



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
31.10.2018 Bulletin 2018/44

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

(21) Application number: **17168251.1**

(22) Date of filing: **26.04.2017**

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

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(54) **INDUCTIVE COOKING DEVICE WITH OVERHEATING PROTECTION AND METHOD THEREOF**

(57) The present invention provides an inductive cooking device (100, 200) comprising a glass plate (101, 201) for carrying a number of cooking vessels (237), a number of induction coils (106, 107, 108, 109, 235, 236) arranged under the glass plate (101, 201), a control unit (110) configured to control a current (111) through the induction coils (106, 107, 108, 109, 235, 236) depending at least on a predefined power level (112), a hollow layer (115) filled with a cooling liquid (225), the hollow layer (115) being arranged under the glass plate (101, 201)

and above the induction coils (106, 107, 108, 109, 235, 236) and comprising a first liquid inlet (116, 216) on a first frame side (117) and a second liquid inlet (118, 218) on a second frame side (119), wherein the first frame side (117) is opposite to the second frame side (119), and a rod (120, 220) arranged inside of the hollow layer (115) movable from the first frame side (117) to the second frame side (119). Further, the present invention provides a respective method.

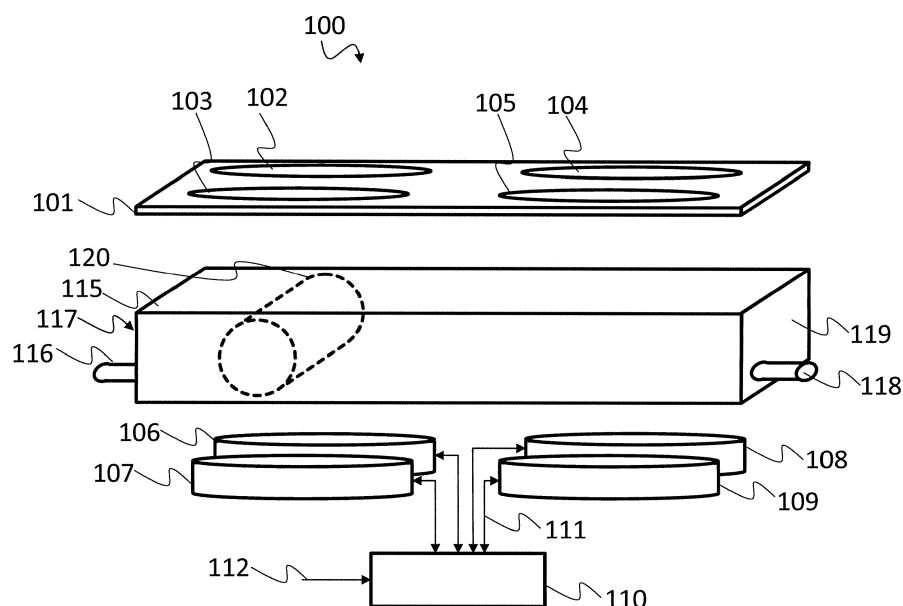


Fig. 1

Description**TECHNICAL FIELD**

5 [0001] The invention relates to an inductive cooking device and a respective method.

BACKGROUND

10 [0002] Although applicable to any system that uses energy transfer via induction to heat an element, the present invention will be mainly described in combination with induction cookers.

[0003] Induction cookers are usually used to heat cooking vessels by magnetic induction. Usually a high frequency power signal is provided to an induction coil. This generates a magnetic field around the induction coil, which is magnetically coupled to a conductive or ferromagnetic cooking vessel, such as a pan, placed over the induction coil. The magnetic field then generates eddy currents in the cooking vessel, causing the cooking vessel to heat.

15 [0004] If the cooking vessel heats up that heat may be transferred via the cooking vessel bottom surface into the ceramic glass that carries the cooking vessel. With increasing time of use the heat that is transferred from the cooking vessel to the ceramic glass will increase and the temperature of the ceramic glass may reach a critical point.

[0005] A person touching such a heated ceramic glass may perceive the heat as uncomfortable. Further, touch sensors may be embedded in the ceramic glass. Such touch sensors however may be susceptible to heat induced sensitivity loss.

20 [0006] Accordingly, there is a need for an improved cooling for induction cookers.

SUMMARY OF THE INVENTION

25 [0007] The present invention provides an inductive cooking device with the features of claim 1 and a method with the features of claim 9.

[0008] Therefore it is provided:

30 - An inductive cooking device comprising a glass plate for carrying a number, i.e. one or more, of cooking vessels, a number of induction coils arranged under the glass plate, a control unit configured to control a current through the induction coils depending at least on a predefined power level, a hollow layer filled with a cooling liquid, the hollow layer being arranged under the glass plate and above the induction coils and comprising a first liquid inlet on a first frame side and a second liquid inlet on a second frame side, wherein the first frame side is opposite to the second frame side, and a rod arranged inside of the hollow layer movable from the first frame side to the second frame side.

