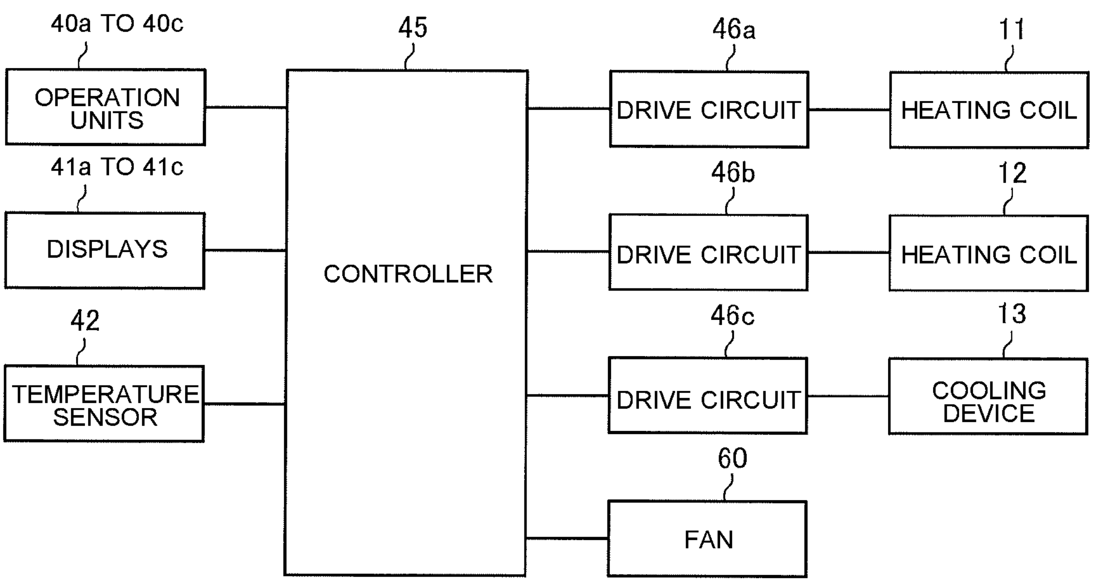

40a TO 40c
OPERATION UNITS
41a TO 41c
DISPLAYS
42
TEMPERATURE SENSOR
45
CONTROLLER
46a
DRIVE CIRCUIT
46b
DRIVE CIRCUIT
46c
DRIVE CIRCUIT
60
FAN
11
HEATING COIL
12
HEATING COIL
13
COOLING DEVICE

