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(54) INDUCTIVE COOKING DEVICE AND METHOD

(57) The present invention provides an inductive cooking device (100, 200, 300) comprising a glass plate (101) comprising a number of cooking vessel spots (102, 103, 104, 105, 302), a number of liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306) arranged in or under the glass plate (101) for every one of the cooking vessel spots (102, 103, 104, 105, 302), and a measurement device (110, 210) configured to circulate a liquid (111, 211) containing magnetic particles (221, 222, 223, 224, 225) in the liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306) and to determine the presence of a ferromagnetic cooking vessel on the respective cooking vessel spot (102, 103, 104, 105, 302) based on the amount of magnetic particles (221, 222, 223, 224, 225) flowing into the liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306) and the amount of magnetic particles (221, 222, 223, 224, 225) flowing out of the liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306). Further, the present invention provides a respective method.

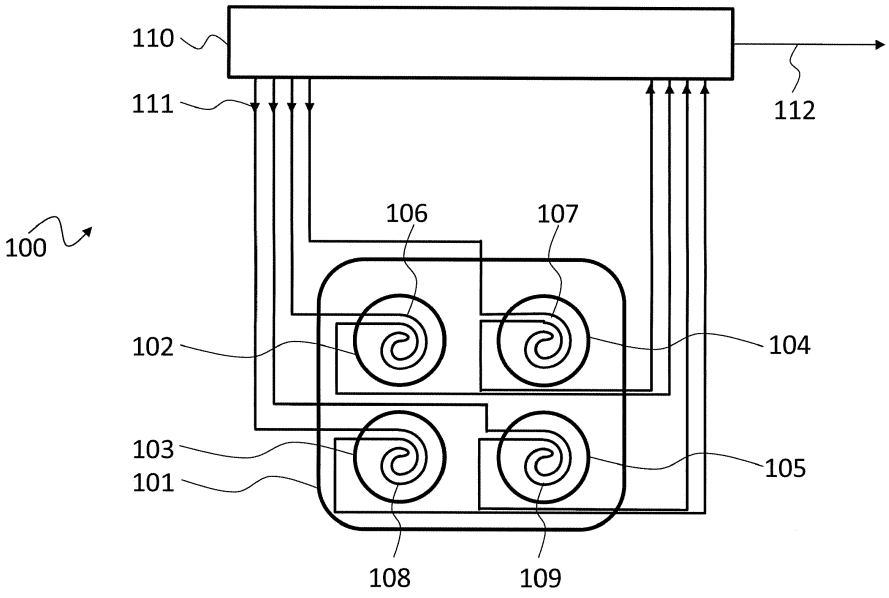

Fig. 1

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Description

TECHNICAL FIELD

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

BACKGROUND

[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.

[0004] In induction cookers a coil of copper wire exists under the cooking zone and the cooking vessel must be placed according to the coil boundary, wherein the coil diameter determines the cooking zone. Usually a ceramic glass is placed between the coil and the cooking vessel. Induction cookers operate only with cooking vessels that are made of ferromagnetic material and the heating process should only start if a user puts a ferromagnetic material on the cooking zone.

[0005] The size, position and magnetic property of cooking vessel that is placed on the cooking surface affect the working power and heat transferred to the cooking vessel. In addition, using inappropriate cooking vessels (e.g. small size, non-ferromagnetic vessels) and placing them incorrectly may cause malfunctions (e.g. coil saturation, over-voltage) and damage an induction cooker. Therefore, cooking vessel detection is an important function in induction cookers.

[0006] Accordingly, there is a need for an improved cooking vessel detection in induction cookers.

SUMMARY Of THE INVENTION

[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:

- An inductive cooking device comprising a glass plate comprising a number, i.e. one or more, of cooking vessel spots, a number of liquid conduits arranged in or under the glass plate for every one of the cooking vessel spots, and a measurement device configured to circulate a liquid containing magnetic particles in the liquid conduits and to determine the presence of a ferromagnetic cooking vessel on the respective cooking vessel spot based on the amount of magnetic particles flowing into the liquid conduits and the amount of magnetic particles flowing out of the liquid conduits.

[0009] Further, it is provided:

- A method for determining presence of a cooking vessel on an inductive cooking device, the method comprising circulating a liquid containing magnetic particles in liquid conduits in or under a glass plate of the inductive cooking device, the glass plate comprising a number of cooking vessel spots, measuring an amount of magnetic particles flowing into the liquid conduits and an amount of magnetic particles flowing out of the liquid conduits, and determining the presence of a ferromagnetic cooking vessel on one of the cooking vessel spots based on the amount of magnetic particles flowing into the liquid conduits and the amount of magnetic particles flowing out of the liquid conduits.

[0010] Common vessel detection algorithms for induction cookers rely on the analysis of electrical power consumption of the induction coils of the induction cooker. The present invention instead is based on a separate or dedicated sensor arrangement that improves the information that can be retrieved about a cooking vessel on the glass plate of the inductive cooking device.

[0011] The present invention provides liquid conduits in or on the glass plate. "In the glass plate" refers to the liquid conduits being integrated into the glass plate. "On the glass plate" refers to the liquid conduits being arranged e.g. as tubes on a surface, e.g. the lower surface, of the glass plate. Such tubes may be easily arranged on any glass plate without complex manufacturing processes. Further, such tubes may e.g. be magnetically shielded section-wise where necessary.

