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(54) INDUCTION COOKER, METHOD FOR OPERATING AN INDUCTION COOKER AND CONTROLLER FOR AN INDUCTION COOKER

(57) There is provided an induction cooker (5), a controller (70) and a method for controlling the induction cooker (5). The induction cooker (5) has an induction cooking coil (10, 15, 20, 25) mounted upon and movable by a mechanical system (75, 80, 85, 90) within a predetermined region beneath a cooking surface (30) of the cooker (5). The cooker (5) comprises a plurality of sensors (50), each positioned to sense the presence of a cooking vessel when placed at a respective position upon the cooking surface (30). A controller (70) is configured: to receive from any of the plurality of sensors (50) an indication of the presence of a cooking vessel at a respective position of the sensor (50); to determine from the received indications a position of the cooking vessel upon the cooking surface (30); and to control the mechanical system (75, 80, 85, 90) to move the induction cooking coil (10, 15, 20, 25) to a position beneath the cooking surface (30) corresponding to the determined position of the cooking vessel.

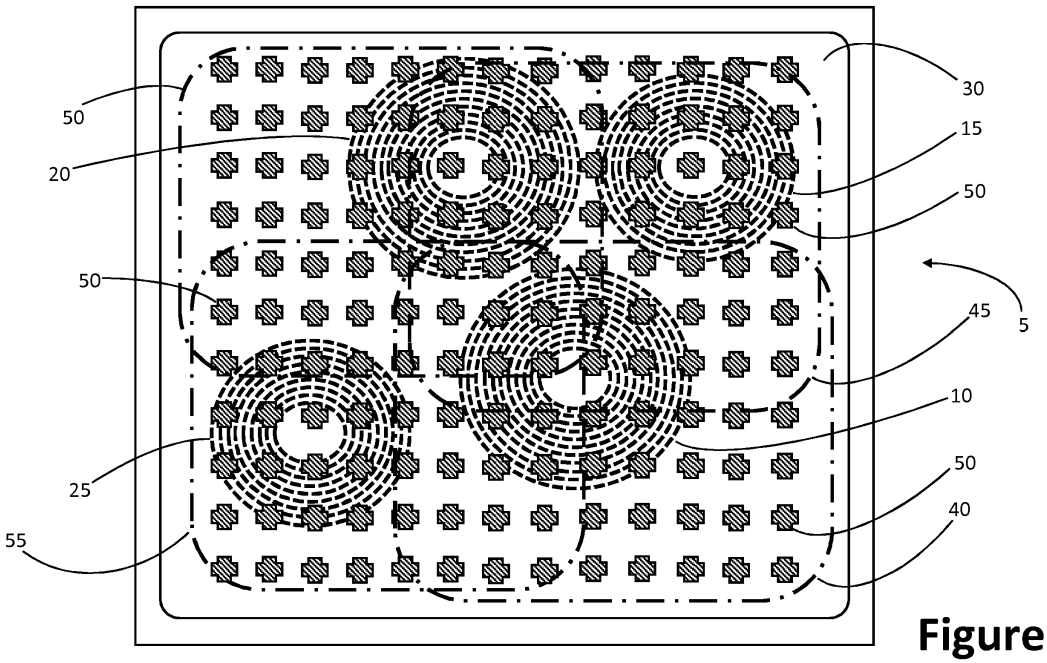

Figure 3

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Description

Technical Field

[0001] The present disclosure relates to an induction cooker, to a method for operating an induction cooker and to a controller for an induction cooker.

Background

[0002] When cooking using an induction cooker or a cooker having direct heating elements, it is beneficial for a cooking vessel to be positioned accurately over an induction heating coil or direct heating element to ensure an intended heating effect. However, if a cooking vessel is not, or cannot, be accurately positioned then it is known, in the field of induction cookers in particular, to provide movable induction cooking coils.