FIG. 5

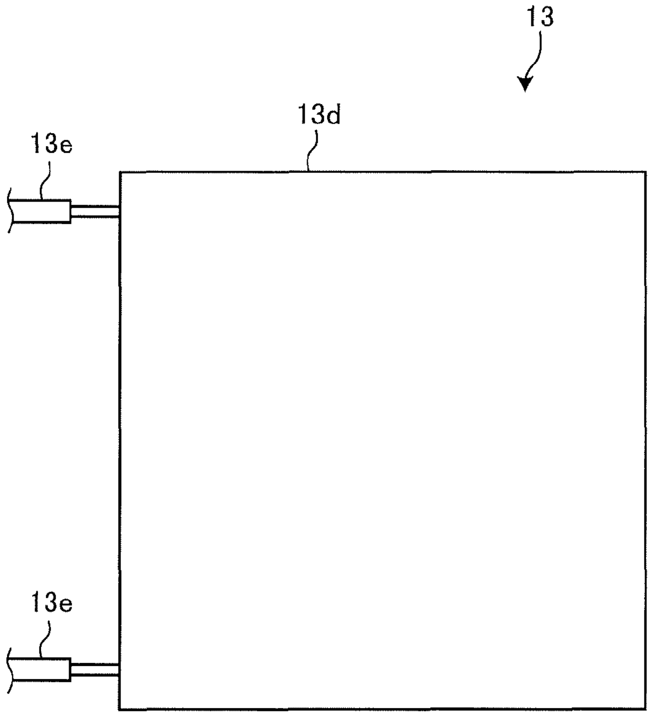


FIG. 6

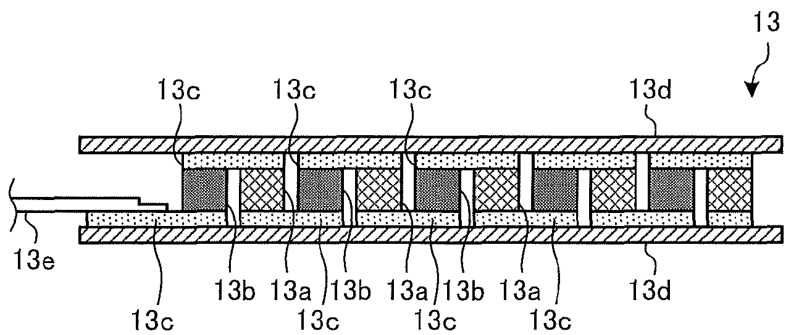


FIG. 7

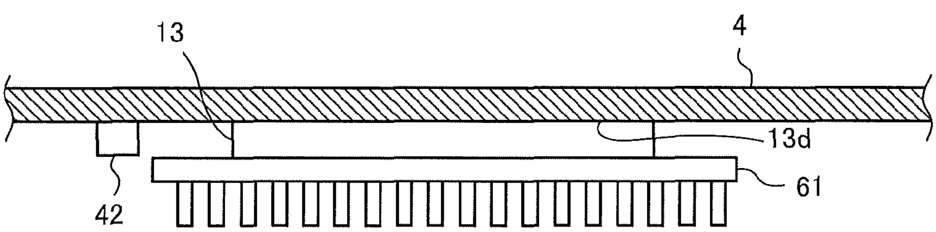