35 [0009] Further, it is provided:

40 - A method for operating an inductive cooking device with a glass plate for carrying a number, i.e. one or more, of cooking vessels, a number of induction coils arranged under the glass plate, and a control unit configured to control a current through the induction coils depending at least on a predefined power level, the method comprising moving a rod inside of a hollow layer filled with a cooling liquid, the hollow layer being arranged under the glass plate, and

45 effusing the liquid via a first liquid inlet on a first frame side and infusing the liquid via a second liquid inlet on a second frame side, or infusing the liquid via the first liquid inlet on a first frame side and effusing the liquid via the second liquid inlet on a second frame side based on the movement of the rod, wherein the first frame side is opposite to the second frame side.

[0010] The present invention acknowledges that active cooling devices with pumps and the like are complex and hard to maintain. Therefore, the present invention provides a passive cooling device for induction cooking devices that exploits or utilizes the physical circumstances in an induction cooking device.

50 [0011] The induction cooking device of the present invention comprises a glass plate that serves as a carrier for cooking devices and may further e.g. comprise touch sensitive buttons or the like for user input. Under the glass plate the induction coils are arranged such that when provided with a current they generate a magnetic field that induces eddy currents in the respective cooking vessel for heating up the cooking vessel.

[0012] The cooling of the glass plate is provided by the hollow layer that is arranged under the glass plate, i.e. between the glass plate and the induction coils. This means that the magnetic field that is generated by the induction coils flows through the hollow layer. The hollow layer is flooded or filled with a cooling liquid. Such a cooling liquid may e.g. have a high boiling point and a good thermal conductivity.

55 [0013] The hollow layer may be provided in contact with the glass plate. In addition, the glass plate may e.g. form the upper surface or cover layer of the hollow layer.

[0014] Therefore, if the glass plate heats up, e.g. because of a hot cooking vessel being positioned on the glass plate for an increased amount of time, the heat may transfer from the glass plate to the cooling liquid.

[0015] Finally, the cooling liquid is moved or pumped through inlets of the hollow layer by the movable rod. The inlets are provided on opposite edges or frame sides of a frame of the hollow layer. The rod may extend from one side of the hollow layer to the opposite side of the hollow layer and be arranged orthogonally to the axis between the sides that carry the inlets.

[0016] Moving the rod from the second frame side to the first frame side will therefore pump the cooling liquid through the first inlet and suck in the cooling liquid through the second inlet. Moving the rod in the opposite direction will pump the cooling liquid through the second inlet and suck in the cooling liquid through the first inlet. The first inlet and the second inlet may be coupled by liquid conduits. The cooling liquid may therefore cool down on its way through the liquid conduits.

[0017] Any means are possible for moving the rod, like e.g. motors or the like.

[0018] Further embodiments of the present invention are subject of the further subclaims and of the following description, referring to the drawings.

[0019] In an embodiment, the inductive cooking device may comprise a heat exchanging device, wherein a first inlet of the heat exchanging device may be coupled to the first liquid inlet and wherein a second inlet of the heat exchanging device may be coupled to the second liquid inlet.

[0020] The heat exchanging device may e.g. be provided as serpentine arrangement of the above mentioned liquid conduits. As alternative or in addition, any type of heat exchange device, e.g. with fins or the like may be provided.

[0021] The heat exchanging device supports the cooling of the glass plate by more efficiently cooling down the heated cooling liquid that is circulated through the heat exchanging device.

[0022] In a further embodiment, the rod may comprise a seal against the top surface of the hollow layer and a seal against the bottom surface of the hollow layer.

[0023] The term "seal" in this context is to be understood as any means that reduce the amount of cooling liquid that may flow or squeeze around the edges of the rod instead of being pumped through the respective inlets. Such a seal may in a simple form comprise rod being dimensioned such that the gaps between the rod and the inner surfaces of the hollow layer are small enough to reduce the liquid flow around the edges.

[0024] However, the seal may e.g. also comprise a brush, a lamellar brush, a rubber lip or the like.

[0025] In another embodiment, the rod may comprise a magnetic material.

[0026] As already explained above, the magnetic field caused by a current through the induction coils flows through the glass plate and the hollow layer. If the rod is provided at least in part with a magnetic material, the magnetic field will cause a magnetic force to act on the rod. The rod will therefore be moved by the magnetic field that is present in an induction cooking device anyway, without the need to provide a dedicated drive unit.

[0027] In an embodiment, the inductive cooking device may comprise a first conductor on a third frame side of the hollow layer and a second conductor on a fourth frame side of the hollow layer. In addition, the third frame side may be parallel to the fourth frame side, and the third frame side and the fourth frame side may be orthogonally arranged with respect to the first frame side and the second frame side.

[0028] The frame sides of the hollow layer that are parallel to the movement of the rod in the hollow layer are provided with electrical contacts. Such electrical contacts may e.g. comprise current bars or the like. If the cooling liquid is electrically non-conductive, the current bars may be provided on an inside wall of the frame of the hollow layer without any electrical isolation. As an alternative, e.g. for use with electrically conductive cooling liquids, the electrical contacts may e.g. comprise retractable cables that may contact the rod on its ends and be electrically isolated against the cooling liquid.

[0029] In a further embodiment, the rod may comprise a first electrical contact on a first end configured to contact the first conductor and a second electrical contact on a second end configured to contact the second conductor.

[0030] If the rod is electrically connected to the electrical conductors on its ends, it is possible to provide an electric current through the rod. If an electric current flows through the rod while a magnetic field is provided by the induction coils, a Lorenz force will affect the rod and effectively drag the rod from the first frame side to the second frame side or vice versa.