[0012] The glass plate may comprise cooking vessel spots. Such cooking vessel spots may e.g. be visual indications of the spots at which the cooking vessels should be placed. The induction cooking device may comprise single or multiple induction coils arranged under the cooking vessel spots that are used to transfer energy to a cooking vessel placed on

the glass plate.

[0013] As an alternative, the glass plate may comprise only one cooking vessel spot. This means that the whole surface of the glass plate may be used to place cooking vessels. A plurality of small induction coils may be provided under the glass plate and after detecting the position of the cooking vessel, the respective induction coils may be activated. With such induction cooking devices the user may freely place the cooking vessel on the glass plate.

[0014] The measurement device may now use the liquid conduits as a sensor or sensing device to detect the presence of a cooking vessel on the glass plate. The measurement device may e.g. circulate a liquid containing magnetic particles in the liquid conduits. The liquid may e.g. be a ferrofluid or a magnetorheological fluid. Ferrofluids may comprise nanoscale ferromagnetic, or ferrimagnetic, particles suspended in a carrier fluid. Magnetorheological fluid particles may be on the micrometre-scale.

[0015] The magnetic particles in the liquid will be influenced, e.g. attracted, by any ferromagnetic cooking vessel placed on the glass plate over the liquid conduits. Magnetic particles may therefore be held in the liquid conduits. The amount of magnetic particles that enter the liquid conduits may therefore be different to the amount of magnetic particles that exit the liquid conduits.

[0016] The measurement device may therefore determine the presence of a cooking vessel on the glass plate based on the amount of magnetic particles flowing into the liquid conduits and the number of magnetic particles flowing out of the liquid conduits.

[0017] The present invention therefore provides a direct measurement of the presence of a cooking vessel for inductive cooking devices, instead of the indirect measurements, which are e.g. based on the power or current consumption in the induction coils of the inductive cooking device.

[0018] It is understood that in this context the "cooking vessel" refers to a ferromagnetic cooking vessel as can be used with inductive cooking devices.

[0019] Further embodiments of the present invention are subject of the further subclaims and of the following description, referring to the drawings.

[0020] In an embodiment, the liquid conduits may be arranged at the cooking vessel spots in a nested manner.

[0021] "Nested" may e.g. refer to liquid conduits being circularly or square shaped and liquid conduits with larger diameter surrounding liquid conduits with smaller diameter. The largest-diameter liquid conduit may e.g. be as large as the cooking vessel spot.

[0022] Nesting the liquid conduits allows not only determining the presence of a cooking vessel on the glass plate of the inductive cooking device. With the help of the nested liquid conduits also the size of the cooking vessel may be determined.

[0023] If for example a cooking vessel is placed on the cooking vessel spot that is smaller than the spot size, only the inner liquid conduits may show a significant difference between the amount of magnetic particles flowing into the liquid conduits and the number of magnetic particles flowing out of the liquid conduits. The size of the cooking vessel may therefore be determined with a resolution that is determined by the distance between the single liquid conduits.

[0024] In an embodiment, the liquid conduits may comprise a circular shape, especially a circular segment-like shape.

[0025] Most cooking vessels comprise circular boundaries. Using circular shaped liquid conduits therefore allows adapting the sensing elements to the shape of the cooking vessels.

[0026] If the single liquid conduits only cover a segment of a circle, e.g. a 90° or a 180° degree segment, it is also possible to detect if a cooking vessel is placed off-center on the cooking vessel spot. If for example three levels of full circular liquid conduits are provided and a small cooking vessel is placed off-center on the cooking vessel spot, that cooking vessel may cover all three circular conduits and a large cooking vessel may be detected.

[0027] With segmented circular liquid conduits only the segments under the cooking vessel would show a significant difference in the amount of magnetic particles flowing into the liquid conduits and the number of magnetic particles flowing out of the liquid conduits.

[0028] Alternatively, a large cooking vessel spot may be provided with a plurality of small diameter liquid conduits that all comprise the same diameter. Small diameter refers to a diameter that is smaller than the surface of the cooking vessel spot such that a predetermined number of liquid conduits may be provided under the cooking vessel spot. The small diameter liquid conduits may e.g. comprise a diameter that is 1/10 - 1/2 of the diameter, length or height of the cooking vessel spot. Such small diameter liquid conduits may be provided next to each other, i.e. not nested.

[0029] The shape and size of a cooking vessel may then be detected by detecting the single liquid conduits with a significant difference in the amount of magnetic particles flowing into the liquid conduits and the number of magnetic particles flowing out of the liquid conduits.

[0030] This arrangement is especially adequate for inductive cooking devices that comprise a plurality of small induction coils under the glass plate that may be individually actuated. The cooking device may e.g. comprise induction coils of the size of the small diameter liquid conduits. The single liquid conduits may therefore serve as dedicated sensors for the single induction coils.

[0031] In an embodiment, the liquid conduits may comprise a rectangular shape, especially a rectangular segment-

like shape.

[0032] Rectangular shaped liquid conduits may e.g. be used with cooking vessel spots that comprise a rectangular shape for rectangular cooking vessels.

[0033] As an alternative, the rectangular liquid conduits may be provided with a small diameter as already explained for the circular shaped liquid conduits.