FIG. 8

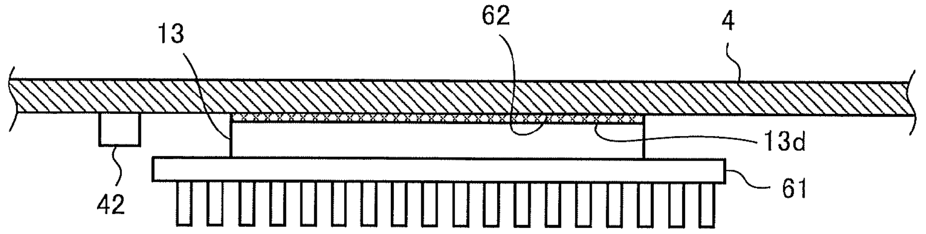


FIG. 9

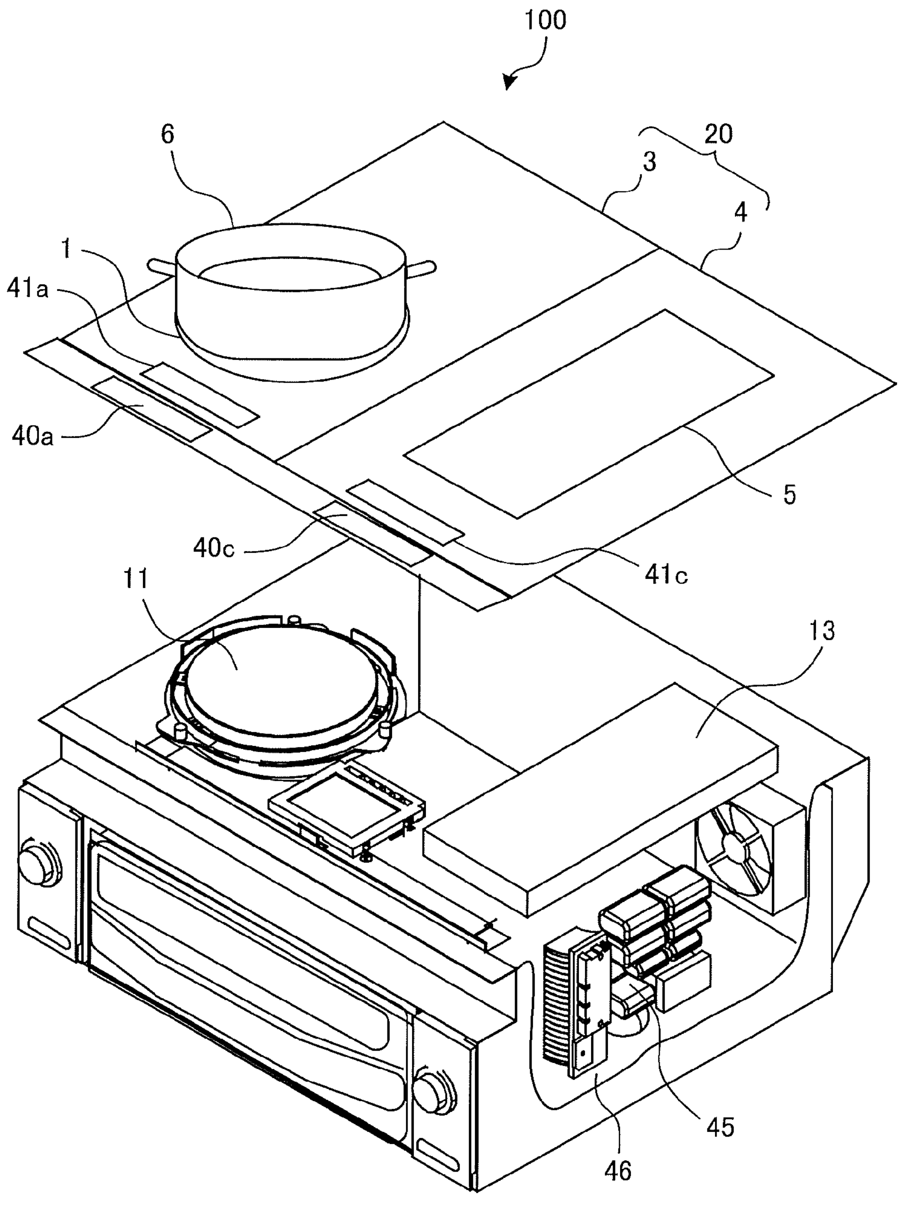
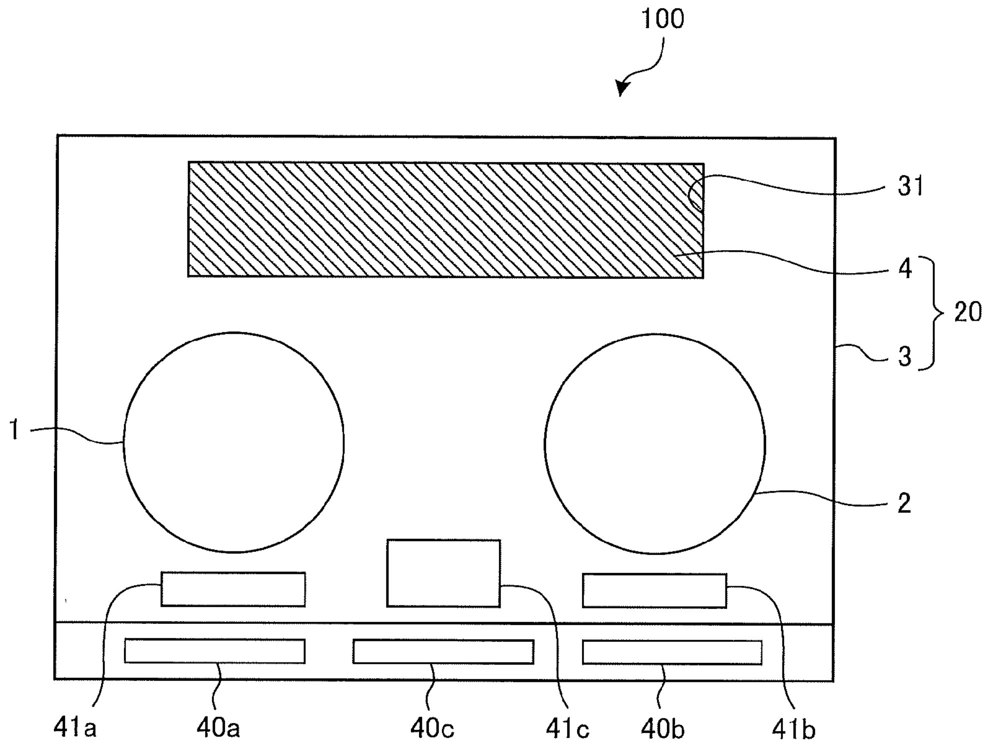