[0031] In an embodiment, the inductive cooking device may comprise a controllable current source configured to provide an electrical current through the first conductor and the rod and the second conductor.

[0032] The controllable current source may e.g. be used by a control unit of the induction cooking device to only provide an electric current through the rod, when it is needed. The need for active cooling of the glass plate may e.g. only arise after a certain time of high power operation of a cooking vessel spot of the induction cooking device or a continued use of all cooking vessel spots of the induction cooking device. The conditions under which the active cooling may be necessary may be determined e.g. during development or in the prototyping phase of the induction cooking device. The control unit may e.g. store the details of these conditions in a memory and control the current source accordingly.

[0033] In another embodiment, the inductive cooking device may comprise a position sensor configured to detect the

position of the rod, wherein the control unit may be configured to control the direction of the current through the induction coils based on the position of the rod.

[0034] The direction in which the Lorentz force acts on the rod depends on two variables, namely the direction of the current through the rod and the direction of the magnetic field. With the arrangement of the induction coils under the glass plate, it is possible to generate a magnetic field that is vertical to the surface of the glass plate directed into the glass plate or out of the glass plate.

[0035] If the magnetic field is continuously directed in the same direction, the rod will arrive at the first frame side or the second frame side and stop moving. It is therefore necessary to detect the rod when it arrives at the first or the second frame side and reverse the direction of the magnetic field that is generated by the induction coils.

[0036] The position sensor may be any type of sensor that may detect the presence of the rod either on the first frame side or the second frame side. Such a position sensor may e.g. be a switch provided on the respective frame side. As an alternative such a position sensor may also comprise an optical or sound based distance sensor or a hall-type sensor.

[0037] Therefore, it may reliably be detected when the rod reaches the first or second frame side and the direction of the rod may be reversed.

[0038] Since the cooling liquid that is effused last into the respective inlet is directly infused into the hollow layer when the direction of the rod is reversed that cooling liquid may heat up, since it does not reach the heat exchanging device.

[0039] Therefore, diffusors may be provided at the inlets that diffuse the cooling liquid when it is infused into the hollow layer and therefore mix the cooling liquid in the hollow layer to provide a uniform heat distribution in the cooling liquid.

BRIEF DESCRIPTION OF THE DRAWINGS

[0040] For a more complete understanding of the present invention and advantages thereof, reference is now made to the following description taken in conjunction with the accompanying drawings. The invention is explained in more detail below using exemplary embodiments which are specified in the schematic figures of the drawings, in which:

Fig. 1 shows a block diagram of an embodiment of an inductive cooking device according to the present invention;

Fig. 2 shows a block diagram of another embodiment of an inductive cooking device according to the present invention;

Fig. 3 shows another block diagram of the embodiment of an inductive cooking device according to the present invention of Fig. 2;

Fig. 4 shows another block diagram of the embodiment of an inductive cooking device according to the present invention of Fig. 2; and

Fig. 5 shows a flow diagram of an embodiment of a method according to the present invention.

[0041] In the figures like reference signs denote like elements unless stated otherwise.

DETAILED DESCRIPTION OF THE DRAWINGS

[0042] Fig. 1 shows a block diagram of an inductive cooking device 100. The inductive cooking device 100 comprises a glass plate 101. In the glass plate 101 there are four cooking vessel spots 102, 103, 104, 105, on which cooking vessels may be placed, when using the inductive cooking device 100. Under the glass plate 101 a hollow layer 115 is provided and under the hollow layer 115 four induction coils 106, 107, 108, 109 are provided that correspond to the cooking vessel spots 102, 103, 104, 105. A control unit 110 is coupled to the induction coils 106, 107, 108, 109 and provides driving current 111 to the induction coils 106, 107, 108, 109. The control unit 110 may e.g. receive a power level command from a user that uses the inductive cooking device 100 and adapt the driving current 111 accordingly.

[0043] It is understood, that even though shown with a gap in-between, the glass plate 101 and the hollow layer 115 may be provided touching each other. It is further possible that the glass plate 101 forms the upper layer or cover for the hollow space in the hollow layer 115.

[0044] The hollow layer 115 comprises a hollow space in between a frame. On a first frame side 117 a first liquid inlet 116 is provided. A second liquid inlet 118 is provided on the second frame side 119. Inside of the hollow layer 115 is a rod 120 movably arranged such that the rod 120 may move from the first frame side 117 to the second frame side 119. The rod 120 is shown as round rod 120. It is understood, that any shape may be chosen for the rod 120. The rod 120 may e.g. be chosen with a square shape or the like. The rod may be sealed against the top surface or cover of the hollow layer 115 and against the bottom surface or cover of the hollow layer 115. The seal may be provided by simply dimensioning the rod 120 such that only a minimum allowed amount of cooling liquid may pass between the rod 120 and the

top surface and the bottom surface respectively.

[0045] Any movement device for the rod 120 may be provided with the inductive cooking device 100. However, in the following an efficient arrangement will be described that does not require any additional drive for the rod 120.

[0046] The rod 120 may comprise a magnetic material or be provided with a current that flows from one end of the rod 120 to the other end of the rod 120. A dedicated current source may be provided in this regard. When the control unit 110 provides the induction coils 106, 107, 108, 109 with the current 111 a magnetic field will flow through the hollow layer 115 and the glass plate 101. This magnetic field will induce a magnetic force in the magnetic material or will generate a Lorentz force with the current that flows through the rod 120.