[0034] In another embodiment, the liquid conduits may be separately arranged on each of two halves of each one of the cooking vessel spots or on each of four quarter sections of each one of the cooking vessel spots.

[0035] As already explained above, arranging the liquid conduits in segments of the single cooking vessel spots allows detecting an off-center placed cooking vessel with a diameter that is smaller than the cooking vessel spot.

[0036] In an embodiment, the measurement device may comprise a liquid pump for pumping the liquid through the liquid conduits and an inlet sensor for sensing the amount of magnetic particles flowing into the liquid conduits and an outlet sensor for sensing the amount of magnetic particles flowing out of the liquid conduits.

[0037] The liquid pump may be any type of pump that is adequate for pumping the liquid through the liquid conduits. Such a pump may e.g. be actuated by an electric motor or the like.

[0038] The inlet and outlet sensors may be provided depending on the type of liquid used. If the liquid for example has magnetic particles that are retained in the liquid conduits if a ferromagnetic cooking vessel is placed on the glass plate, a hall-type sensor may be used to measure a magnetic field produced by the magnetic particles that enter and exit the liquid conduits.

[0039] If for example a magnetorheological fluid is used that fluid may change its viscosity and a flow meter may measure the amount of liquid that flows through the liquid conduits for a given pump power setting.

[0040] In a further embodiment, the measurement device may comprise a control unit configured to determine the presence of a cooking vessel on one of the cooking vessel spots and/or determine the magnetic properties of the cooking vessel based on the difference and/or relation of the amount of magnetic particles flowing into the liquid conduits and the amount of magnetic particles flowing out of the liquid conduits.

[0041] Depending on the specific arrangement of the liquid conduits and the glass plate in a specific embodiment of the inductive cooking device, the difference or relation of the amount of magnetic particles flowing into the liquid conduits and the amount of magnetic particles flowing out of the liquid conduits may e.g. be experimentally determined during development of the inductive cooking device or during a calibration procedure during the manufacturing of the inductive cooking device.

[0042] In an embodiment, the control unit may be configured to determine a position of a cooking vessel on one of the cooking vessel spots based on which of the liquid conduits of the respective cooking vessel spot comprise a difference of the amount of magnetic particles flowing into the respective liquid conduits and the amount of magnetic particles flowing out of the respective liquid conduits.

[0043] As already indicated above, different or only some of the liquid conduits of a single cooking vessel spot may comprise a significant difference in the amount of magnetic particles flowing into the liquid conduits and the number of magnetic particles flowing out of the liquid conduits with a cooking vessel present on the cooking vessel spot. This may e.g. happen if the cooking vessel is smaller than the cooking vessel spot.

[0044] The control unit may therefore determine an off-center placement of a small cooking vessel by determining which of the liquid conduits of one single cooking vessel spot comprise such a significant difference in the amount of magnetic particles flowing into the liquid conduits and the number of magnetic particles flowing out of the liquid conduits.

BRIEF DESCRIPTION OF THE DRAWINGS

[0045] 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 a block diagram of another embodiment of an inductive cooking device according to the present invention; and

Fig. 4 shows a block diagram of an embodiment of a method according to the present invention.

[0046] In the figures like reference signs denote like elements unless stated otherwise.

DETAILED DESCRIPTION OF THE DRAWINGS

[0047] Fig. 1 shows a block diagram of an embodiment of an inductive cooking device 100. The inductive cooking device 100 comprises a glass plate 101. In the glass plate 101 four cooking vessel spots 102, 103, 104, 105 are shown. The cooking vessel spots 102, 103, 104, 105 may e.g. be marked on the glass plate 101 for a user to determine where to place a cooking vessel on the glass plate 101. Under or in the glass plate 101 there are arranged liquid conduits 106, 107, 108, 109. Although not shown, it is understood that under the glass plate 101, especially under the cooking vessel spots 102, 103, 104, 105 there may be induction coils arranged that generate a magnetic field to transfer energy to a cooking vessel.

[0048] The liquid conduits 106, 107, 108, 109 are coupled to a measurement device 110. The measurement device 110 circulates a liquid 111 containing magnetic particles through the single liquid conduits 106, 107, 108, 109. The measurement device 110 may determine the presence of a cooking vessel on one of the liquid conduits 106, 107, 108, 109 by comparing the amount of magnetic particles flowing into the single liquid conduits 106, 107, 108, 109 and the amount of magnetic particles flowing out of the single liquid conduits 106, 107, 108, 109.

[0049] As already explained above the presence of ferromagnetic cooking vessel will cause the magnetic particles to be attracted and slowed down. The number of magnetic particles that flow into the liquid conduits 106, 107, 108, 109 in the presence of a ferromagnetic cooking vessel will therefore be higher than the number of magnetic particles that flow out of the liquid conduits 106, 107, 108, 109.

[0050] The measurement device 110 may then e.g. determine the presence of a cooking vessel and provide a respective presence signal 112 if the difference or the relation between the amount of magnetic particles flowing into the single liquid conduits 106, 107, 108, 109 and the amount of magnetic particles flowing out of the single liquid conduits 106, 107, 108, 109 is above a predefined threshold value.

[0051] In the inductive cooking device 100 a single liquid conduit 106, 107, 108, 109 is shown for every one of the cooking vessel spots 102, 103, 104, 105. It is understood, that this arrangement is just an example and that any other arrangement may also be provided.