FIG. 10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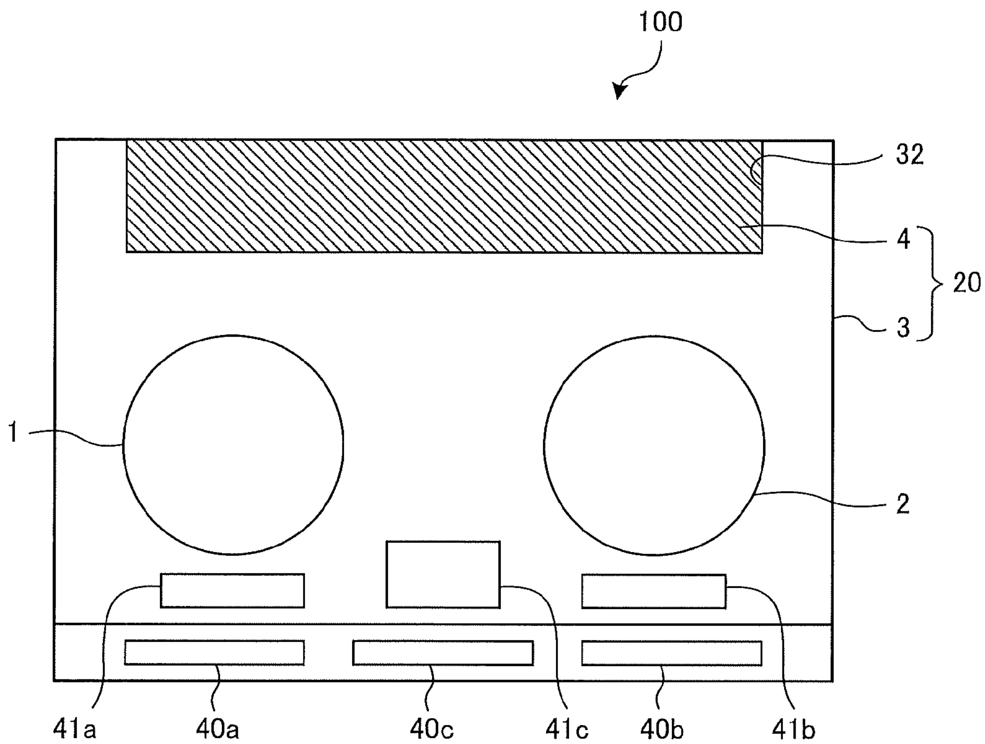
41b

FIG. 11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3
1
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40c
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40b
41b

