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(71) Applicant: **E.G.O. Elektro-Gerätebau GmbH**
75038 Oberderdingen (DE)

(72) Inventors:
- **Millán Serrano, Ignacio**
  08185 Llica de Vall (ES)
- **Fernández Vilar, Damián**
  08185 Llica de Vall (ES)
- **Verdaguer Garcia, Sergi**
  08185 Llica de Vall (ES)

(74) Representative: **Patentanwälte**
Ruff, Wilhelm, Beier, Dauster & Partner mbB
Kronenstraße 30
70174 Stuttgart (DE)

(54) METHOD FOR CONTROLLING THE POWER SUPPLIED TO AN INDUCTION HEATING COIL OF AN INDUCTION HOB AND INDUCTION HOB

(57) A method is provided for controlling the power supplied to an induction heating coil of an induction hob for inductively heating a pot with a pot base placed at least partially above the induction heating coil as a function of the relative position between a coil center point of the induction heating coil and a base center point of the base of the pot. A change of the relative position of the pot base relative to the induction heating coil is determined by means of the induction heating coil and used as a basis for changing the power supplied to the induction heating coil. If the pot is moved away from the induction heating coil, the power is reduced. The initial position of the base center point of the pot relative to the coil center point of the induction heating coil can be whatever as long as the pot stills covers at least a part of the induction heating coil.

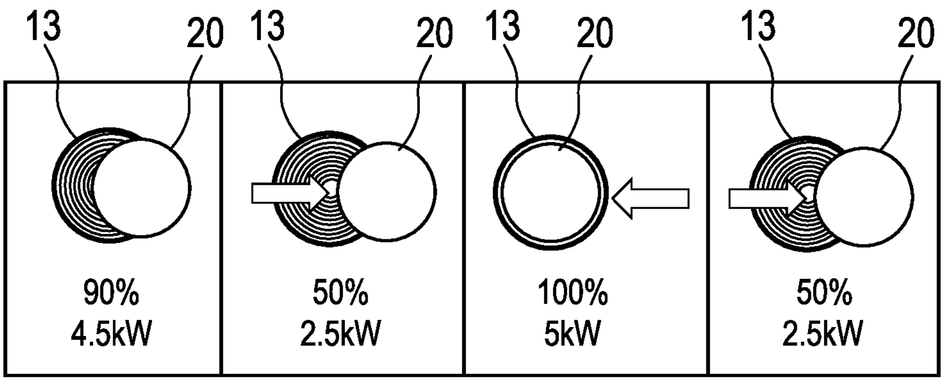

FIG. 7

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Description

Field of application and prior art

[0001] The invention relates to a method for controlling the power supplied to an induction heating coil of an induction hob for inductively heating a pot as well as to an induction hob that is adapted and configured to apply this method for inductively heating a pot.

[0002] Conventionally, an induction hob has several operating elements that are manually operated by an operator to adjust or vary power supplied to an induction heating coil of the hob for inductively heating a pot placed upon the induction heating coil. This regularly induces that the operator must look for the correct operating element corresponding to the induction heating coil whose power shall be adapted. Furthermore, depending on the construction principle of the manual operating element, it poses additional effort in manufacturing the hob and in costs for components.

[0003] From EP 2 087 770 A1 it is known to provide a method for controlling the power supplied to an induction heating coil by detecting a movement of a pot placed thereupon. This method also poses several drawbacks in that it is difficult to determine a movement of the pot depending on its position on the coil.

Problem and solution

[0004] It is an object of the invention to provide a method for controlling the power supplied to an induction heating coil as well as to provide an induction hob adapted to apply this method, with which method and induction hob problems of the prior art can be solved and, in particular, it is possible to realize an advantageous way of inductive heating of a pot on the hob and to change a power setting, wherein preferably this method is particularly easy to be applied by an operator.

[0005] This problem is solved by a method for controlling power supplied to an induction heating coil having the features of claim 1 and also by an induction hob having the features of claim 15. Advantageous and preferred embodiments of the invention are the subject-matter of the further claims and will be explained in more detail below. In so doing, some of the features will be explained only for the method or only for the induction hob. However, irrespective of this, they are intended to be able to be applied both to the method and also to the induction hob on their own and independently of one another. The wording of the claims is incorporated in the description by express reference.

[0006] The method is for a pot placed at least partially above the induction heating coil, wherein a power setting is determined as a function of the relative position between a coil center point of the induction heating coil and a base center point of the base of the pot. The method has several steps, wherein in a preceding step a pot may be placed on an induction hob or on its hob plate, respectively. It should at least partially be placed above an induction heating coil. Then the position of a center point of a base of the pot in relation to a center point of the induction heating coil is determined as well as a change of this relative position. For such a determination method, several options are known in the art, one of which can be chosen for this step. It may be possible to not directly determine a center point of a base of the pot, but rather the area that the pot is covering and, based on the assumption that the pot is round-circular, the center point can be determined. A change of the relative position of the pot base relative to the induction heating coil is determined by means of the induction heating coil and used as a basis for changing a power setting, in particular for increasing the power supplied to the induction heating coil or reducing the power supplied to the induction heating coil.

[0007] When it has been found that the induction heating coil is covered with a pot, preferably with a certain minimum coverage, the inductive heating of the pot can start. This can be made by using a certain initial power, which again may depend on the degree of the relative overlapping or on the distance between the two center points. It can then be provided that the power supplied to the induction heating coil is higher the closer the two center points are or, respectively, the less distance is between the two center points. This is the change of the relative positions mentioned before.

[0008] It is remarked that generally the method of the invention may preferably work with a movement of the pot in any direction, not just in front-back direction. So the pot may be moved to the left or to the right or in any direction whatsoever. It is only the distance between the two center points that is relevant, irrespective of the direction.

[0009] In an optional embodiment of the invention, it does not matter how the inductive heating process of the pot has started, only the position of a center point of a base of the pot in relation to the center point of the induction heating coil is determined then, or their distance respectively. By moving the pot with its center point closer to the center point of the induction heating coil, a power supplied to the induction heating coil is increased or made bigger for a more intense inductive heating. This may include that the coverage between the two is increased, which, however is not a mandatory prerogative for increasing the power. The value or degree of the coverage can be used in addition, but need not necessarily. The core feature of the invention is measuring or detecting the movement of the center points relative to each other or a change of their distance, respectively. If the power cannot be increased, in particular because it is already at its maximum, it simply stays the same.

[0010] When the pot is moved with its center point away from the center point of the induction heating coil, or the coverage is reduced, respectively, the power supplied to the induction heating coil is reduced. This reduction is made under any circumstances. If a reduction of the power may lead to reaching a minimum power that can be supplied to the induction heating coil or with which the induction heating coil can be operated, respectively, then this may indeed lead to a situation where there is no more inductive heating of the pot. Such a minimum power may be one due to the construction and configuration of a power supply for the induction heating coil, additionally due to a distance between the two center points being too large for efficiently heating the pot.