[0052] The liquid conduits 106, 107, 108, 109 may e.g. comprise another shape, like e.g. a rectangular shape or any shape that is adequate for a specific inductive cooking device 100.

[0053] In addition for a single cooking vessel spot 102, 103, 104, 105 a plurality, i.e. more than one, of liquid conduits 106, 107, 108, 109 may be provided. A plurality of liquid conduits 106, 107, 108, 109 for a single cooking vessel spot 102, 103, 104, 105 allow determining the exact position of the cooking vessel on the respective cooking vessel spot 102, 103, 104, 105 by evaluating, which of the liquid conduits 106, 107, 108, 109 are influenced by the cooking vessel. This will be described in more detail with regard to Figs. 2 and 3.

[0054] Fig. 2 shows a block diagram of another inductive cooking device 200, wherein only one cooking vessel spot (not separately referenced) is exemplarily shown. It is understood that the principle explained with regard to Fig. 2 may be used with any number of cooking vessel spots.

[0055] The liquid conduits 206, 207, 208, 209, 215, 216, 217, 218, 219, 220 of the inductive cooking device 200 are segmented into two groups of semicircular shaped left liquid conduits 206, 207, 208, 209, 215 and right liquid conduits 216, 217, 218, 219, 220. Semicircular shaped refers to the single liquid conduits 206, 207, 208, 209, 215, 216, 217, 218, 219, 220 comprising a semicircular upstream section and a semicircular downstream section that run approximately in parallel.

[0056] In addition, the liquid conduits 206, 207, 208, 209, 215, 216, 217, 218, 219, 220 are nested. On each group the inner liquid conduits 215, 220 are surrounded on the respective side by liquid conduits 209, 219 with larger diameter, which again are surrounded on the respective side by liquid conduits 208, 218 with larger diameter and so on. The nesting comprises exemplary five levels of liquid conduits 206, 207, 208, 209, 215, 216, 217, 218, 219, 220.

[0057] The inductive cooking device 200 also comprises an exemplary measurement device 210. The measurement device 210 comprises a liquid pump 230 for the left group of liquid conduits 206, 207, 208, 209, 215 and a liquid pump 231 for the right group of liquid conduits 216, 217, 218, 219, 220. The liquid pumps 230, 231 serve for pumping a liquid 211 containing magnetic particles 221, 222, 223, 224, 225 through the liquid conduits 206, 207, 208, 209, 215, 216, 217, 218, 219, 220. The magnetic particles 221, 222, 223, 224, 225 are just exemplarily shown. It is understood that the magnetic particles 221, 222, 223, 224, 225 may be homogenously distributed in the liquid 211.

[0058] The measurement device 210 further comprises an inlet sensor 232 and an outlet sensor 234 for the left group of liquid conduits 206, 207, 208, 209, 215, and an inlet sensor 233 and an outlet sensor 235 for the right group of liquid conduits 216, 217, 218, 219, 220.

[0059] The inlet sensors 232, 233 serve for measuring the amount of magnetic particles 221, 222, 223, 224, 225 that flow into the single liquid conduits 206, 207, 208, 209, 215, 216, 217, 218, 219, 220. The outlet sensors 234, 235 serve for measuring the amount of magnetic particles 221, 222, 223, 224, 225 that flow out of the single liquid conduits 206, 207, 208, 209, 215, 216,217,218,219,220.

[0060] With the information of the inlet sensors 232, 233 and the information of the outlet sensors 234, 235 the

measurement device 210, e.g. a controller or processor, may determine the presence of a cooking vessel. With the arrangement of the inductive cooking device 200 the measurement device 210 may further determine the approximate position of a cooking vessel by determining, which of the liquid conduits 206, 207, 208, 209, 215, 216, 217, 218, 219, 220 are influenced by the cooking vessel. Further, by determining the total amount of magnetic particles 221, 222, 223, 224, 225 that are withheld inside of the liquid conduits 206, 207, 208, 209, 215, 216, 217, 218, 219, 220 as a result of the cooking vessel being placed on the cooking vessel spot, the ferromagnetic properties of the cooking vessel may be determined.

[0061] Fig. 3 shows a block diagram of another inductive cooking device 300. Only one cooking vessel spot 302 is shown. The cooking vessel spot 302 comprises a rectangular shape. For this single cooking vessel spot 302 a plurality of fifteen liquid conduits 306 (only one is referenced) are provided.

[0062] The inductive cooking device 300 may e.g. comprise a single induction coil for every one of the fifteen liquid conduits 306. The size and shape of the induction coils may e.g. approximately correspond to the size and shape of the liquid conduits 306. A controller (not shown) of the inductive cooking device 300 may separately actuate the single induction coils.

[0063] With the arrangement of the inductive cooking device 300 it is therefore possible to determine where the cooking vessel is placed on the cooking vessel spot 302 and which size the cooking vessel has. The controller may then specifically actuate only the induction coils that are covered by the cooking vessel. Cooking vessels of any size smaller than the outer circumference of the cooking vessel spot 302 may therefore be freely placed on the cooking vessel spot 302. The inductive cooking device 300 may e.g. only comprise a single cooking vessel spot 302 that is as large as the glass plate of the inductive cooking device 300.