FIG. 12

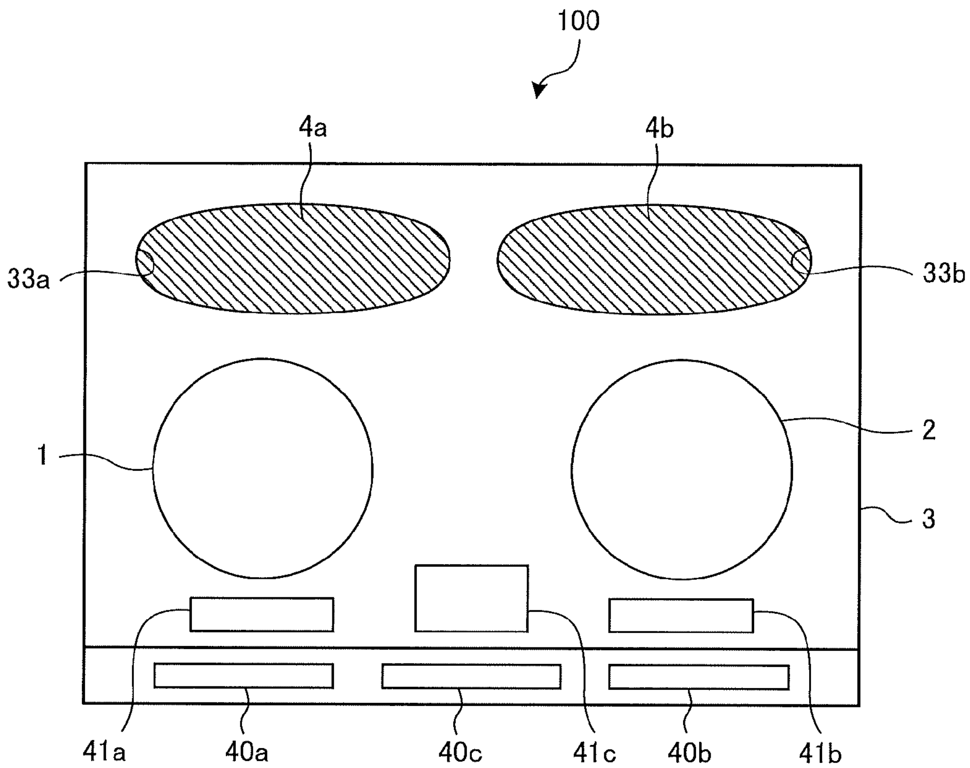


FIG. 13

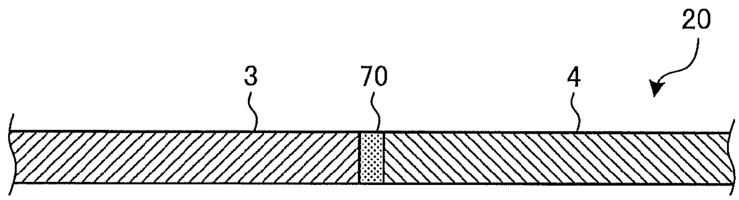


FIG. 14

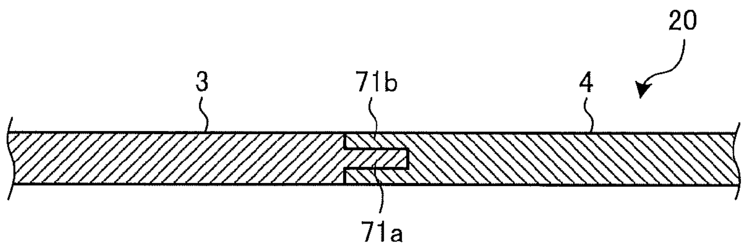
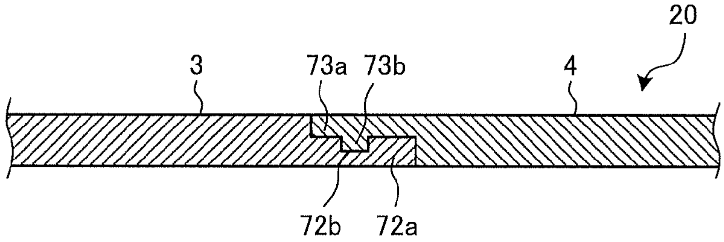