[0011] In consequence, the invention allows for a very simple method for controlling the power supplied to the induction heating coil that only implies that the pot needs to be handled. Furthermore, the method for controlling the power or increasing it or reducing it, respectively, is very intuitive. A movement of the pot closer to a center of the induction heating coil or to cover it more, or less, is very intuitive due to the fact that this is what an operator would suppose what would happen. It is possible to display the power that is actually being supplied to the induction heating coil to a user, for example in conventional power stages, so that it is easy for the user to control the power exactly by moving the pot relative to the induction heating coil.

[0012] The hob preferably has a marking on its hob plate to indicate to an operator where the center point of an induction heating coil is located. Even more preferably, in particular in the case of round-circular induction heating coils, the outline of the induction heating coil is marked or indicated, respectively. This can be made in a conventional way by marks, lines or the like on the top surface of the hob plate which can be printed or the like. Alternatively, such an indication or marking can be made by lighting means placed beneath a light-permeable hob plate. By indicating not only a center point of the induction heating coil, but also its outline, it is very easy for an operator to see and comprehend how a pot may be moved to change the displacement of the two center points in relation to each other.

[0013] The power level of the induction heating coil for an initial power supplied to the induction heating coil can be whatever in one embodiment of the invention. This means that an initial power need not be the maximum allowable power even if the pot completely covers an induction heating coil and is also centered on it. This is described in further detail later, preferably power can also be controlled by an operating element.

[0014] A shape of the induction heating coil can be whatever, in particular it can be round, circular round, ring-like, oval, square, rectangle or any kind of polygon. A round induction coil has the advantage that a relative position to a pot is the same in every direction. This allows for the method to be able to generally work with a movement of the pot in any direction relative to the induction heating coil.

[0015] The shape and/or size and/or material of the base of the pot can be whatever material which can be inductively heated by the induction heating coil. This is known in the art. Problems may arise with pots having a pot base that cannot be heated with high power due to their construction. This is being described later.

[0016] In addition to control the power supplied to the induction heating coil for inductively heating the pot via changing the relative position of the pot in relation to the induction heating coil, or their center points respectively, it is also possible to control and change the power supplied to the induction heating coil via an operating element being operated by an operator. This can be a conventional operating element of the induction hob.

[0017] In a further embodiment of the invention the user or a control of the induction hob can change the power any time from an initial power level to a changed power level, for example by an operating element mentioned before. Then the power supplied to the induction heating coil can be changed in correlation to this change of power levels. Preferably the correlation can be a quadratic correlation wherein other options are also possible.

[0018] In the method several steps may be provided. The relative position of the base center point in relation to the coil center point can be determined as a distance, preferably as a distance or as an absolute distance. A value for such a distance may be stored in a control of the induction hob. When the pot with its base center point is moved closer to the coil center point, the power supplied to the induction heating coil is increased, at least if such is possible. If it is not possible, then the power stays the same. When the pot with its base center point is moved away from the coil center point, the power supplied to the induction heating coil is reduced in any case. A reduction may mean that the induction heating coil is turned off, but then this is being done.

[0019] In an optional embodiment of the invention, it can be provided that in the step of moving the pot with its center point away from the center point of the induction heating coil, the power supplied to the induction heating coil is not always reduced, but only in case that the absolute distance between the center point of the hob and the center point of the induction heating coil is larger than 1 cm. More preferably, it should be larger than 3 cm. This means that if the two center points are very close to each other, which can mean that the distance is less than 3 cm or even less than only 1 cm, a relative movement of the pot to the induction heating coil which does not exceed this distance does not lead to a change of power. The relative coverage is staying very high in any way.

[0020] In a possible further embodiment of the invention, in particular in connection with the feature described before, it can be provided that the power is only increased or reduced if a percentage of coverage is changed. This means that if a pot is larger than the induction heating coil, the power is not varied until the induction heating coil is not fully covered by it, but only then if a part of the induction heating coil is not covered anymore. If the pot is smaller than the induction heating coil, the power usually varies with the relative position between the center points as described before.

[0021] Preferably, however, the power is increased or reduced in any case if the relative positions of the center points have changed or, respectively, if their distance has changed.

[0022] In a further embodiment of the invention, the relative position between the center point of the pot and the center point of the induction heating coil can be measured by detection means. These detection means can be different and separate from the induction heating coil, although in some embodiments the induction heating coil can be a part of these detection means or, respectively, their information about coverage can be used in addition to other information generated by the detection means. In particular, the relative position can be measured by inductive sensors that are positioned underneath the hob plate of the induction hob, preferably above the induction heating coil. They can be small and flat inductive sensor coils, for example according to EP 3 026 981 or EP 3 079 443 A1. These inductive sensors can be placed between the hob plate and the induction heating coils for heating. In practice, it may be provided that not exactly the center point of the pot or the pot base, respectively, is determined, but rather the outline of the pot. This then allows to determine the position of the center point of the pot. The center point of the induction heating coil is known in any way.

[0023] Preferably, however, the relative position between the center point of the pot and the center point of the induction heating coil is measured only by using the induction heating coils and no other detection means in the form of inductive or capacitive or optical sensor means.

[0024] It may be provided that the size of the area of the pot base should be above a predefined safety minimum size, wherein in particular this size is within +/- 20% of the size of the area of the induction heating coil. Preferably the induction heating coil and/or the pot have a round-circular form.

[0025] It is possible to apply this method with a pot with a power limitation for heating of its pot base, such that the pot may not be heated too much and/or too fast. The induction hob may be adapted to recognize this limitation, preferably via the electrical measures of the induction heating coil, and the power supply to the induction heating coil is in such a case reduced by at least 20% of a given value. This may also be at least 30%. In particular such a power limitation is recognized by analyzing at least two electrical measures of the power supplied to the induction heating coil.

[0026] In a still further embodiment of the invention, a change in the relative position between the center point of the pot and the center point of the induction heating coil can be measured by analyzing at least two electrical measures, in particular at least a current of the load or of the inverter and at least a power supplied to the load or a power measured in the inverter or an input power, preferably a load current or an output inverter voltage and a power supplied to the induction heating coil. In particular, this may also include that a load voltage or a voltage of the inverter are analyzed. This also allows for determining a coverage of the pot and the induction heating coil, which then allows for detecting a relative movement of the two center points to each other if this results in a change of coverage. It is then easy to determine that if the coverage is increased, the two center points have moved closer to each other. If, on the other hand, the coverage is reduced, as has also been explained before, then the two center points have been moved away from each other somewhat.

[0027] In an optional embodiment of the invention, both methods described before can be used, which means that detection means are provided and, in addition to that, some parameters of the power supplied to the induction heating coil are also used and analyzed. Then the result will be a more precise result.