[0003] CN 104540260 A discloses an arrangement comprising a main heating coil and four auxiliary heating coils mounted in sliding grooves on a heating base plate. Adjusting rods enable the positions of the main heating coil and auxiliary heating coils to be adjusted within their sliding grooves to ensure uniform heating of a cooking vessel.

Summary

[0004] According to a first aspect disclosed herein, there is provided an induction cooker, comprising:

an induction cooking coil mounted upon a mechanical system to enable movement of the induction cooking coil within a predetermined region beneath a cooking surface of the cooker;
a plurality of sensors, each positioned to sense the presence of a cooking vessel when placed upon the cooking surface at a respective position of the sensor; and
a controller configured:

to receive from any of the plurality of sensors an indication of the presence of a cooking vessel at a respective position of the sensor;
to determine from the received indications a position of the cooking vessel upon the cooking surface; and
to control the mechanical system to move the induction cooking coil to a position beneath the cooking surface corresponding to the determined position of the cooking vessel.

[0005] The induction cooker according to this first aspect is therefore able automatically to compensate for imprecise placement of a cooking vessel upon a cooking surface within a range of movement of an induction cooking coil beneath the cooking surface. This ensures that the cooking vessel is heated with the intended level of power.

[0006] In an example, the plurality of sensors comprise a plurality of light sensors for sensing light incident at a respective position on the cooking surface. The light may for example be ambient light incident upon the cooking surface.

[0007] In an example, the induction cooker comprises a plurality of light sources arranged to emit light detectable by the plurality of light sensors. In this way, ambient light need not be relied upon for the detection of a cooking vessel.

[0008] In an example, the plurality of light sensors are arranged such that placement of a cooking vessel upon the cooking surface inhibits the passage of incident light to one or more of the plurality of light sensors. In this way, any sensor not receiving light indicates that a cooking vessel is present on the cooking surface at a position above the sensor. The incident light may be incident ambient light or incident light emitted by a plurality of light sources provided on the cooker.

[0009] In an example, the plurality of light sensors and the plurality of light sources are arranged such that placement of a cooking vessel upon the cooking surface reflects the emitted light towards one or more of the plurality of light sensors. In this way, any sensor receiving reflected light indicates that a cooking vessel is present on the cooking surface at a position above the sensor.

[0010] In an example, the plurality of sensors comprise one or more electromagnetic sensors.

[0011] In an example, the controller is configured to determine a centre position of a group of one or more of the plurality of sensors indicating that a cooking vessel is present and thereby to control the mechanical system to align a centre of the cooking coil with the determined centre position of the group of sensors. In this way the positioning of induction cooking coils of different sizes may be achieved under cooking vessels of different sizes without needing to know the actual size of either.

[0012] In an example, the mechanical system comprises an arrangement of one or more rails or arms linked to a respective actuator to move the induction cooking coil under the control of the controller.

[0013] In an example, the mechanical system comprises a position sensor arranged to output a signal indicative of the position of the induction cooking coil and wherein the controller is arranged to receive signals from the position sensor. In this way the controller is able to monitor the position of the cooking coil as it moves.

[0014] In an example, the induction cooker comprises a plurality of induction cooking coils of which at least two are movable by a respective said mechanical system each within a respective region beneath the cooking surface of the cooker. In such an example, the respective regions may overlap such that any one of the at least two movable cooking coils may be positioned beneath a cooking vessel placed within the overlap of the respective regions.

[0015] According to a second aspect disclosed herein,

there is provided a method for operating an induction cooker having an induction cooking coil movable beneath a cooking surface and one or more sensors for indicating the presence of a cooking vessel at a respective position when placed upon the cooking surface, the method comprising determining from indications received from the one or more sensors a position of a cooking vessel on the cooking surface and controlling movement of the induction cooking coil to a position beneath the cooking surface substantially coincident with the determined position.

[0016] In an example of the method, the induction cooker comprises two or more movable induction cooking coils and the method comprises determining the position of each of the two or more coils and controlling movement of the two or more coils to avoid a conflict in their respective positions.