FIG. 15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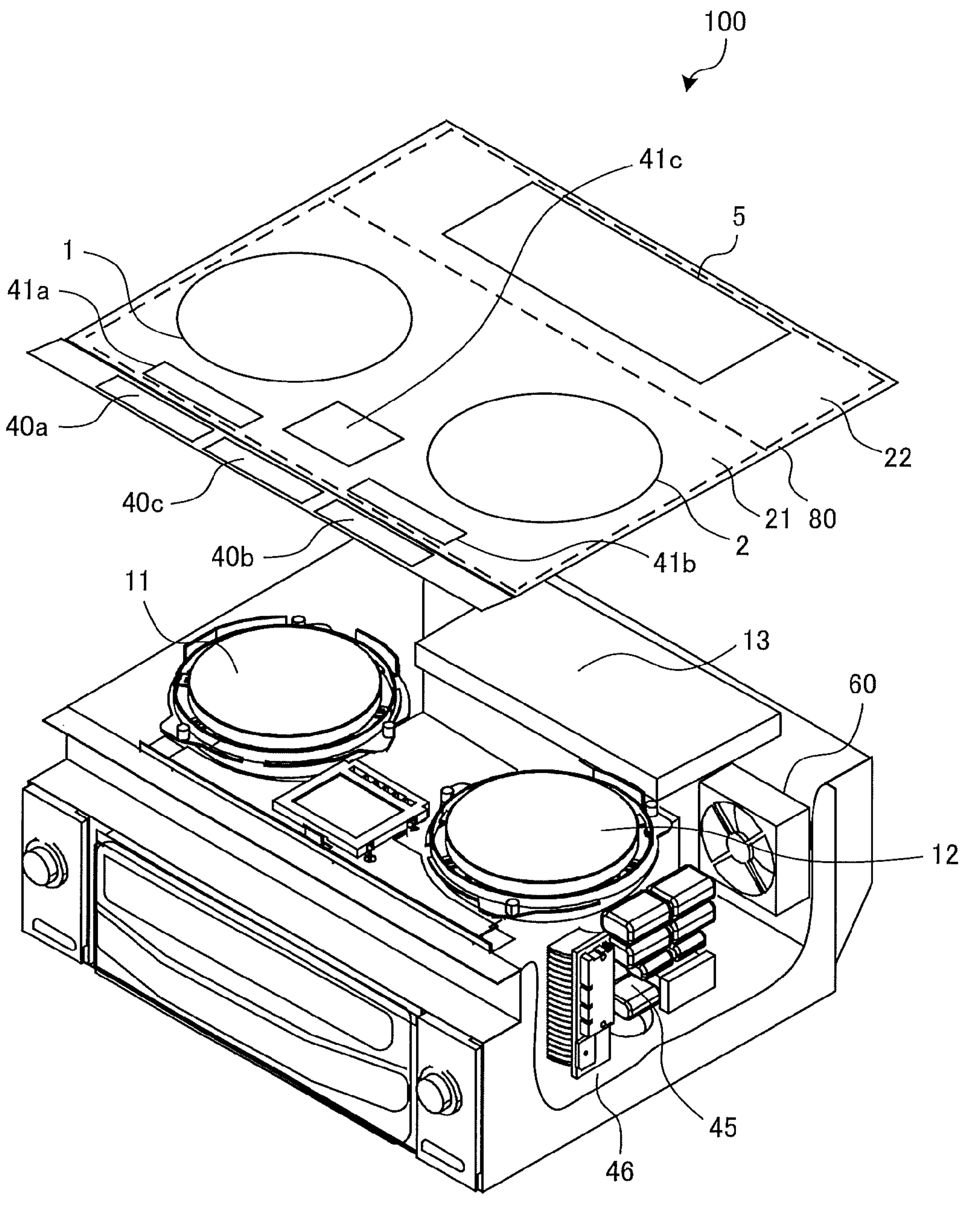
73b
4
72b
72a

FIG. 16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41c
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1
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40a
22
40c
21
80
2
40b
41b
11
13
60
12
45
46