[0064] For sake of better understanding the reference signs used above throughout the explanation regarding apparatus-based Figs. 1 - 3 will also be used in the below explanation of method-based Fig. 4.

[0065] Fig. 4 shows a block diagram of an embodiment of a method for determining presence of a cooking vessel on an inductive cooking device 100, 200, 300.

[0066] The method comprises circulating S1 a liquid 111, 211 containing magnetic particles 221, 222, 223, 224, 225 in liquid conduits 106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306 under or in a glass plate 101 of the inductive cooking device 100, 200, 300, the glass plate 101 comprising a number of cooking vessel spots 102, 103, 104, 105, 302. The method further comprises measuring S2 an amount of magnetic particles 221, 222, 223, 224, 225 flowing into the liquid conduits 106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306 and an amount of magnetic particles 221, 222, 223, 224, 225 flowing out of the liquid conduits 106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306.

[0067] Finally, the method comprises determining S3 the presence of a ferromagnetic cooking vessel on one of the cooking vessel spots 102, 103, 104, 105, 302 based on the amount of magnetic particles 221, 222, 223, 224, 225 flowing into the liquid conduits 106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306 and the amount of magnetic particles 221, 222, 223, 224, 225 flowing out of the liquid conduits 106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306.

[0068] Circulating S1 may comprise circulating the liquid 111, 211 in liquid conduits 106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306 that are arranged at the cooking vessel spots 102, 103, 104, 105, 302 in a nested manner. Circulating S1 may also comprise circulating the liquid 111, 211 in liquid conduits 106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306 that comprise a circular shape, especially a circular segment-like shape, or that comprise a rectangular shape, especially a rectangular segment-like shape.

[0069] Circulating S1 may further comprise circulating the liquid 111, 211 in liquid conduits 106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306 that are separately arranged on each of two halves of each one of the cooking vessel spots 102, 103, 104, 105, 302 or on each of four quarter sections of each one of the cooking vessel spots 102, 103, 104, 105, 302.

[0070] Determining S3 may comprise pumping the liquid 111, 211 through the liquid conduits 106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306 and sensing the amount of magnetic particles 221, 222, 223, 224, 225 flowing into the liquid conduits 106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306 and sensing the amount of magnetic particles 221, 222, 223, 224, 225 flowing out of the liquid conduits 106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306.

[0071] Determining S3 may also comprise determining the presence of a cooking vessel on one of the cooking vessel spots 102, 103, 104, 105, 302 and/or determining the magnetic properties of the cooking vessel based on the difference and/or relation of the amount of magnetic particles 221, 222, 223, 224, 225 flowing into the liquid conduits 106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306 and the amount of magnetic particles 221, 222, 223, 224, 225 flowing out of the liquid conduits 106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306. Determining S3 may further comprise determining a position of a cooking vessel on one of the cooking vessel spots 102, 103, 104, 105, 302 based on which of the liquid conduits 106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306 of the respective cooking vessel spot 102, 103, 104, 105, 302 comprise a difference of the amount

of magnetic particles 221, 222, 223, 224, 225 flowing into the respective liquid conduits 106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306 and the amount of magnetic particles 221, 222, 223, 224, 225 flowing out of the respective liquid conduits 106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306.

[0072] 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.

[0073] Thus, the present invention provides an inductive cooking device 100, 200, 300 comprising a glass plate 101 comprising a number of cooking vessel spots 102, 103, 104, 105, 302, a number of liquid conduits 106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306 arranged in or under the glass plate 101 for every one of the cooking vessel spots 102, 103, 104, 105, 302, and a measurement device 110, 210 configured to circulate a liquid 111, 211 containing magnetic particles 221, 222, 223, 224, 225 in the liquid conduits 106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306 and to determine the presence of a ferromagnetic cooking vessel on the respective cooking vessel spot 102, 103, 104, 105, 302 based on the amount of magnetic particles 221, 222, 223, 224, 225 flowing into the liquid conduits 106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306 and the amount of magnetic particles 221, 222, 223, 224, 225 flowing out of the liquid conduits 106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306. Further, the present invention provides a respective method.

List of reference signs

[0074]

100, 200, 300	Inductive cooking device
101	glass plate
102, 103, 104, 105, 302	cooking vessel spots
106, 107, 108, 109	liquid conduits
206, 207, 208, 209, 215	liquid conduits
216, 217, 218, 219, 220, 306	liquid conduits
110, 210	measurement device
111, 211	liquid
112	presence signal
221, 222, 223, 224, 225	magnetic particles
230, 231	liquid pump
232, 233	inlet sensor
234, 235	outlet sensor

S1 - S3 method steps

Claims

1. Inductive cooking device (100, 200, 300) comprising:

a glass plate (101) comprising a number of cooking vessel spots (102, 103, 104, 105, 302),
a number of liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306) arranged in or under the glass plate (101) for every one of the cooking vessel spots (102, 103, 104, 105, 302), and
a measurement device (110, 210) configured to circulate a liquid (111, 211) containing magnetic particles (221, 222, 223, 224, 225) in the liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306) and to determine the presence of a ferromagnetic cooking vessel on the respective cooking vessel spot (102, 103, 104, 105, 302) based on the amount of magnetic particles (221, 222, 223, 224, 225) flowing into the liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306) and the amount of magnetic particles (221, 222, 223, 224, 225) flowing out of the liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306).