[0017] In an example, the method comprises receiving an indication from a user of a power level required for cooking, and selecting a respective one of the two or more movable induction cooking coils to move to the determined position of a cooking vessel.

[0018] According to a third aspect disclosed herein, there is provided a controller for an induction cooker, configured to implement a method for operating an induction cooker a described above according to the second aspect disclosed herein.

Brief Description of the Drawings

[0019] To assist understanding of the present disclosure and to show how embodiments may be put into effect, reference is made by way of example to the accompanying drawings in which:

Figure 1 shows schematically a plan view of an example induction cooker having four induction cooking coils according to an embodiment disclosed herein;

Figure 2 shows schematically a plan view of an example induction cooker according to an embodiment disclosed herein;

Figure 3 shows schematically a plan view of an example induction cooker according to an embodiment disclosed herein;

Figure 4 shows schematically an arrangement for controlling the position of an induction cooking coil in an induction cooker according to an embodiment disclosed herein; and

Figure 5 shows schematically a plan view of an example induction cooker according to an embodiment disclosed herein.

Detailed Description

[0020] An example of an induction cooker will now be described with reference to Figure 1, able to detect the position of a cooking vessel upon a cooking surface of the cooker and to move an induction cooking coil into alignment with the cooking vessel automatically.

[0021] Referring to Figure 1, there is shown schematically an induction cooker 5 in a plan view, comprising four induction cooking coils 10, 15, 20, 25, shown in an evenly spaced arrangement, mounted on a mechanical system (not shown in Figure 1). The mechanical system enables independent movement and positioning of each of the four induction cooking coils 10-25 within a respective region beneath a cooking surface 30.

[0022] There are a number of possible arrangements for the mechanical system, as would be apparent to a person of ordinary skill in the relevant art, to enable each of the induction cooking coils 10-25 to be positioned relative to the other cooking coils 10-25. For example, each cooking coil 10-25 may be positioned by movement along a respective supporting rail and/or by rotation of a supporting arm about a pivot which may itself be movable along the rail or fixed. The rail may for example be straight or curved. Movement of each induction cooking coil 10-25 may be achieved for example using a connecting cord and pulley arrangement or a system of levers and/or gears, movable by respective actuators, for example actuators comprising electric motors, operating under the control of a controller. The actuators may cause a supported cooking coil 10-25 to travel along a respective rail or to move by rotating a respective supporting arm about a pivot for example.

[0023] All four induction cooking coils 10-25 shown in Figure 1, and as will be described below, are indicated as being movable by the principles to be described. However, in another example arrangement of two or more cooking coils 10-25, at least one of the cooking coils 10-25 may be fixed and the other or others movable. Movement of each movable induction cooking coil 10-25 may be constrained by the supporting mechanical system to move within a respective region beneath the cooking surface 30, an example of which will now be described with reference to Figure 2.

[0024] Referring to Figure 2, an example arrangement of induction cooking coils 10-25 is shown as may be achieved with the mechanical system of rails and/or arms in the cooker 5. A region 40, 45, 50, 55 may be marked upon the cooking surface 30 to indicate the extent of a region within which a cooking vessel may be placed to receive optimal heating from a respective induction cooking coil 10, 15, 20, 25. The marked regions may overlap. The regions 40-55 correspond to the extent of a rail or length of a supporting arm in the mechanical system supporting a respective cooking coil 10-25. The controller may be configured take account of the positions of the other cooking coils 10-25 when moving one cooking coil 10-25 to ensure that there is no conflict in the positioning

of any two cooking coils 10-25, if such is possible due to the overlap of the regions 40-55.

[0025] As was mentioned above, the induction cooker 5 according to the present disclosure is able to detect the position of a cooking vessel upon the cooking surface 30 and to move a respective cooking coil 10-25 into position beneath the cooking vessel automatically. An arrangement for detecting the position of a cooking vessel will now be described with reference to Figure 3, Figure 4 and Figure 5.