[0028] It is possible to control the power of only exactly one single induction heating coil with this method that is used together with one single pot for its inductive heating. This provides for that an induction hob having a plurality of induction heating coils, wherein in each or most cases at least two or three of these induction heating coils are used to inductively heat one pot, is not adapted for this method of the invention. It can then also be provided that every single induction heating coil that can be operated with the method of the invention is positioned in the induction hob with some distance to its neighboring induction heating coils. Such a distance can preferably be at least 3 cm or 5 cm to the closest further or neighboring induction heating coil. However, it may be provided that the induction hob has several such induction heating coils, and the method of the invention can be used for every one of these induction heating coils. They simply are not adapted to be used together to heat one single pot in a combined heating operation. Only in an induction hob according to the principles of WO 2008/058614 A1 with a plurality of induction heating coils very close to each other, such a distance can preferably be at least 5 mm between neighboring induction heating coils.

[0029] It may be provided that before inductively heating a pot, a coverage by area of the pot and of the induction heating coil is measured. This may be done, as has been explained before, by analyzing at least the electric parameters of a current of the load or of the inverter and/or at least a voltage of the inverter or of the load and at least a power supplied to the load or a power measured in the inverter or an input power, preferably a load current or an output inverter voltage and a power supplied to the induction heating coil. Any one or a combination of these parameters may be used. The coverage by area may then be calculated as a variable in percentage and not in terms of area itself. In case the coverage by area is more than a predefined safety minimum size, preferably more than 20% and less than 90% of the area of the pot or of the induction heating coil, whichever is smaller by area, the power supplied to the induction heating coil is set to be 10% to 90% of the maximum power. Any coverage under 20% or even under 10% should rather not be used for operation of the induction heating coil, as a heating of a pot placed thereupon with less than 20% or 10% coverage by area would not work in a satisfying way. Furthermore, this would result in a very inhomogeneous heating of the pot. On the other hand, the range for the coverage in this case should not be more than 90%, so that there is still the option for an operator to make the coverage by area larger to increase the power. This option provides for the possibility that the operator with a medium or high degree of coverage by area can use a medium or rather high power to heat the pot. There is the option for the operator to move the pot further away from the induction heating coil, which may result in a reduction of power or even in turning the power off if the pot is moved for more than a minimum threshold distance. On the other hand, there still is some spare coverage by area that can also be used, such that the coverage may be enlarged to 100%, which allows for a way to increase the power to inductively heat the pot even some more.

[0030] In a preferred embodiment, a maximum distance between a pot and an induction heating coil can be such that the pot with its outer rim does still completely cover an innermost winding of the induction heating coil or at least for 50% of the area covered by this innermost winding of the induction heating coil, but not the winding next to it. If the pot is then moved further away from the induction heating coil, the power supply to the induction heating coil is turned off. In a further embodiment, a maximum distance can be such that the pot with its outer rim does still cover the center point of the induction heating coil but does not cover an area larger than this overlap. This provides for a sufficient covering or overlap, respectively, for safety reasons and efficient inductive heating of the pot.

[0031] It is possible that in the case that the coverage by area of an induction heating coil by the pot is measured to be more than 90% of the area of the pot or of the induction heating coil, whichever is smaller by area, the power supplied to the induction heating coil for heating the pot is set to be the maximum power. This means that for example if the coverage by area is raised to 95% or 98% or even 100%, the maximum power of the induction heating coil has already been reached and cannot be increased further. This allows for an operator that not an absolute exact adjustment of the two center points must be made, which results in a more comfortable way of operating the induction hob.

[0032] In a further refinement of the invention it can be provided that in any case when it has been detected that the center point of the pot is moved away from the center point of the induction heating coil, or their distance has been increased, which may also result in a reduced coverage, that the power supplied to the induction heating coil for heating the pot is reduced. This can in particular be irrespective of whether the pot is still fully covered by the induction heating coil or whether the induction heating coil is still fully covered by the pot. In this refinement, other than described before when the center points are very close to each other, a reduction of the power is made in any way. This allows for a strictly consequent and strictly logical way to adapt the power setting to how the pot is handled on the hob plate over the induction heating coil. This refinement of the invention can be under the precondition that a movement is for more than 1 cm. This means that any very small or unintended movement of the pot does not result in a change of the power. Preferably, this distance can be for more than 3 cm, because a movement exceeding 3 cm is clearly intentional, below 3 cm it may also be unintentional.

[0033] It can be provided that an induction hob is adapted to activate this method and to also deactivate it. This can be in case that an operator does not want the position of the pot or a movement of the pot to have any implication on the power supply. An activation can be made in a basic settings menu with the help of conventional operating elements.

[0034] It can preferably be provided that in one embodiment of the invention it can be detected whether a pot is lifted from the hob plate, at least partially with one side, and, furthermore, whether it is taken away from the hob plate, replaced at a distance of more than 10 cm or whether the pot is directly placed onto the hob plate again with the center points having been moved closer to each other or further away from each other. Such an option can be used to either pause the method such that, as soon as the pot has been lifted off from the hob plate, even only partially or only on one side, when the other side still has contact with the hob plate, this results in that no power increase or reduction is being made. This does of course include that the induction heating coil is regularly turned off, in particular temporarily, if the pot is not placed on the hob plate above the induction heating coil anymore due to safety regulations. This means that a lifting of the pot, even only a partial lifting, cannot lead to a change of the power supplied to the induction heating coil according to the method of this invention. It will rather depend on with what new distance of the center points the pot is set back onto the hob plate.

[0035] In the other case, if the pot is placed onto the hob plate over the same induction heating coil again, preferably within a time span of maximum 5 sec, maximum 3 sec or only maximum 1 sec, a potential movement of the center points relative to each other is detected and used according to the principle of this invention to potentially change the power. In this way, a movement of the pot including a lifting or partial lifting of the pot can also lead to a change of power because the parameters of time and, potentially also distance, indicate that a change of power is what an operator has intended.

[0036] It is furthermore possible with the invention that a reduction of the power supplied to the induction heating coil for inductively heating the pot is reduced in proportion to a growing distance of the two center points to each other. This may be a direct proportion, such that it can preferably be provided that a reduction of the power from maximum power or from a power level selected by an operator to minimum power is a piecewise curve, a quadratic curve or is proportional or in linear correlation with a growing distance between the two center points starting from zero or form a minimum distance to a maximum distance. At this maximum distance, the induction heating coil still is supplied with power for heating the pot, wherein the distance may not be any larger, otherwise the power supply would stop when the distance between the base center point and the coil center point is increased to more than this maximum distance. Such a maximum distance may be provided when a coverage by area is in the range of 20% or only 10% as described before. Such a proportional change of the power, in particular with a linear correlation, results in that it is easy to foresee for the operator how a movement of the pot will result in a power change.