2. Inductive cooking device (100, 200, 300) according to claim 1, wherein the liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306) are arranged at the cooking vessel spots (102, 103, 104, 105, 302) in a nested manner.

3. Inductive cooking device (100, 200, 300) according to any one of the preceding claims, wherein the liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306) comprise a circular shape, especially a circular segment-like shape.

4. Inductive cooking device (100, 200, 300) according to any one of the preceding claims, wherein the liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306) comprise a rectangular shape, especially a rectangular segment-like shape.

5. Inductive cooking device (100, 200, 300) according to any one of the preceding claims, wherein the liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306) are separately arranged on each of two halves of each one of the cooking vessel spots (102, 103, 104, 105, 302) or on each of four quarter sections of each one of the cooking vessel spots (102, 103, 104, 105, 302).

6. Inductive cooking device (100, 200, 300) according to any one of the preceding claims, wherein the measurement device (110, 210) comprises a liquid pump (230, 231) for pumping the liquid (111, 211) through the liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306) and an inlet sensor (232, 233) for sensing the amount of magnetic particles (221, 222, 223, 224, 225) flowing into the liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306) and an outlet sensor (234, 235) for sensing the amount of magnetic particles (221, 222, 223, 224, 225) flowing out of the liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306).

7. Inductive cooking device (100, 200, 300) according to any one of the preceding claims, wherein the measurement device (110, 210) comprises a control unit configured to determine the presence of a cooking vessel on one of the cooking vessel spots (102, 103, 104, 105, 302) and/or determine the magnetic properties of the cooking vessel based on the difference and/or relation of the amount of magnetic particles (221, 222, 223, 224, 225) flowing into the liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306) and the amount of magnetic particles (221, 222, 223, 224, 225) flowing out of the liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306).

8. Inductive cooking device (100, 200, 300) according to claim 7, wherein the control unit is configured to determine a position of a cooking vessel on one of the cooking vessel spots (102, 103, 104, 105, 302) based on which of the liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306) of the respective cooking vessel spot (102, 103, 104, 105, 302) comprise a difference of the amount of magnetic particles (221, 222, 223, 224, 225) flowing into the respective liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306) and the amount of magnetic particles (221, 222, 223, 224, 225) flowing out of the respective liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306).

9. Method for determining presence of a cooking vessel on an inductive cooking device (100, 200, 300), the method comprising:

circulating (S1) a liquid (111, 211) containing magnetic particles (221, 222, 223, 224, 225) in liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306) under or in a glass plate (101) of the inductive cooking device (100, 200, 300), the glass plate (101) comprising a number of cooking vessel spots (102, 103, 104, 105, 302),
measuring (S2) an amount of magnetic particles (221, 222, 223, 224, 225) flowing into the liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306) and an amount of magnetic particles (221, 222, 223, 224, 225) flowing out of the liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306), and
determining (S3) the presence of a ferromagnetic cooking vessel on one of the cooking vessel spots (102, 103, 104, 105, 302) based on the amount of magnetic particles (221, 222, 223, 224, 225) flowing into the liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306) and the amount of magnetic particles (221, 222, 223, 224, 225) flowing out of the liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306).

10. Method according to claim 9, wherein circulating (S1) comprises circulating the liquid (111, 211) in liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306) that are arranged at the cooking vessel spots (102, 103, 104, 105, 302) in a nested manner.

11. Method according to any one of the preceding claims 9 and 10, wherein circulating (S1) comprises circulating the liquid (111, 211) in liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306) that comprise a circular shape, especially a circular segment-like shape; and/or
wherein circulating (S1) comprises circulating the liquid (111, 211) in liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306) that comprise a rectangular shape, especially a rectangular segment-like shape.

12. Method according to any one of the preceding claims 9 to 11, wherein circulating (S1) comprises circulating the liquid (111, 211) in liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306) that are separately arranged on each of two halves of each one of the cooking vessel spots (102, 103, 104, 105, 302) or on each of four quarter sections of each one of the cooking vessel spots (102, 103, 104, 105, 302).

13. Method according to any one of the preceding claims 9 to 12, wherein determining (S3) comprises pumping the liquid (111, 211) through the liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306) and sensing the amount of magnetic particles (221, 222, 223, 224, 225) flowing into the liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306) and sensing the amount of magnetic particles (221, 222, 223, 224, 225) flowing out of the liquid conduits (106, 107, 108, 109, 206, 207,208,209,215,216,217,218,219,220,306).

14. Method according to any one of the preceding claims 9 to 13, wherein determining (S3) comprises determining the presence of a cooking vessel on one of the cooking vessel spots (102, 103, 104, 105, 302) and/or determining the magnetic properties of the cooking vessel based on the difference and/or relation of the amount of magnetic particles (221, 222, 223, 224, 225) flowing into the liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306) and the amount of magnetic particles (221, 222, 223, 224, 225) flowing out of the liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306).

15. Method according to claim 14, wherein determining (S3) comprises determining a position of a cooking vessel on one of the cooking vessel spots (102, 103, 104, 105, 302) based on which of the liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306) of the respective cooking vessel spot (102, 103, 104, 105, 302) comprise a difference of the amount of magnetic particles (221, 222, 223, 224, 225) flowing into the respective liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306) and the amount of magnetic particles (221, 222, 223, 224, 225) flowing out of the respective liquid conduits (106, 107, 108, 109, 206, 207, 208, 209, 215, 216, 217, 218, 219, 220, 306).