[0026] Referring initially to Figure 3, the example induction cooker 5 of Figure 2 is shown with an example of an underlying arrangement of the induction cooking coils 10-25. Also shown in Figure 3 is an array of photoelectric or other type of light sensors 50 which may be mounted beneath the cooking surface 30 or embedded within the cooking surface 30. The sensors 50 are sensitive to the intensity of light, for example of light of visible or infra-red wavelengths, reaching the sensors 50. A cooking vessel placed upon the cooking surface 30 prevents ambient light, or light emitted from light sources associated with the cooker above the cooking surface 30 reaching those photoelectric sensors 50 located beneath the vessel. In an alternative implementation, the sensors 50 may reflect light incident upon and reflected by the cooking vessel from below the cooking surface 30.

[0027] In an alternative example, the sensors 50 may comprise infra-red or visible light sensors each having an associated infra-red or visible light source. The light sensor is arranged to sense light emitted by the associated light source when reflected from the underside of a cooking vessel when placed above the light sensor upon the cooking surface 30.

[0028] In a further example embodiment, the sensors 50 may comprised electromagnetic sensors.

[0029] Referring also to Figure 4, a controller 70 of the induction cooker 5 may be connected to each of the photoelectric sensors 50, for example via a respective analogue to digital converter (ADC), and configured to sense the respective light levels at each sensor 50. The controller 70 may be configured to determine which of the sensors 50 in the array of sensors 50 is receiving little or no light from above the cooking surface 30 and to determine a position approximately central amongst those unilluminated sensors 50. The determined central position represents an approximate centre of the region occupied by a cooking vessel placed upon the cooking surface 30.

[0030] In the example arrangement of infra-red sensors 50 having associated infra-red sources beneath the cooking surface 30, the controller 70 may determine which of the sensors 50 is receiving reflected infra-red light and determine therefrom the position of a cooking vessel.

[0031] Having determined an approximately central position of a cooking vessel upon the cooking surface, and optionally subject to an indication from a user to activate a respective cooking coil 10-25, the controller 70 may energise one or more actuators of a rail/arm mechanical system 75, 80, 85, 90 of the respective cooking coil 10-25 to move the cooking coil 10-25 to a position coincident with the determined position of the cooking vessel. The one or more actuators may have associated position sensors to enable the controller 70 to determine the extent of movement of the respective cooking coil 10-25 and so determine when the cooking coil 10-25 reaches the determined position. At the same time, the controller 70 may receive position signals from position sensors associated with the rail/arm systems of the other cooking coils 10-25 and so determine the existing positions of the other cooking coils 10-25. If the existing position of one or more of those coils 10-25 overlaps with the determined position of the cooking vessel, then the controller 70 may move the potentially conflicting cooking coil 10-25 to a non-conflicting position, if not already in use with another cooking vessel. Any unresolvable conflicts may be indicated by the controller 70 in an alert to the user to prompt a repositioning of one or more cooking vessels on the cooking surface 30.

[0032] If a cooking vessel is positioned within an overlapping area of two of the regions 40-55, then it may be heated by either of two induction cooking coils 10-25, for example by a low power coil 15, 25 or a high power coil 10, 20. The user may select a required power level and the controller 70 may select a cooking coil 10-25 appropriate to the selected power level and to the determined position of the cooking vessel and position the selected cooking coil 10-25 beneath the cooking vessel.

[0033] The photoelectric sensors 50 may detect the level of ambient light reaching the cooking surface 30 or they may be arranged to detect light supplied from above the cooking surface 30 by a light source associated with the induction cooker. An example arrangement for a light source associate with the cooker will now be described with reference to Figure 5.