[0037] It can be provided that the minimum power supplied to the induction heating coil for inductively heating the pot is 100 W or 1% of the maximum power, which may be at a certain distance between the two center points. If then the pot is moved even somewhat further away from the center point of the induction heating coil, power supply to the induction heating coil stays constantly at this value of fixed minimum power as long as the pot can be detected to be above this induction heating coil. Alternatively, the power supply simply is stopped.

[0038] It is also possible to stop the power supply to the induction heating coil completely as soon as the distance of the center points or their relative positions become more than a predefined safety limit distance. Such a predefined safety limit distance may be more than 75% of the diameter of the pot or of the induction heating coil, whichever is bigger, in particular more than 50%.

[0039] Preferably the induction hob is configured to display or indicate the power supplied to the induction heating coil to an operator. This may be made via a luminous display, for example via a number correlated with a power stage or with a bar graph or the like. This luminous power display should preferably always indicate the actual power stage or power that is supplied to the induction heating coil for heating the pot corresponding to a power stage as is known in the art.

[0040] It is advantageously possible to control the power supplied to the induction heating coil either with frequency modulation or with duty cycle modulation. This allows for better options to adapt the power supply to the induction heating coil to various situations during operation of the induction heating coil. Alternatively, both methods may be used and mixed.

[0041] It may be provided that, departing from a linear correlation of the power change to a change of the distance between the two center points, it can be provided that in the range of a high power or small distance between the two center points, respectively, a movement for a certain distance changes the power much more than in a medium or even low range of power. This means that for example if the two center points are about directly over each other with a coverage of 100%, a relative movement of 1 cm of the pot away from the center point of the induction heating coil leads to a reduction of power between 5% and 30%, preferably between 10% and 20%. If the power is only small, for example less than 30% of the maximum power, a movement of about the same distance results in a change of power between 20% and 50%. This allows for the option to control the power more exactly in a high power setting, where a difference in power has more impact than in the case of low power or even close to minimum power.

[0042] It can be provided that in addition to the method described herein before, the hob has operating elements that allow manual operation by an operator. Such operating elements may also be provided to change a power setting for an induction heating coil to inductively heat a pot placed thereupon, for example if an operator wants to have a defined power setting, in particular for a medium or lower power where it would be advisable to have a coverage of close to 100% or 100% exactly. This may preferably be used when making complicated dishes such as sauce hollandaise or sauce bearnaise, where a homogeneous heating of the pot base is very important. These operating elements may be touch switches or mechanical switches for pushing or turning.

[0043] These and further features may be gathered from the claims and also from the description and the drawings, with the individual features being capable of being implemented in each case by themselves or severally in the form of sub-combinations in an embodiment of the invention and in other fields and being capable of constituting advantageous and independently patentable versions for which protection is claimed here. The subdivision of the application into individual sections and intermediate headings does not restrict the general validity of the statements made under these.

Brief description of the drawings

[0044] Exemplary embodiments of the invention are schematically illustrated in the drawings and will be explained in more detail below. In the drawings:

Fig. 1: shows a plan view of above of a simplified sketch showing the invention in principle for a power reduction,

Fig. 2: shows, similar to fig. 1, a power increase,

Fig. 3: a detailed embodiment of a part of an induction hob with inductive sensor coils provided at the circumference of the induction heating coil,

Fig. 4: shows a view of above of a pot with a center point of a pot base,

Fig. 5: an example of two different relative positions between the center points of the induction heating coil and the pot,

Fig. 6: another example of the invention with an induction heating coil and a pot being much

smaller in different relative positions,

Fig. 7: a movement scheme of a pot relative to an induction heating coil,

Fig. 8: another movement scheme of a pot relative to an induction heating coil,

Fig. 9: a diagram of the Power versus a relative to a Setpoint K for the induction heating coil, and

Fig. 10: a simplified view onto an induction hob.

Detailed description of the exemplary embodiments

[0045] In Fig. 1 a very simplified induction hob 11 is shown in view from above, wherein a hob plate is not shown. Induction hob 11 has a number of induction heating coils 13, preferably 4, of which only one is shown here. There may be provided three or five more induction heating coils, potentially in various sizes, wherein each of these induction heating coils has a distance of about 3 cm to 5 cm to their neighbors. This means that they are adapted to be operated on their own for inductively heating only one single pot placed upon it.

[0046] Induction hob 11 is further provided with an operating element 18 that is constructed as a so-called slider, which is known for example from EP 1 787 393 A1, EP 2 309 647 A1 as well as EP 2 830 220 A1. Movement of a fingertip on top of the hob plate along the slider operating element 18 can be used to define a certain power level or power stage. Next to operating element 18, a luminous display 19 is provided, which shows in the case at hand a numeral "8". It can be configured as described in the prior art before with single separate LED segments for displaying the power stage or power level that is defined for induction heating coil 13. A simplified view from above onto such an induction hob 11 with a hob plate 12 is shown in Fig. 10. This induction hob 11 has four induction heating coils 13a to 13d placed beneath the hob plate 12. In an operating control having at least one microcontroller for analyzing the electrical measures mentioned before operating elements 18 and the luminous display 19 are provided.

[0047] In Fig. 1, a round-circular pot 20 with a round-circular pot base is placed on the hob plate above induction heating coil 13. In an initial position shown in dashed line, they are concentric and, accordingly, their center points are one over the other or identical, respectively. It can be seen that pot 20 is slightly smaller than induction heating coil 13. In a very schematic way Fig. 1 shows that if now the pot 20 is moved from its initial position in dashed line to the new position in solid line at its right hand, which is a movement to the right, power P supplied to the induction heating coil 13 for inductively heating pot 20 is reduced. How much the power P is reduced in relation to a distance between the center points of induction heating coil 13 and pot 20 is not yet shown here. This has been discussed before and will be discussed in further detail hereinafter.

[0048] Fig. 2 shows in a corresponding simple manner that pot 20 has been moved from its initial position in dashed line, in which pot 20 has protruded slightly to the right over induction heating coil 13, into a concentric position directly above induction heating coil 13. As now obviously the center points have moved closer together an so their relative position has changed, power P for the induction heating coil 13 is increased, as is indicated in Fig. 2. A direction of the relative movement does not matter in these embodiments, so the movement is irrespective of whether it is to the right or to the left or up as long as the distance has become smaller.

[0049] Fig. 3 shows an induction hob 11 where induction heating coil 13 is provided with coil turns 14 in spiral manner as is common in the art. A center point 16 of the induction heating coil 13 is shown with a small cross having a vertical and a horizontal line. It is also possible to realize the invention with an induction heating coil that does not have a circular form or circumference, but a square form or a rectangular form. It is then also possible to define a center point, preferably a center point of extension, as well as an area of such an induction heating coil, to compare them to the center point or the coverage by area of the pot.

[0050] The position of induction heating coil 13 should be marked on the top surface of hob plate, preferably in a way known in the art by imprinting with weight or grey color. It is possible to mark the center point 16 of induction heating coil 13 or only the circumference or, preferably, both of them.