[0047] Therefore the rod 120 will move under the magnetic force or the Lorentz force without any additional external drive unit. The direction of movement of the rod 120 may simply be controlled by reversing the direction of the current 111 in the induction coils 106, 107, 108, 109. The control unit 110 may e.g. be configured to PWM (pulse-width modulation) modulate the current 111 for setting the power level and reverse the polarity for moving the rod 120 in the respective direction.

[0048] Position sensors may e.g. be provided that serve for detecting the position of the rod 120. The control unit 110 may then control the direction of the current 111 through the induction coils 106, 107, 108, 109 based on the sensor values and the sensed position of the rod 120.

[0049] Fig. 2 shows a block diagram of another inductive cooking device 200 in a top view. The inductive cooking device 200 comprises a glass plate 201 with cooking vessel spots 202, 203, 204, 205 and the hollow layer below the glass plate 201. Although not shown in the top view, it is understood that the inductive cooking device 200 also comprises induction coils under the cooking vessel spots 202, 203, 204, 205. The magnet field produced by each of the cooking vessel spots 202, 203, 204, 205 is shown as flowing into the glass plate 201 by an (X) in the centers of the cooking vessel spots 202, 203, 204, 205.

[0050] The hollow layer is connected via the first liquid inlet 216 and the second liquid inlet 218 to a heat exchanging device 227. The heat exchanging device 227 may e.g. comprise flattened pipes with a larger surface or the like.

[0051] Inside of the hollow layer on the left frame side and the right frame side electrical conductors 229, 230 are provided that allow providing an electric current 228 to the rod 220. The rod 220 may comprise electrical contacts 231, 232 on both ends to contact the conductors 229, 230. The electrical contacts 231, 232 may e.g. be sliding contacts. As an alternative the conductors 229, 230 may be provided as cables.

[0052] In Fig. 2 the force 233 is shown that is generated on the rod 220 if the current flows via the left conductor 229 through the rod 220 and the right conductor 230. The force 233 drags the rod 220 upward.

[0053] The movement of the rod 220 will then push the cooling liquid 225 into the first liquid inlet 216 through the heat exchanging device 227 and back into the hollow layer via the second liquid inlet 218.

[0054] Fig. 3 shows another block diagram of the inductive cooking device 200 of Fig. 2. In Fig. 3 the rod 220 is moved to the top, i.e. the first frame side with the first liquid inlet 216. Further, the direction of the magnetic field 226 is reversed.

[0055] It can be seen in Fig. 3 that the force 234 that now acts on the rod 220 is in the reverse direction as compared to the force 233 in Fig. 2. The rod 220 will therefore be dragged back to the second frame side with the second liquid inlet 218.

[0056] In Fig. 3 it is shown that the direction of the magnetic field 226 is reversed. It is however understood that as an alternative also the direction of the current 228 may be reversed.

[0057] Fig. 4 shows another diagram of the inductive cooking device 200 of Fig. 2 in a side view. It can be seen that the glass plate 201 and the hollow layer 215 are integrally formed as a single element and that the induction coils 235, 236 are provided below this single element.

[0058] It is understood, that the heat exchanging device 227 is just exemplarily shown next to the glass plate 201 and may in other embodiments be placed in any adequate place, such as e.g. below the hollow layer 215.

[0059] For sake of better understanding in the following description of method-based Fig. 5 the reference signs used in the above description of apparatus-based Figs. 1 - 4 will be maintained.

[0060] Fig. 5 shows a flow diagram of a method for operating an inductive cooking device 100, 200 with a glass plate 101, 201 for carrying a number of cooking vessels 237, a number of induction coils 106, 107, 108, 109, 235, 236 arranged under the glass plate 101, 201, and a control unit 110 configured to control a current 111 through the induction coils 106, 107, 108, 109, 235, 236 depending at least on a predefined power level 112.

[0061] The method comprises moving S1 a rod 120, 220 inside of a hollow layer 115 filled with a cooling liquid 225, the hollow layer 115 being arranged under the glass plate 101, 201. The method further comprises effusing S2 the liquid via a first liquid inlet 116 on a first frame side 117 of the hollow layer 115 and infusing the liquid via a second liquid inlet 118 on a second frame side 119 of the hollow layer 115, or infusing the liquid via the first liquid inlet 116 on the first frame side 117 and effusing the liquid via the second liquid inlet 118 on the second frame side 119 based on the movement of the rod 120, 220, wherein the first frame side 117 is opposite to the second frame side 119.

[0062] The method may also comprise circulating the effused liquid via a heat exchanging device 227.

[0063] Moving S1 the rod 120, 220 may comprise moving the rod 120, 220 sealed against a top surface of the hollow

layer 115 and sealed against a bottom surface of the hollow layer 115.

[0064] The rod 120, 220 may comprise a magnetic material and moving S1 the rod 120, 220 may comprise providing a magnetic field 226 around the rod 120, 220, especially via the induction coils 106, 107, 108, 109, 235, 236. Moving S1 the rod 120, 220 may further comprise conducting an electric current 228 through the rod 120, 220. The current 228 may be conducted to the rod 120, 220 e.g. via a first conductor 229 on a third frame side of the hollow layer 115 and a second conductor 230 on a fourth frame side of the hollow layer 115, wherein the third frame side is parallel to the fourth frame side, and wherein the third frame side and the fourth frame side are orthogonally arranged to the first frame side 117 and the second frame side 119.