[0034] Referring additionally to Figure 5, the induction cooker 5 of Figure 3 is reproduced with the addition of light sources 60 mounted around a perimeter section 65 of the induction cooker 5, surrounding the cooking surface 30. Light emitted by at least some of the light sources 60 is detectable by each of the photoelectric sensors 50 unless a cooking vessel is placed upon the cooking surface 30 and prevents that light reaching respective sensors 50. In this way, it is not necessary for the controller 70 to rely upon the sensors 50 detecting the brightness of ambient light in order to determine the position of a cooking vessel, using instead a system of illumination associated with the induction cooker 5.

[0035] The light emitted by the light sources 60 may be within a predetermined range of wavelengths, for example in a visible or infra-red range of wavelengths. The photoelectric sensors 50 may be selected for their sensitivity to light of the wavelengths emitted by the light sources 60. The light sources 60 may for example be energised by the controller 70 when a user activates a particular induction cooking coil 10-25 or selects a required power level. The controller 70 may energise the

light sources 60 to emit a pulse of light or a sequence of light pulses or to emit light for a period of continuous illumination until a cooking vessel is detected and its approximate position on the cooking surface 30 is determined.

[0036] The controller 70 and the connected components 50, 75-90 as shown in Figure 4 are represented as a schematic block diagram for the purposes of explaining the functionality of the controller 70 and the connected components only. The configuration and implementation of the controller 70 and of the connected components 50, 75-90 may comprise any one of a number of variants as would be apparent to a person of ordinary skill in the relevant art according to the principles described herein.

[0037] The controller 70 may in practice be provided by a single chip or integrated circuit or plural chips or integrated circuits, optionally provided as a chipset, an application-specific integrated circuit (ASIC), field-programmable gate array (FPGA), digital signal processor (DSP), graphics processing units (GPUs), etc. The chip or chips may comprise circuitry (as well as possibly firmware) for embodying at least one or more of a data processor or processors, a digital signal processor or processors, baseband circuitry and radio frequency circuitry, which are configurable so as to operate in accordance with the exemplary embodiments. In this regard, the exemplary embodiments may be implemented at least in part by computer software stored in (non-transitory) memory and executable by the processor, or by hardware, or by a combination of tangibly stored software and hardware (and tangibly stored firmware).

[0038] Data storage associated with the controller 70 may be provided by a single device or by plural devices. Suitable devices include for example a hard disk and non-volatile semiconductor memory.

[0039] Although at least some aspects of the embodiments described herein with reference to the drawings comprise computer processes performed in processing systems or processors, the invention also extends to computer programs, particularly computer programs on or in a carrier, adapted for putting the invention into practice. The program may be in the form of non-transitory source code, object code, a code intermediate source and object code such as in partially compiled form, or in any other non-transitory form suitable for use in the implementation of processes according to the invention. The carrier may be any entity or device capable of carrying the program. For example, the carrier may comprise a storage medium, such as a solid-state drive (SSD) or other semiconductor-based RAM; a ROM, for example a CD ROM or a semiconductor ROM; a magnetic recording medium; optical memory devices in general; etc.

[0040] The examples described herein are to be understood as illustrative examples of embodiments of the invention. Further embodiments and examples are envisaged. Any feature described in relation to any one example or embodiment may be used alone or in combination with other features. In addition, any feature described in relation to any one example or embodiment may also be used in combination with one or more features of any other of the examples or embodiments, or any combination of any other of the examples or embodiments. Furthermore, equivalents and modifications not described herein may also be employed within the scope of the invention, which is defined in the claims.

Claims

1. An induction cooker (5), comprising:

   an induction cooking coil (10, 15, 20, 25) mounted upon a mechanical system (75, 80, 85, 90) to enable movement of the induction cooking coil (10, 15, 20, 25) within a predetermined region (40, 45, 50, 55) beneath a cooking surface (30) of the cooker (5);
   a plurality of sensors (50), each positioned to sense the presence of a cooking vessel when placed upon the cooking surface (30) at a respective position of the sensor(50); and
   a controller (70) configured:

      to receive from any of the plurality of sensors (50) an indication of the presence of a cooking vessel at a respective position of the sensor (50);
      to determine from the received indications a position of the cooking vessel upon the cooking surface (30); and
      to control the mechanical system (75, 80, 85, 90) to move the induction cooking coil (10, 15, 20, 25) to a position beneath the cooking surface (30) corresponding to the determined position of the cooking vessel.