FIG. 17

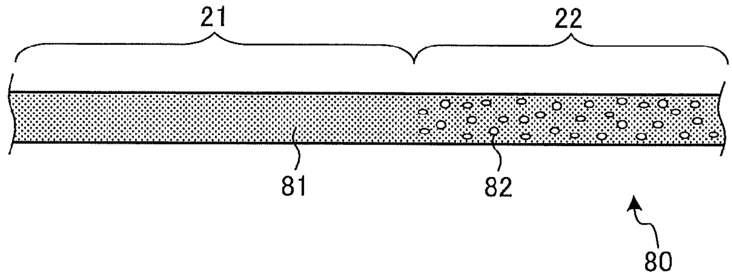


FIG. 18

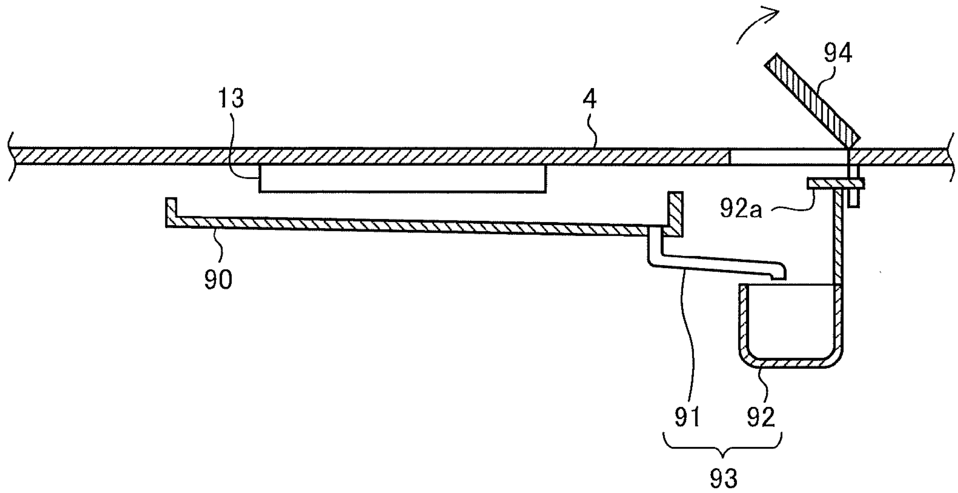
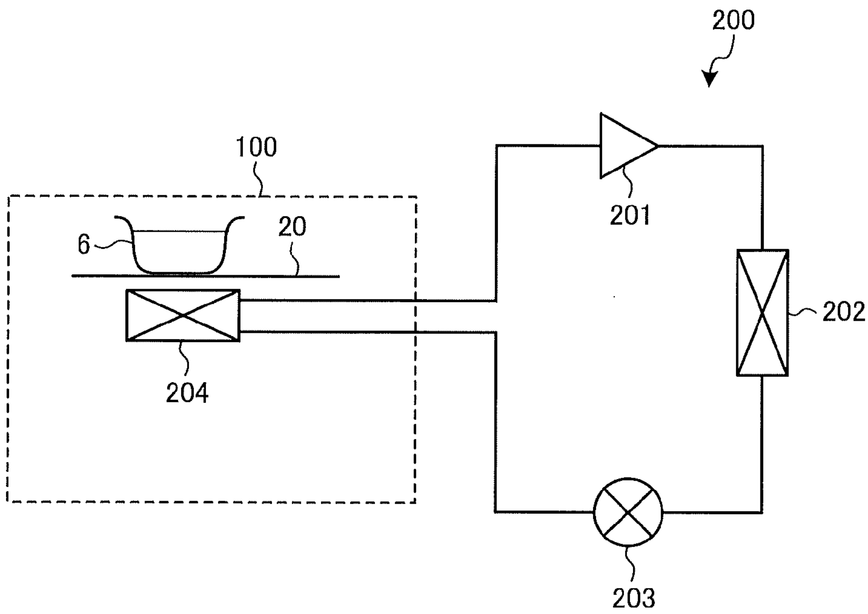


FIG. 19



INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2018/035676

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. 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)

Int. Cl. H05B6/12

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

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2018
Registered utility model specifications of Japan	1996-2018
Published registered utility model applications of Japan	1994-2018

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	JP 2008-287938 A (THE CHUGOKU ELECTRIC POWER CO., INC.) 27 November 2008, paragraphs [0024]-[0072], fig. 1-6 (Family: none)	1-14
Y	JP 2017-161138 A (PANASONIC INTELLECTUAL PROPERTY MANAGEMENT CO., LTD.) 14 September 2017, paragraphs [0017]-[0023], [0030], fig. 1-4 & US 2017/0261240 A1, paragraphs [0028]-[0034], [0041], fig. 1-4	1-14
Y	WO 2014/038230 A1 (NGK INSULATORS, LTD.) 13 March 2014, paragraphs [0008], [0009] & US 2014/0206522 A1, paragraphs [0008], [0009] & EP 2894137 A1	7-14

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

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10.12.2018	18.12.2018

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/035676

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2003-299435 A (MATSUSHITA REFRIGERATION CO.) 21 October 2003, paragraph [0048], fig. 1-4 (Family: none)	14
Y	JP 2008-096054 A (GAC CORP.) 24 April 2008, paragraph [0040], fig. 1-6 (Family: none)	14
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REFERENCES CITED IN THE DESCRIPTION

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