[0051] It is also shown that hob 11 is provided with three sensor coils 22a to 22c, which are evenly distributed along the circumference of induction heating coil 13. They can be constructed and operated according to the prior art mentioned in the introductory part of the description. The sensor coils 22a to 22c can each detect whether they are covered at all by pot 20 and whether this is a complete coverage or only a partial coverage. When the coverage of all three sensors coils 22a to 22c is combined in a control of the induction hob 11, a position of pot 20 can be calculated, or a coverage, respectively. This is also known in the prior art mentioned before.

[0052] In addition to the three sensor coils 22a to 22c, a fourth sensor coil 22d of the same construction is provided over the coil center point 16. This also helps to exactly locate position and/or coverage of the pot 20 above the induction heating coil 13. Also the electric parameters of the power supply to induction heating coil 13 can be used to determine whether and with which coverage by area the induction heating coil 13 is covered by a pot 20. This is also known in the prior art.

[0053] Fig. 4 shows pot 20 in view of above. Pot 20 has a pot center point 21 in the form of an oblique cross. As is common in the art, a pot base has the same diameter and form as the pot itself, a variation might be in the order of only some millimeters.

[0054] Now with the help of sensor coils 22a to 22d of Fig. 3 it can be detected whether pot 20 has been moved according to figs. 1 and 2, and then the power supplied to the induction heating coil 13 for inductively heating pot

20 can be increased or reduced, respectively. This can also be seen in Fig. 5. In an initial position, pot 20' in dashed lines is concentrically placed above induction heating coil 13. Their respective center points 16 and 21' are identical.

[0055] Now an operator has moved pot 20 in solid line to a position corresponding to Fig. 1, wherein the distance d between their respective center points 16 and 21 is shown. Such a rather small movement can for example mean that the power P for the power supply to the induction heating coil 13 is reduced, possibly for about 30% to 40%. This means that if pot 20 has been heated in its initial position in dashed line with maximum power, it is now heated in the position with solid line only with 60% to 70% of the maximum power.

[0056] If pot 20" in dotted lines has been moved even further away from the induction heating coil or their center points 16 and 21" respectively, the power is reduced even more. Due to the coverage by area that is now obviously very small, for example about 10% of the area of pot 20, the power can be reduced to the minimum power, which may for example be only 10% to 15% of the maximum power. In corresponding manner, due to this relatively large distance between the center points 16 and 21", the power can be reduced to the minimum power mentioned before.

[0057] If the pot 20 would be moved even more to the right from the position in dotted lines, the power supply to induction heating coil 13 would and should be stopped due to the coverage being obviously too small.

[0058] In Fig. 6 an embodiment is shown where induction heating coil 13 with its center point 16 is the same as before. However, pot 20 is now much smaller than before, with its diameter being about 60% of the diameter of induction heating coil 13. In a position in dashed-dotted line, pot 20" is about concentrically over center point 16 of induction heating coil 13. This means that pot 20" cannot be moved any closer to induction heating coil 13 or in a position more concentrical or with more coverage anyway. So the power supplied to induction heating coil 13 should be at its maximum.

[0059] In the position of pot 20' in dashed line, pot 20' has been moved significantly down and to the left in relation to center point 16. Apart from pot 20 being most probably much too small for induction heating coil 13, its area would still be completely covered by induction heating coil 13 in spite of the relatively significant movement. But as a distance between the center points is now significant, for example about 20% of the diameter of induction heating coil 13, which means 3 cm to 5 cm, a movement of pot 20 from the dashed-dotted position to the dashed position should result in a reduction of power supplied to the induction heating coil 13. As an example, the power may be reduced for about 20% to 30%.

[0060] If pot 20 is moved even more to the side, which is shown with pot 20 in continuous line, the distance between the center points is now even somewhat larger and about 25% to 30% of the diameter of induction heating coil 13. This means that a power reduction with regard to maximum power should be about 30% to 40%, although pot 20 is still fully covered by induction heating coil 13, which means that it can be inductively heated in a largely homogeneous way.

[0061] If the small pot 20 would be moved even more to the side such that it is no more fully covered by induction heating coil 13, this can also be detected and should result in a further reduction in power supplied to induction heating coil 13.

[0062] The example of Fig. 6 mainly serves for illustrative purposes to show that it may be preferred that a change of the power supplied to the induction heating coil can even take place by relative movement of the pot 20 with its center point 21 to center point 16 of induction heating coil 13, which may be used for a power reduction even if the pot 20 is still largely or fully covered by the induction heating coil. This shows the focus on the movement of the pot relative to the induction heating coil.

[0063] A reduction of inductively coupling energy into the base of pot 20 for heating it is not only varied with coverage of induction heating coil and pot, such that those parts of the pot not covering the induction heating coil are not heated any more automatically. The relative movement of the pot to the induction heating coil is used as a way for the operator positively expressing the wish to change the power supplied to the induction heating coil, either increasing power or reducing the power. It is of course preferable to indicate the power that is currently supplied to the induction heating coil by displaying it, as can be taken from Fig. 1. This enables the operator to control whether the manual movement of the pot has resulted in a change of the power supplied to the induction heating coil as wanted. Such a power display can help the operator in addition to watching the pot and the cooking process in the pot.

[0064] In Fig. 7 it is shown in the first position that the relative position between the center point of the pot 20 and the center point of the induction heating coil 13 as a distance amounts to about some cm, or about 25% of the diameter of the induction heating coil 13. This results in the power supplied to the induction heating coil 13 to be set at 90% of a maximum power. In this case this maximum power is 5 kW, and 90% of it are 4.5 kW.

[0065] Now in the second position the pot 20 has been moved to the right somewhat such that its outer rim does but slightly reach over the center point of the induction heating coil 13. This is the maximum distance that the induction heating coil 13 may still heat the pot 20. So if the pot 20 has now been moved even further away from the induction heating coil 13, or their center points respectively, the power supplied to the induction heating coil 13 is reduced even further. This can in this example with a setpoint for the induction heating coil 13 set at its maximum, which can be a maximum setpoint 12, be a power reduction of 50% resulting in 2.5 kW. So this 2.5 kW is the new power supplied to the induction heating coil 13 for heating the pot 20.

[0066] If now pot 20 in a third position is moved back over the induction heating coil 13 such that their center points are concentric to each other, the power is of course increased to its maximum. This is 100% in this case, resulting in 5 kW supplied to the induction heating coil 13 for heating the pot 20. Then the pot 20 is moved again to the right away from the induction heating coil 13 in the fourth position as the same position described before for the second position, and the same power supply is set.

[0067] In a further alternative embodiment, the power in the second and in the fourth position can be even more reduced, for example down to between 10% and 40%, for example 25%. A power reduction with movement is then more rapid so less space is needed around the induction heating coil 13 for the pot to be moved around. Then the number for the percentage in these two positions could be for example "25%" instead of "50%".