2. The induction cooker (5) according to claim 1, wherein the plurality of sensors (50) comprise a plurality of light sensors for sensing light incident at a respective position on the cooking surface (30).

3. The induction cooker (5) according to claim 2, comprising a plurality of light sources (60) arranged to emit light detectable by the plurality of light sensors (50).

4. The induction cooker (5) according to claim 2 or claim 3, wherein the plurality of light sensors (50) are arranged such that placement of a cooking vessel upon the cooking surface (30) inhibits the passage of incident light to one or more of the plurality of light sensors (50).

5. The induction cooker (5) according to claim 3, wherein the plurality of light sensors (50) and the plurality

of light sources (60) are arranged such that placement of a cooking vessel upon the cooking surface (30) reflects the emitted light towards one or more of the plurality of light sensors (50).

6. The induction cooker (5) according to any one of claims 1 to 5, wherein the plurality of sensors (50) comprise one or more electromagnetic sensors.

7. The induction cooker (5) according to any one of claims 1 to 6, wherein the controller (70) is configured to determine a centre position of a group of one or more of the plurality of sensors (50) indicating that a cooking vessel is present and thereby to control the mechanical system (75, 80, 85, 90) to align a centre of the cooking coil (10, 15, 20, 25) with the determined centre position of the group of sensors (50).

8. The induction cooker (5) according to any one of claims 1 to 7, wherein the mechanical system (75, 80, 85, 90) comprises an arrangement of one or more rails or arms linked to a respective actuator to move the induction cooking coil (10, 15, 20, 25) under the control of the controller (70).

9. The induction cooker (5) according to claim 8, wherein the mechanical system (75, 80, 85, 90) comprises a position sensor arranged to output a signal indicative of the position of the induction cooking coil (10, 15, 20, 25) and wherein the controller (70) is arranged to receive signals from the position sensor.

10. The induction cooker (5) according to any one of claims 1 to 9, comprising a plurality of induction cooking coils (10, 15, 20, 25) of which at least two are movable by a respective said mechanical system (75, 80, 85, 90) each within a respective region (40, 45, 50, 55) beneath the cooking surface (30) of the cooker (5).

11. The induction cooker (5) according to claim 10, wherein the respective regions (40, 45, 50, 55) overlap such that any one of the at least two movable cooking coils (10, 15, 20, 25) may be positioned beneath a cooking vessel placed within the overlap of the respective regions (40, 45, 50, 55).

12. A method for operating an induction cooker (5) having an induction cooking coil (10, 15, 20, 25) movable beneath a cooking surface (30) and one or more sensors (50) for indicating the presence of a cooking vessel at a respective position when placed upon the cooking surface (30), the method comprising determining from indications received from the one or more sensors (50) a position of a cooking vessel on the cooking surface (30) and controlling movement of the induction cooking coil (10, 15, 20, 25) to a position beneath the cooking surface (30) substantially coincident with the determined position.

13. The method according to claim 12, wherein the induction cooker (5) comprises two or more movable induction cooking coils (10, 15, 20, 25), the method comprising determining the position of each of the two or more coils (10, 15, 20, 25) and controlling movement of the two or more coils (10, 15, 20, 25) to avoid a conflict in their respective positions.

14. The method according to claim 13, comprising receiving an indication from a user of a power level required for cooking, and selecting a respective one of the two or more movable induction cooking coils (10, 15, 20, 25) to move to the determined position of a cooking vessel.

15. A controller for an induction cooker, configured to implement a method for operating an induction cooker according to any one of claims 12 to 14.