[0065] Moving S1 the rod 120, 220 may further comprise providing a magnetic field 226 around the rod 120, 220, for example via the induction coils 106, 107, 108, 109, 235, 236.

[0066] In addition, the position of the rod 120, 220 may be detected and the direction of the current 111 through the induction coils 106, 107, 108, 109, 235, 236 may be controlled based on the position of the rod 120, 220.

[0067] Although specific embodiments have been illustrated and described herein, it will be appreciated by those of ordinary skill in the art that a variety of alternate and/or equivalent implementations exist. It should be appreciated that the exemplary embodiment or exemplary embodiments are only examples, and are not intended to limit the scope, applicability, or configuration in any way. Rather, the foregoing summary and detailed description will provide those skilled in the art with a convenient road map for implementing at least one exemplary embodiment, it being understood that various changes may be made in the function and arrangement of elements described in an exemplary embodiment without departing from the scope as set forth in the appended claims and their legal equivalents. Generally, this application is intended to cover any adaptations or variations of the specific embodiments discussed herein.

[0068] Thus, the present invention provides an inductive cooking device 100, 200 comprising a glass plate 101, 201 for carrying a number of cooking vessels 237, a number of induction coils 106, 107, 108, 109, 235, 236 arranged under the glass plate 101, 201, a control unit 110 configured to control a current 111 through the induction coils 106, 107, 108, 109, 235, 236 depending at least on a predefined power level 112, a hollow layer 115 filled with a cooling liquid 225, the hollow layer 115 being arranged under the glass plate 101, 201 and above the induction coils 106, 107, 108, 109, 235, 236 and comprising a first liquid inlet 116, 216 on a first frame side 117 and a second liquid inlet 118, 218 on a second frame side 119, wherein the first frame side 117 is opposite to the second frame side 119, and a rod 120, 220 arranged inside of the hollow layer 115 movable from the first frame side 117 to the second frame side 119. Further, the present invention provides a respective method.

List of reference signs

[0069]

100, 200	inductive cooking device
101, 201	glass plate
102, 103, 104, 105	cooking vessel spot
202, 203, 204, 205	cooking vessel spot
106, 107, 108, 109, 235, 236	induction coil
110	control unit
111, 211	current
112	power level
115	hollow layer
116, 216	first liquid inlet
117	first frame side
118, 218	second liquid inlet
119	second frame side
120, 220	rod

225	cooling liquid
226	magnetic field
227	heat exchanging device
228	current
229, 230	conductor
231, 232	electrical contact
233, 234	force

237 cooking vessel

x, y, z coordinate system axis

S1, S2 method steps

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Claims

1. Inductive cooking device (100, 200) comprising:

10 a glass plate (101, 201) for carrying a number of cooking vessels (237),
a number of induction coils (106, 107, 108, 109, 235, 236) arranged under the glass plate (101, 201),
a control unit (110) configured to control a current (111) through the induction coils (106, 107, 108, 109, 235, 236) depending at least on a predefined power level (112),
15 a hollow layer (115) filled with a cooling liquid (225), the hollow layer (115) being arranged under the glass plate (101, 201) and above the induction coils (106, 107, 108, 109, 235, 236) and comprising a first liquid inlet (116, 216) on a first frame side (117) and a second liquid inlet (118, 218) on a second frame side (119), wherein the first frame side (117) is opposite to the second frame side (119), and
a rod (120, 220) arranged inside of the hollow layer (115) movable from the first frame side (117) to the second frame side (119).

20 2. Inductive cooking device (100, 200) according to claim 1, comprising a heat exchanging device (227), wherein a first inlet of the heat exchanging device (227) is coupled to the first liquid inlet (116, 216) and wherein a second inlet of the heat exchanging device (227) is coupled to the second liquid inlet (118, 218).

25 3. Inductive cooking device (100, 200) according to any one of the preceding claims, wherein the rod (120, 220) comprises a seal against a top surface of the hollow layer (115) and a seal against a bottom surface of the hollow layer (115).

30 4. Inductive cooking device (100, 200) according to any one of the preceding claims, wherein the rod (120, 220) comprises a magnetic material.

35 5. Inductive cooking device (100, 200) according to any one of the preceding claims, comprising a first conductor (229) on a third frame side of the hollow layer (115) and a second conductor (230) on a fourth frame side of the hollow layer (115), wherein the third frame side is parallel to the fourth frame side, and wherein the third frame side and the fourth frame side are orthogonally arranged to the first frame side (117) and the second frame side (119).

6. Inductive cooking device (100, 200) according to claim 5, wherein the rod (120, 220) comprises on a first end a first electrical contact (231) configured to contact the first conductor (229) and on a second end a second electrical contact (232) configured to contact the second conductor (230).

40 7. Inductive cooking device (100, 200) according to claim 6, comprising a controllable current source configured to provide an electrical current (228) through the first conductor (229) and the rod (120, 220) and the second conductor (230).