[0068] In Fig. 8, a sequence of positions of the pot 20 and the induction heating coil 13 similar as to Fig. 7 are provided with the difference that, in addition to relative movement of the pot 20, the setpoint K of the power to be supplied to the induction heating coil 13 is being changed also. The setpoint K for the power is set to 12, corresponding to the maximum setpoint with a maximum power of the induction heating coil 13. In corresponding Fig. 9, a correlation between different curves for power in W over the chosen setpoint is shown as well as how the pot 20 can be moved between them for setting the power supplied to the induction heating coil 13.

[0069] In the first position A in Fig. 8, the power to be supplied to the induction heating coil 13 is 100% of the setpoint 12 resulting in 5 kW as described before. This is the maximum power. This position A with its power setting of 5 kW is also to be taken form Fig. 9.

[0070] In the second position B, corresponding to the second position of Fig. 7, the power is reduced to 50% by moving the pot 20 to the right away from the center point of the induction heating coil 13. The setpoint is, however, not changed. So according to Fig. 9, the power supplied to the induction heating coil 13 is decreased to 50% or 2.5 kW, respectively. This power reduction between points A and B has been made only by movement of the pot 20 relative to the induction heating coil 13.

[0071] In the third position C, the pot is not moved but the setpoint K is changed with one of the operating elements 18. It is being changed from 12 to 8 only. According to the 50%-curve in Fig. 9, this results in the power to be decreased to about 1.2 kW. This power reduction between points B and C has been made only by changing the setpoint.

[0072] In the fourth position D, the pot 20 has been moved relatively to the induction heating coil 13 again such that their center points are concentrical again. At setpoint 8, this results in the maximum power of setpoint 8, which in this case is 2.25 kW. This power increase between points C and D has been made only by movement of the pot 20 relative to the induction heating coil 13.

[0073] In the fifth position E, the setpoint K has been changed back from 8 to 12 again. According to the 100%-curve in Fig. 9, this results in the power to be increased to 5 kW again. This power increase between points D and E has been made only by changing the setpoint again.

[0074] It can be taken from Fig. 9 that, for example starting at point A, there are two ways to reduce the power supplied to the induction heating coil 13. The first way is by moving the pot 20 away from the induction heating coil 13. The second way is to reduce the setpoint, which is the power originally intended to be supplied to the induction heating coil 13.

[0075] It is of course to be understood that the reduction of the power by moving the pot 20 away from the induction heating coil 13 to only 50% of the power originally set for the induction heating coil 13 is only an example. In other embodiments, such a reduction can be for much more, for example down to 20% or only 10% of the power originally set for the induction heating coil. Then the options for a user to change a power supplied to the induction heating coil 13 for inductively heating the pot 20 are more numerous and an induction hob can be operated with more degree of freedom.

Claims

1. Method for controlling the power supplied to an induction heating coil of an induction hob for inductively heating a pot with a pot base as a function of the relative position between a coil center point of the induction heating coil and a base center point of the base of the pot, wherein a change of the relative position of the pot base of the pot relative to the induction heating coil is determined by means of the induction heating coil and used as a basis for increasing the power supplied to the induction heating coil or reducing the power supplied to the induction heating coil, wherein preferably the initial position of the base center point of the pot relative to the coil center point of the induction heating coil can be whatever where the pot stills covers at least a part of the induction heating coil.

2. Method according to claim 1, wherein the power level of the induction heating coil for an initial power supplied to the induction heating coil can be whatever.

3. Method according to claim 1 or 2, wherein in addition to control the power supplied to the induction heating coil for inductively heating the pot via changing the relative position of the pot in relation to the induction heating coil, or their center points respectively, the power supplied to the induction heating coil is also controllable and can be changed via an operating element being operated by an operator.

4. Method according to one of the preceding claims,

with the steps of:

- the relative position of the base center point in relation to the coil center point is determined as a distance, preferably as a distance or as an absolute distance,
- when moving the pot with its base center point closer to the coil center point the power supplied to the induction heating coil is increased, if such is possible, and
- when moving the pot with its base center point away from the coil center point the power supplied to the induction heating coil is reduced in any case.

5. Method according to claim 4, wherein in the step of moving the pot with its base center point away from the coil center point, the power supplied to the induction heating coil is reduced only in case that the absolute distance between the base center point and the coil center point is more than 3 cm, preferably more than 1 cm.

6. Method according to one of the preceding claims, wherein the relative position between the base center point and the coil center point is measured by the induction heating coils of the induction hob only, wherein no further detection means being different and separate from the induction heating coils for detecting a position of the pot on the hob plate are provided.

7. Method according to one of the preceding claims, wherein in case a pot with a power limitation for heating of its pot base is being used in the method, the induction hob recognizes this limitation and the power supply to the induction heating coil is reduced by at least 20% of a given value, preferably at least 30%, wherein in particular this is recognized by analyzing at least two electrical measures of the power supplied to the induction heating coil.

8. Method according to one of the preceding claims, wherein a change in the relative position between the base center point and the coil center point is measured by analyzing at least two electrical measures, in particular at least a current of the load or of the inverter and/or at least a voltage of the inverter or of the load and at least a power supplied to the load or a power measured in the inverter or an input power, preferably a load current or an output inverter voltage and a power supplied to the induction heating coil.

9. Method according to one of the preceding claims, wherein the power of only exactly one single induction heating coil is controlled with this method, wherein in particular this single induction heating coil is positioned in the induction hob with at least 5 mm distance to the closest further induction heating coil of the induction hob.

10. Method according to one of the preceding claims, wherein initially to start heating, a coverage by area of the induction heating coil by the pot is measured, preferably by analyzing at least the parameters of load current, an output inverter voltage and/or a power supplied to the induction heating coil, and wherein in case the coverage by area is more than a predefined safety minimum size, in particular more than 20% and less than 90% of the area of the pot or of the induction heating coil, whichever is smaller by area, the power supplied to the induction heating coil for inductively heating the pot is set to be 10% to 90% of the maximum power.

11. Method according to one of the preceding claims, wherein in the case that the coverage by area of the induction heating coil by the pot is measured to be more than 90% of the area of the pot or of the induction heating coil, whichever is smaller by area, the power supplied to the induction heating coil for heating the pot is set to be the maximum power of the pot in the centered position.

12. Method according to one of the preceding claims, wherein in any case that it is detected that the base center point is moved away from the coil center point, the power supplied to the induction heating coil for heating the pot is reduced irrespective of whether the pot is still fully covered by the induction heating coil or whether the induction heating coil is still fully covered by the pot, preferably at least when a movement is for more than 1 cm, preferably for more than 3 cm.