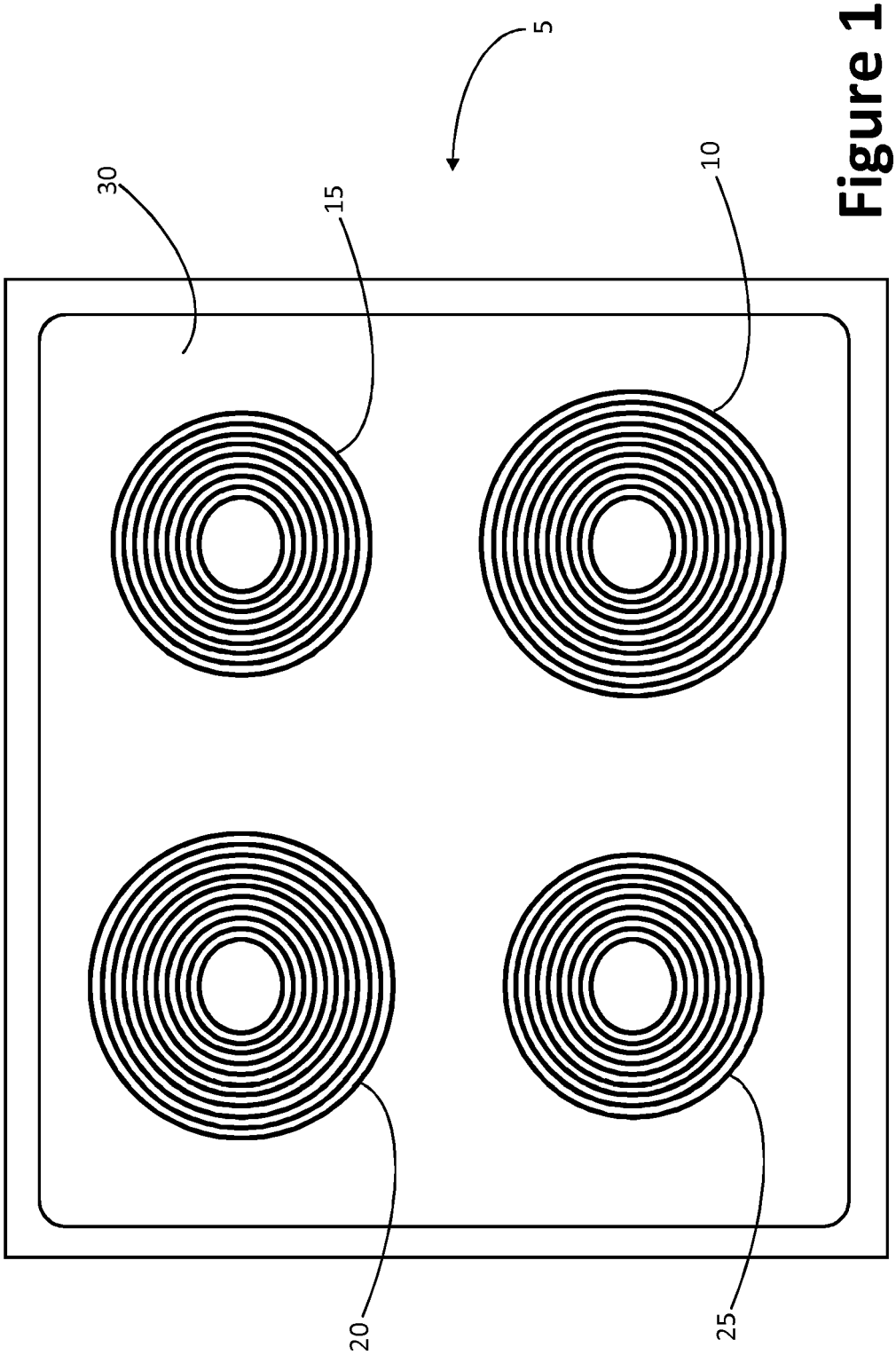