45 8. Inductive cooking device (100, 200) according to any one of the preceding claims, comprising a position sensor configured to detect the position of the rod (120, 220), wherein the control unit (110) is configured to control the direction of the current (111) through the induction coils (106, 107, 108, 109, 235, 236) based on the position of the rod (120, 220).

50 9. Method for operating an inductive cooking device (100, 200) with a glass plate (101, 201) for carrying a number of cooking vessels (237), a number of induction coils (106, 107, 108, 109, 235, 236) arranged under the glass plate (101, 201), and a control unit (110) configured to control a current (111) through the induction coils (106, 107, 108, 109, 235, 236) depending at least on a predefined power level (112), the method comprising:

55 moving (S1) a rod (120, 220) inside of a hollow layer (115) filled with a cooling liquid (225), the hollow layer (115) being arranged under the glass plate (101, 201), and
effusing (S2) the liquid via a first liquid inlet (116, 216) on a first frame side (117) of the hollow layer (115) and infusing the liquid via a second liquid inlet (118, 218) on a second frame side (119) of the hollow layer (115),

or infusing the liquid via the first liquid inlet (116, 216) on the first frame side (117) and effusing the liquid via the second liquid inlet (118, 218) on the second frame side (119) based on the movement of the rod (120, 220), wherein the first frame side (117) is opposite to the second frame side (119).

- 5 **10.** Method according to claim 9, comprising circulating the effused liquid via a heat exchanging device (227).
11. Method according to any one of the preceding claims 9 and 10, wherein moving the rod (120, 220) comprises moving the rod (120, 220) sealed against a top surface of the hollow layer (115) and sealed against a bottom surface of the hollow layer (115).
- 10 **12.** Method according to any one of the preceding claims 9 to 11, wherein the rod (120, 220) comprises a magnetic material and moving the rod (120, 220) comprises providing a magnetic field (226) around the rod (120, 220), especially via the induction coils (106, 107, 108, 109, 235, 236).
- 15 **13.** Method according to any one of the preceding claims 9 to 12, wherein moving the rod (120, 220) comprises conducting an electric current (228) through the rod (120, 220), especially via a first conductor (229) on a third frame side of the hollow layer (115) and a second conductor (230) on a fourth frame side of the hollow layer (115), wherein the third frame side is parallel to the fourth frame side, and wherein the third frame side and the fourth frame side are orthogonally arranged to the first frame side (117) and the second frame side (119).
- 20 **14.** Method according to claim 13, wherein moving the rod (120, 220) further comprises providing a magnetic field (226) around the rod (120, 220), especially via the induction coils (106, 107, 108, 109, 235, 236).
- 25 **15.** Method according to any one of the preceding claims 12 to 14, comprising detecting the position of the rod (120, 220) and controlling the direction of the current (111) through the induction coils (106, 107, 108, 109, 235, 236) based on the position of the rod (120, 220).

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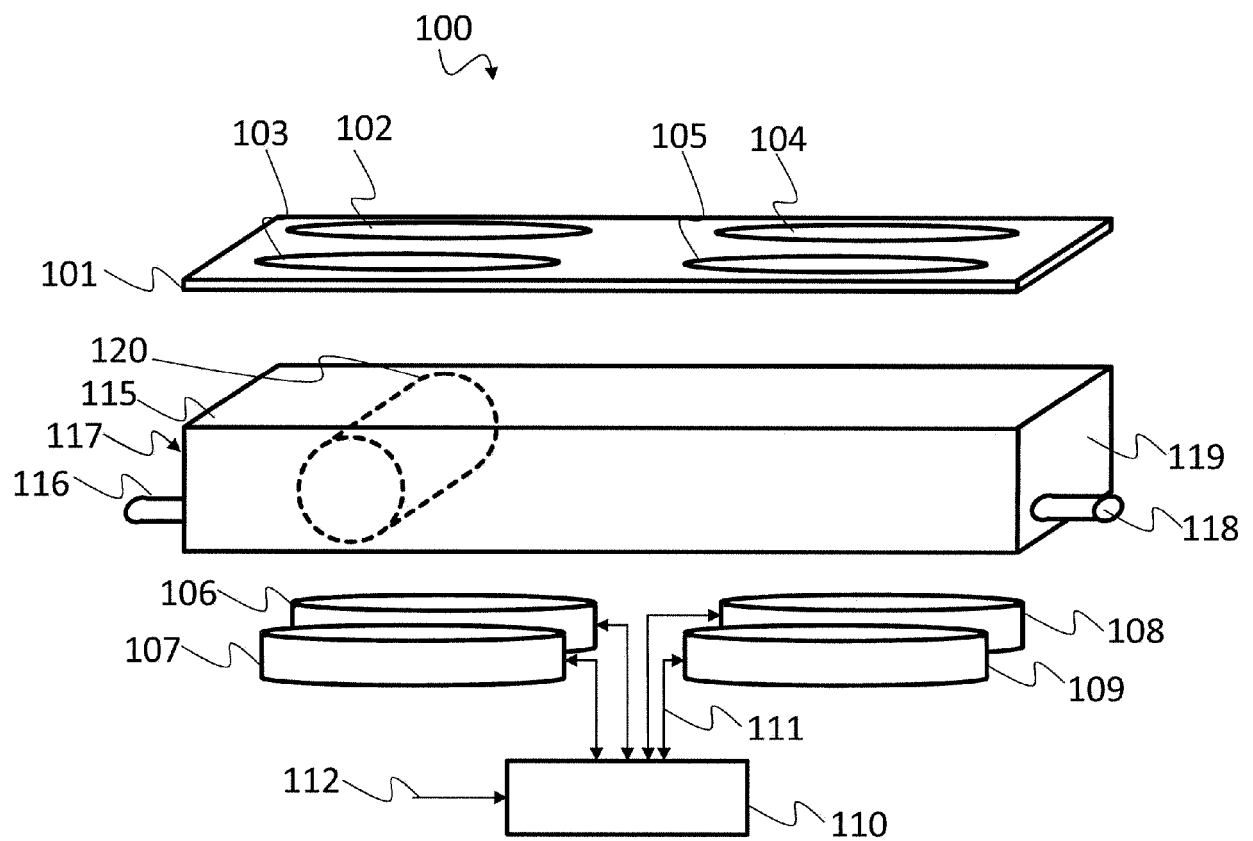