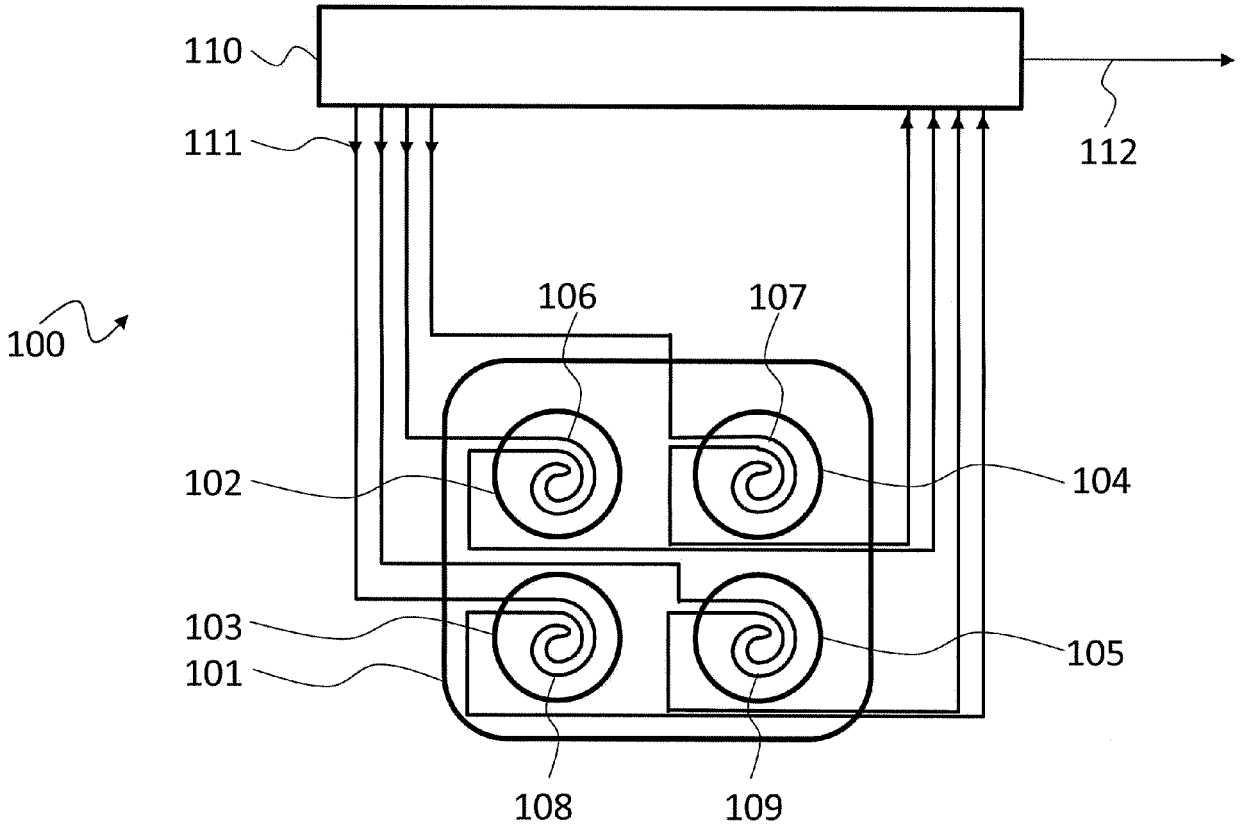

Fig. 1

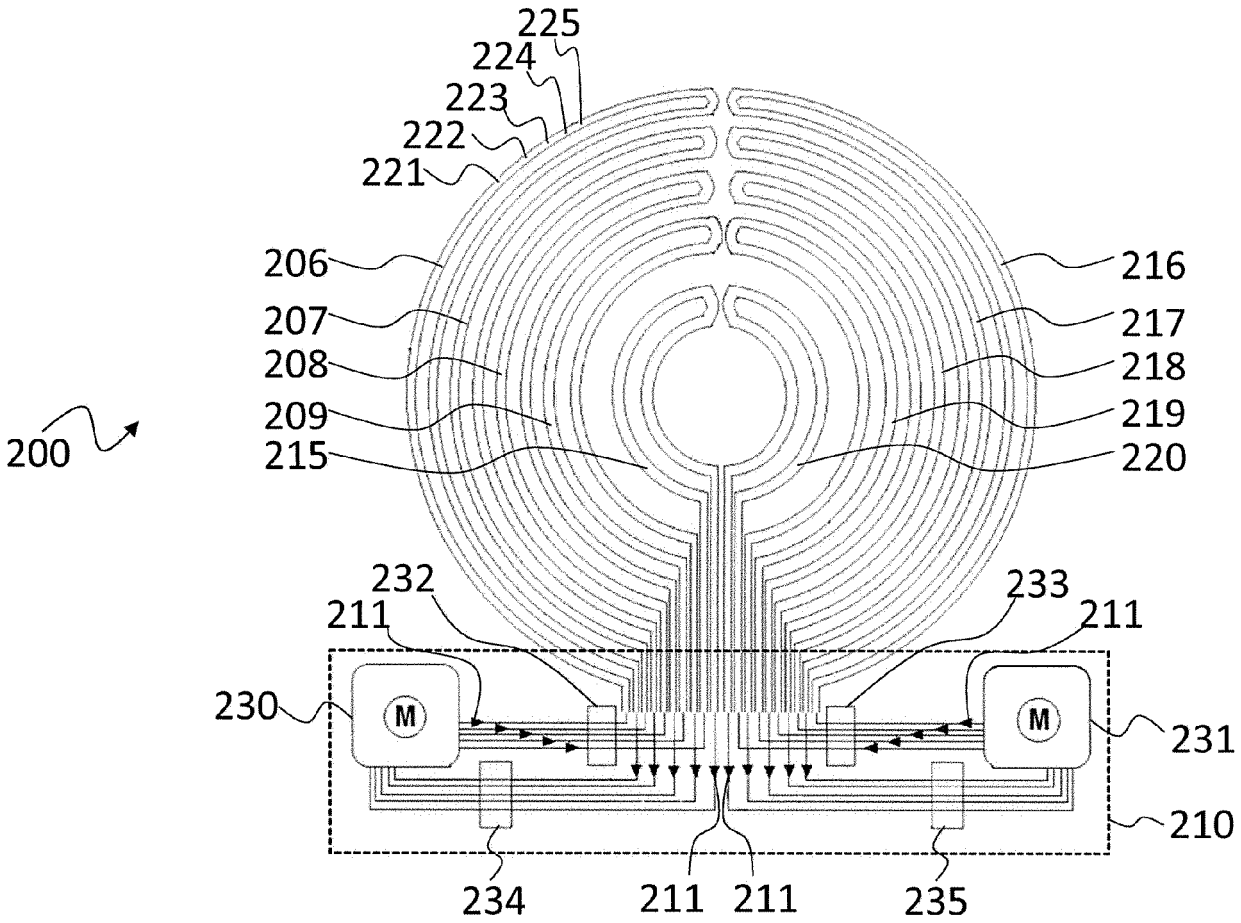
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Fig. 2

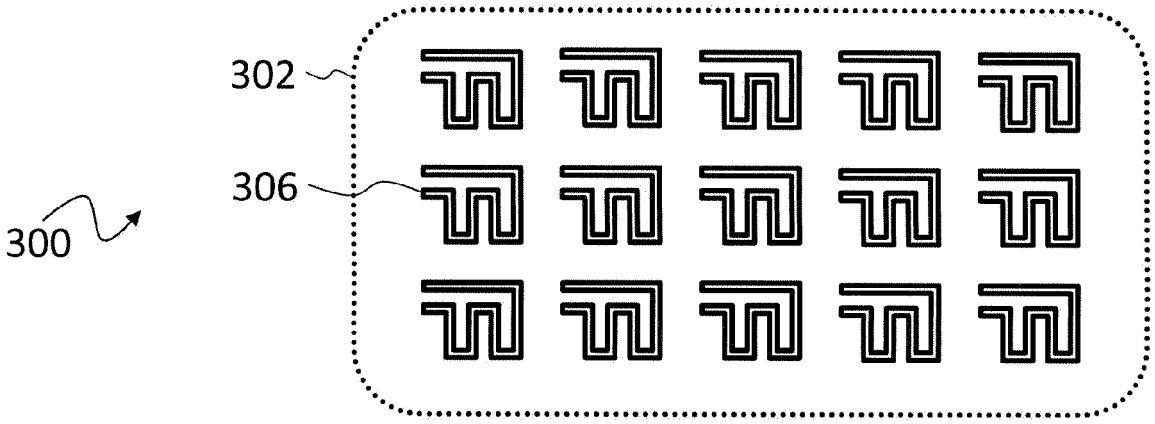

Fig. 3

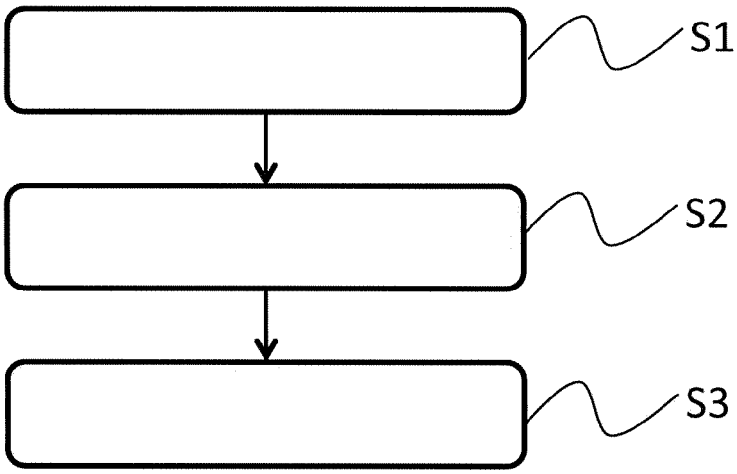

Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 17 16 8138

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	WO 2011/012418 A1 (BSH BOSCH SIEMENS HAUSGERAETE [DE]; BERNAL RUIZ CARLOS [ES]; GARDE ARA) 3 February 2011 (2011-02-03) * page 5, line 18; figure 1 *	1-15	INV. H05B6/12
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TECHNICAL FIELDS SEARCHED (IPC)

H05B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	12 October 2017	Pierron, Christophe

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