13. Method according to one of the preceding claims, wherein it is detected whether a pot is lifted from the induction heating coil, at least partially with one side, and whether the pot is taken away from the induction heating coil, replaced on a hob plate of the induction hob at a distance of more than 10 cm or whether the pot is directly placed above the induction heating coil again with a distance between the base center point and the coil center point having been decreased or increased, and in such case the operation of the induction heating coil is either paused such that, as soon as the pot has been lifted off from the induction heating coil, this results in that no power increase or power reduction is being made, wherein in particular, if the pot is not placed on the hob plate above the induction heating coil again, the power supply to the induction heating coil is regularly turned off.

14. Method according to one of the preceding claims, wherein a reduction of the power supplied to the induction heating coil for inductively heating the pot is reduced with a growing distance between the base center point and the coil center point, wherein preferably a reduction of the power from maximum power to minimum power either is a piecewise curve or a quadratic curve or is proportional or in linear correlation with a growing distance between the base center point and the coil center point starting from zero to a maximum distance where the induction heating coil still is supplied with power for inductively heating the pot, wherein when the distance between the base center point and the coil center point is increased to more than this maximum distance, power supply to the induction heating coil is completely stopped.

15. Induction hob with at least one induction heating coil and a control, wherein the induction hob is configured to work according to the method according to one of the preceding claims, wherein in particular the induction hob is provided with an operating element being operated by the user, preferably a manual operating element being manually operated by the user.

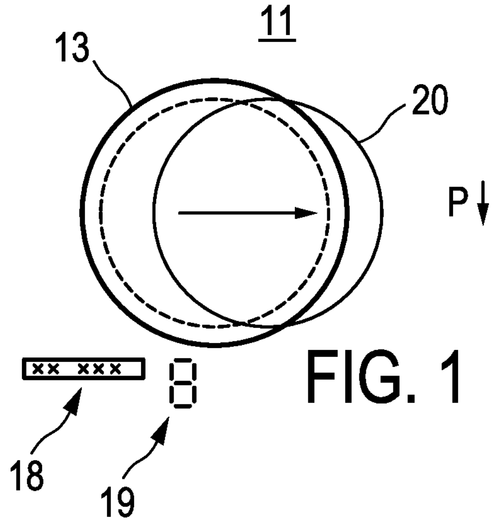

FIG. 1

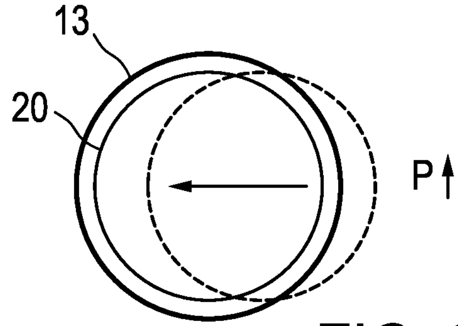

FIG. 2

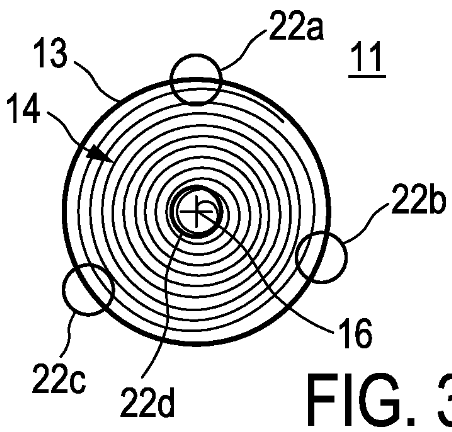

FIG. 3

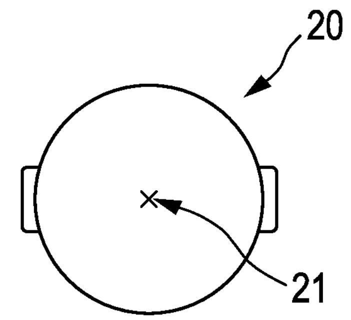

FIG. 4

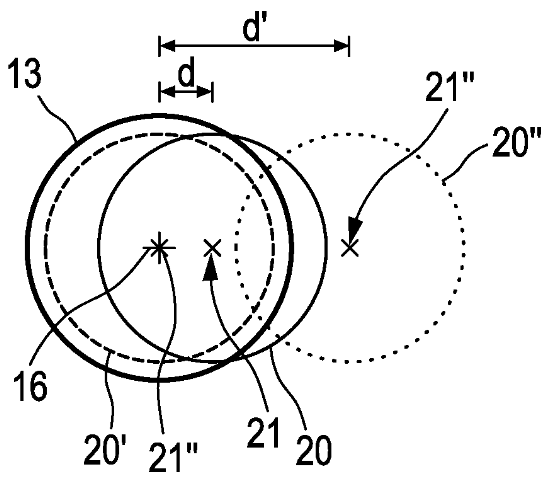

FIG. 5

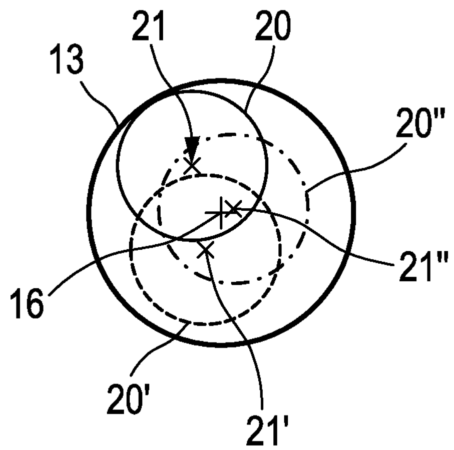

FIG. 6

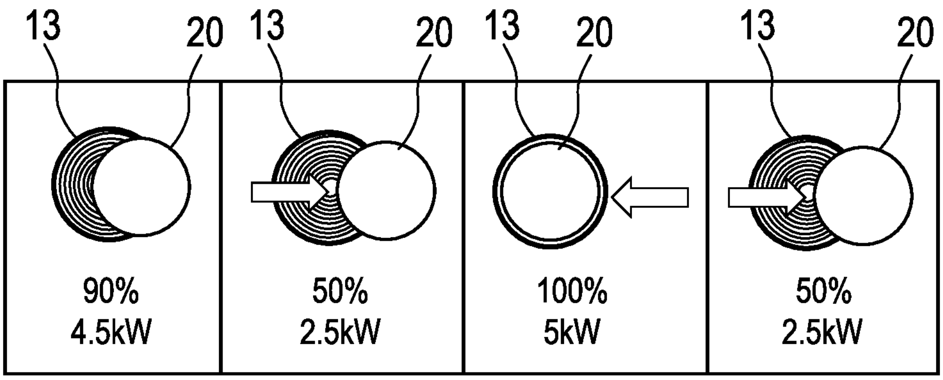
13
20
13
20
13
20
13
20
90%
4.5kW
50%
2.5kW
100%
5kW
50%
2.5kW