Fig. 1

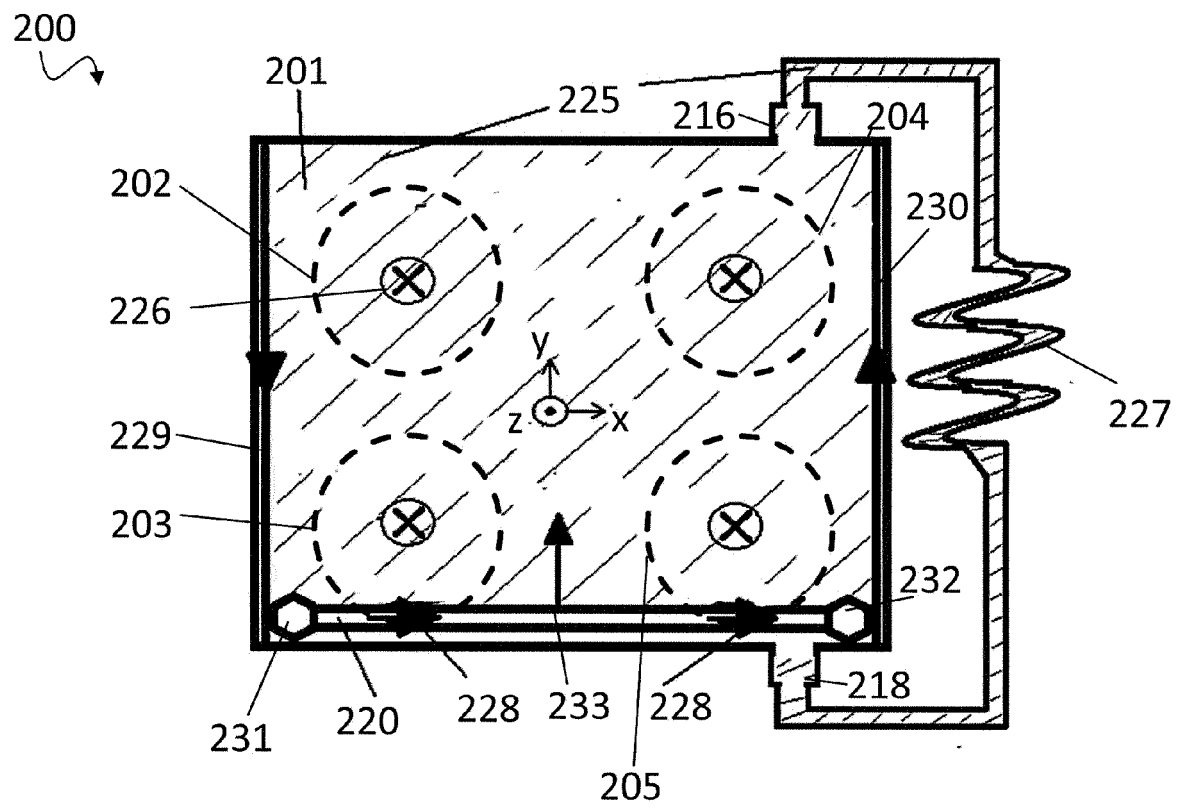


Fig. 2

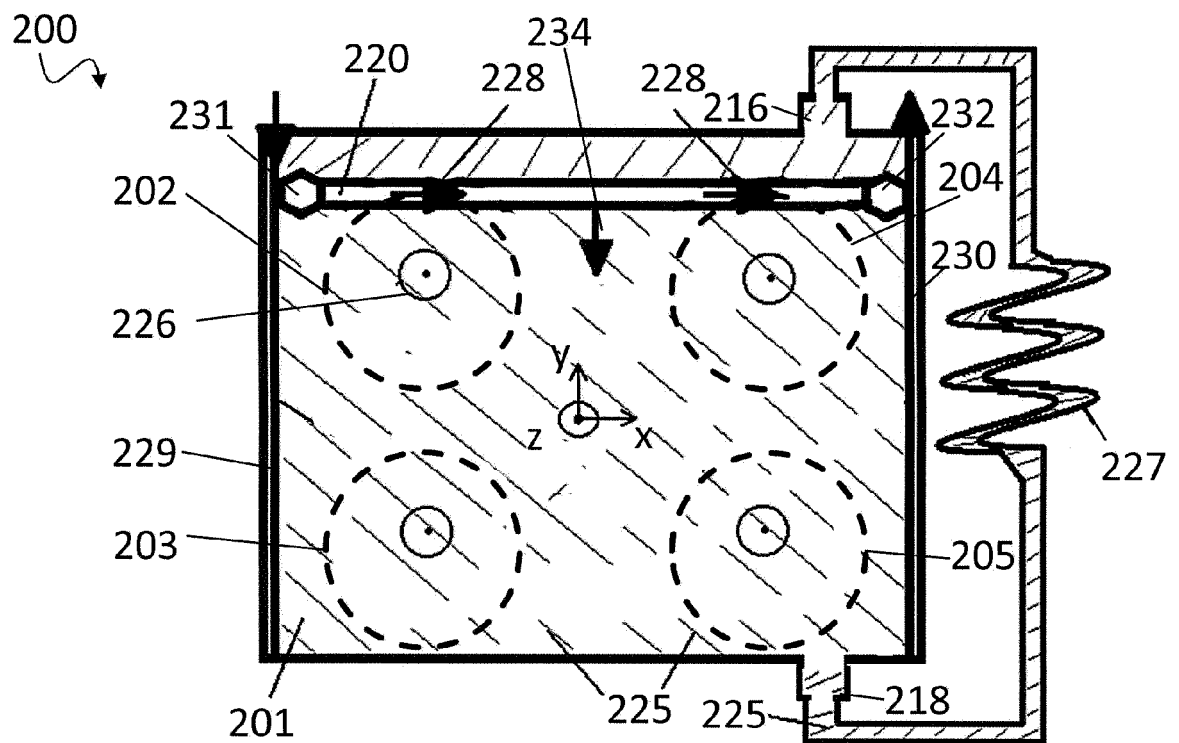


Fig. 3

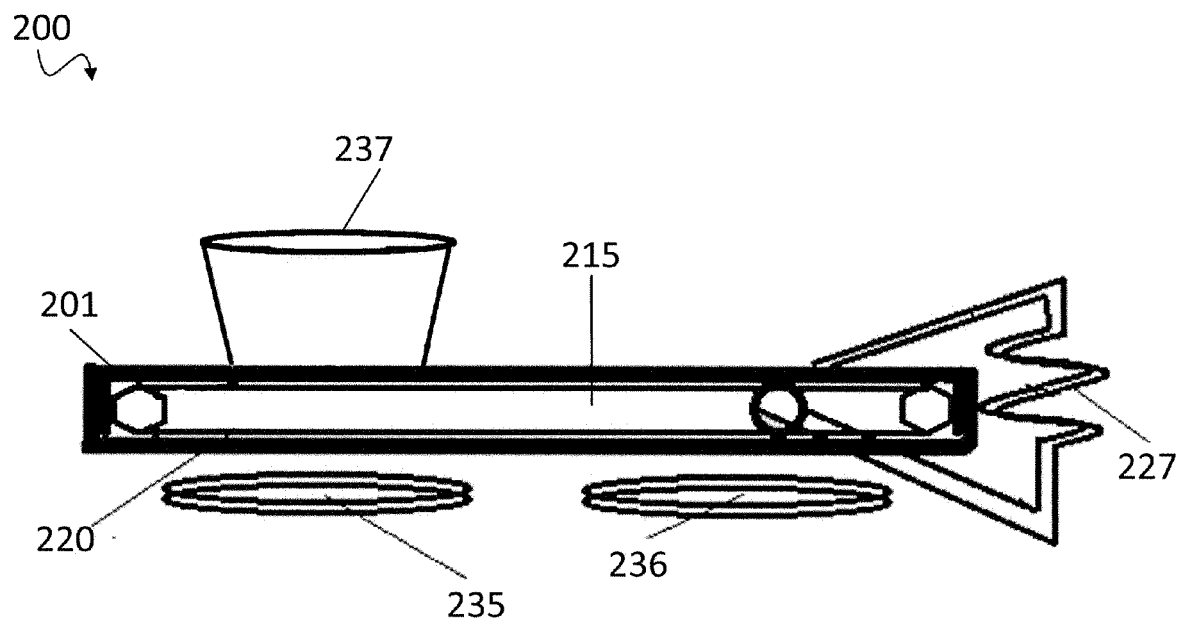


Fig. 4

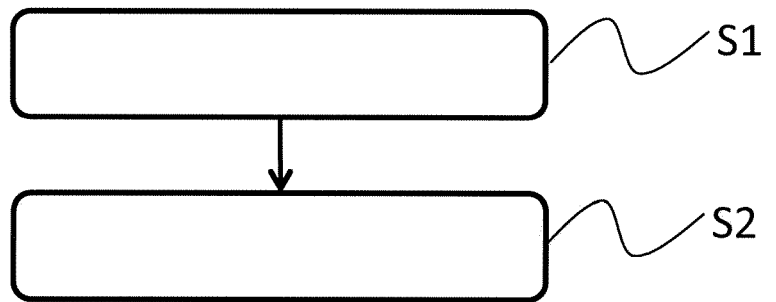


Fig. 5



EUROPEAN SEARCH REPORT

 Application Number
 EP 17 16 8251

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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