FIG. 7

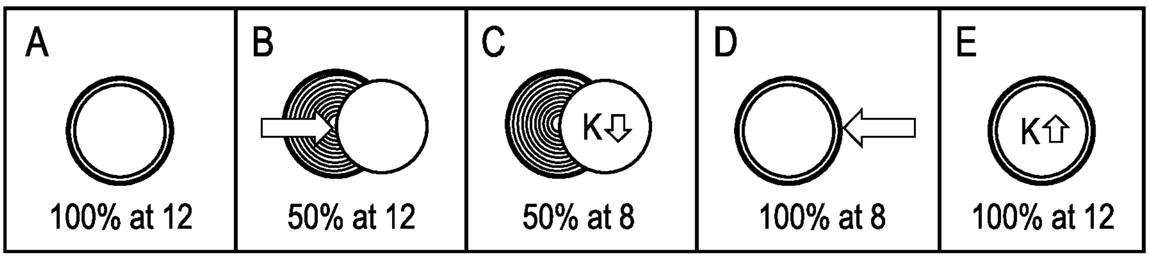
A
100% at 12
B
50% at 12
C
K⇩
50% at 8
D
100% at 8
E
K⇧
100% at 12

FIG. 8

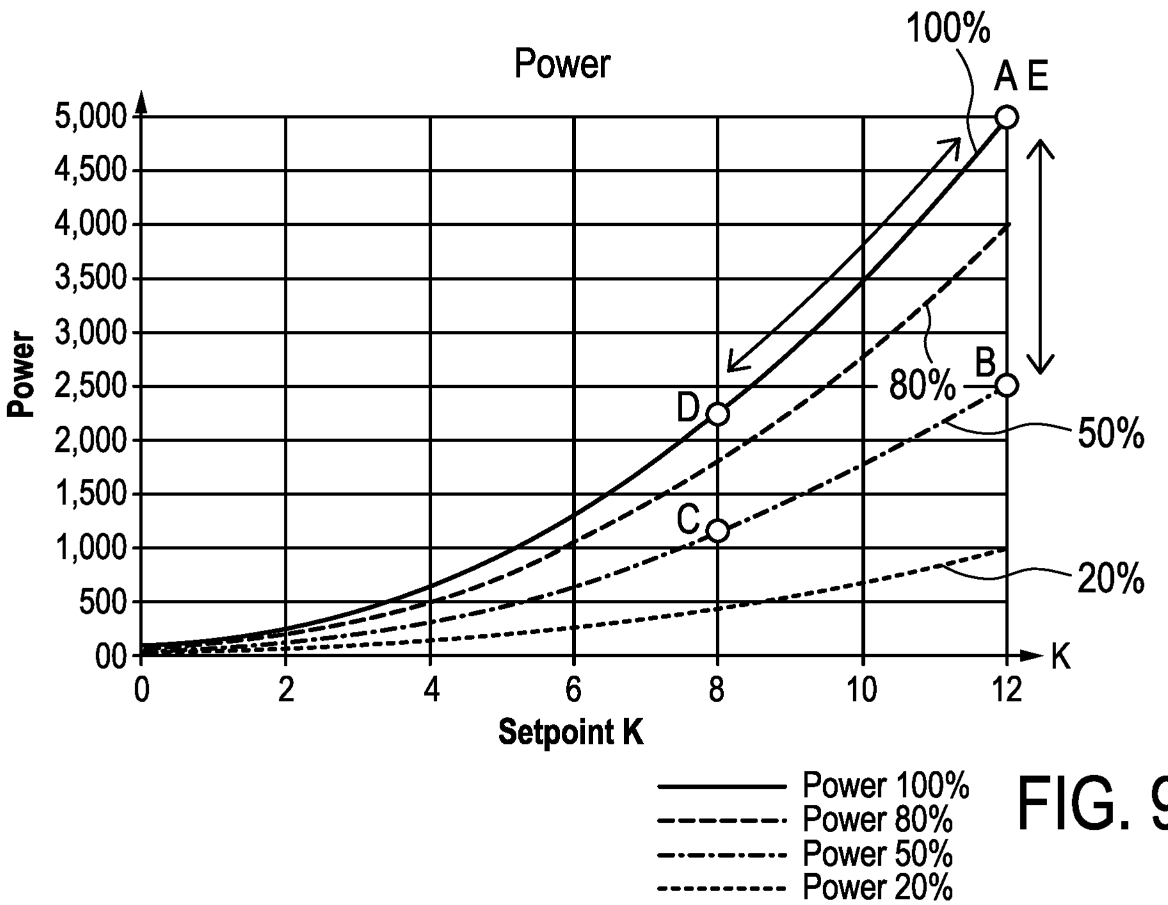
Power
100%
A E
B
D
C
80%
50%
20%
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
00
Power
0
2
4
6
8
10
12
K
Setpoint K
Power 100%
Power 80%
Power 50%
Power 20%

FIG. 9

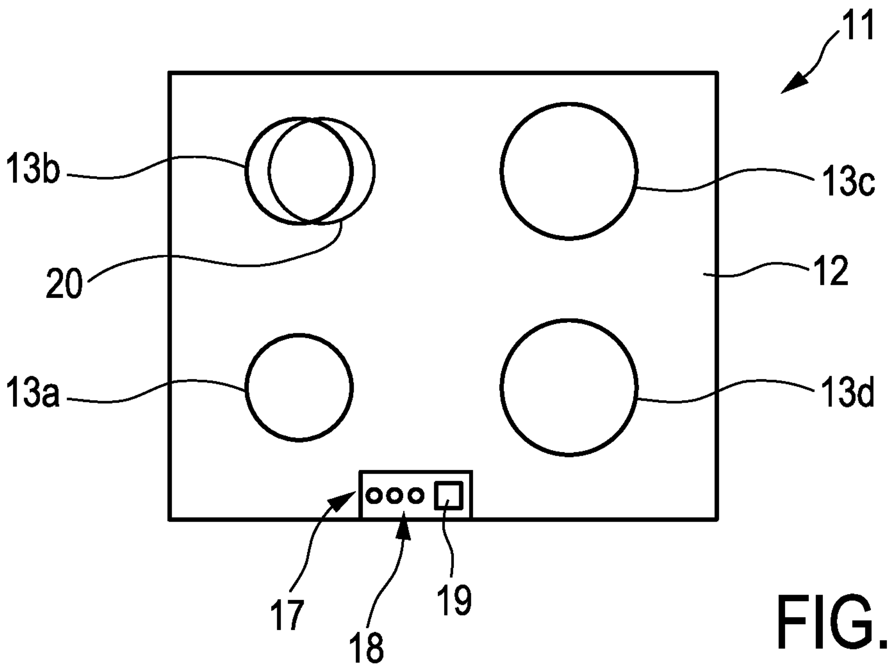
11
13b
13c
20
12
13a
13d
17
18
19

FIG. 10

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EUROPEAN SEARCH REPORT

Application Number
EP 20 15 3023

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The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	30 June 2020	Pierron, Christophe

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