Figure 1

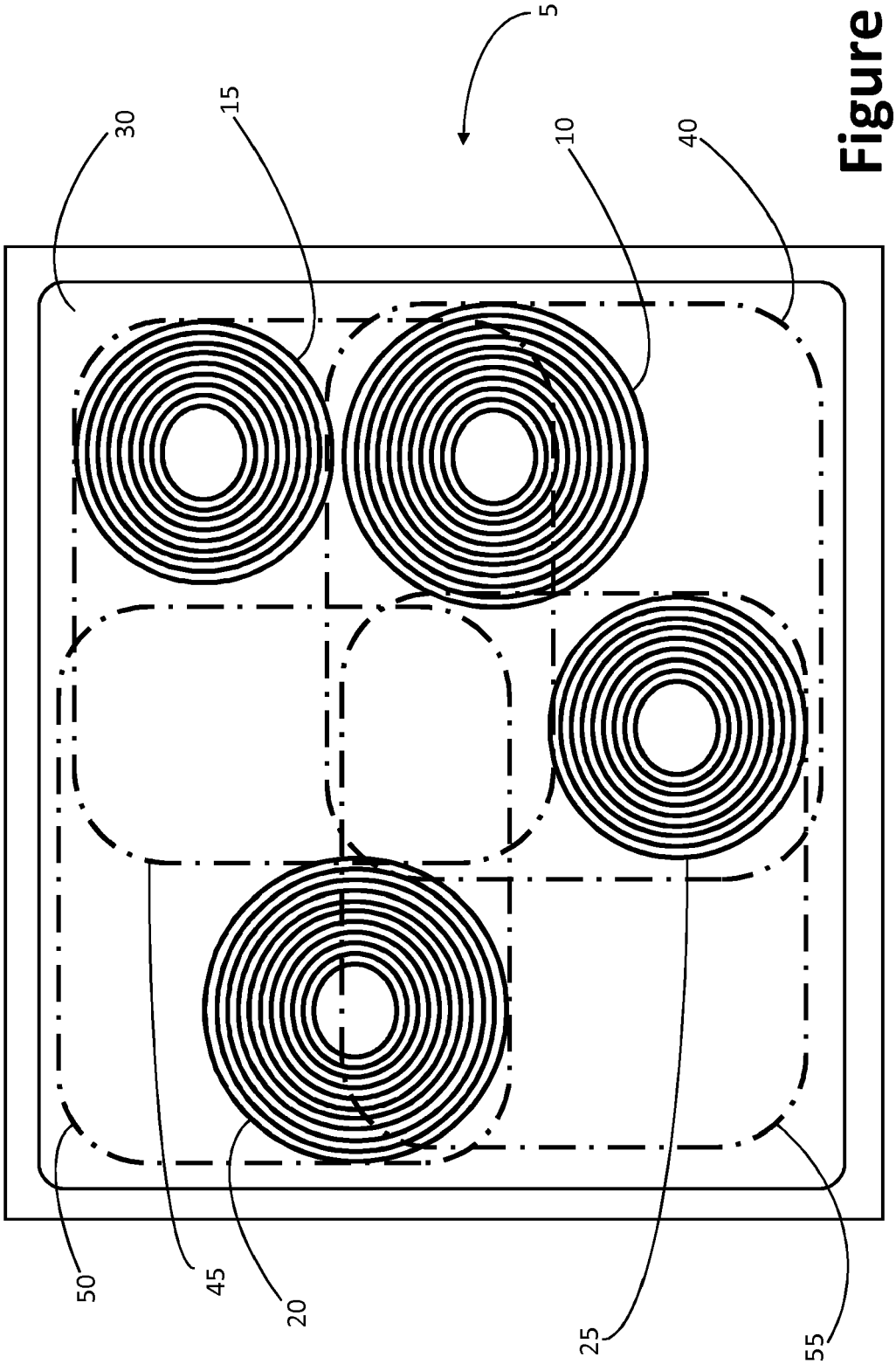
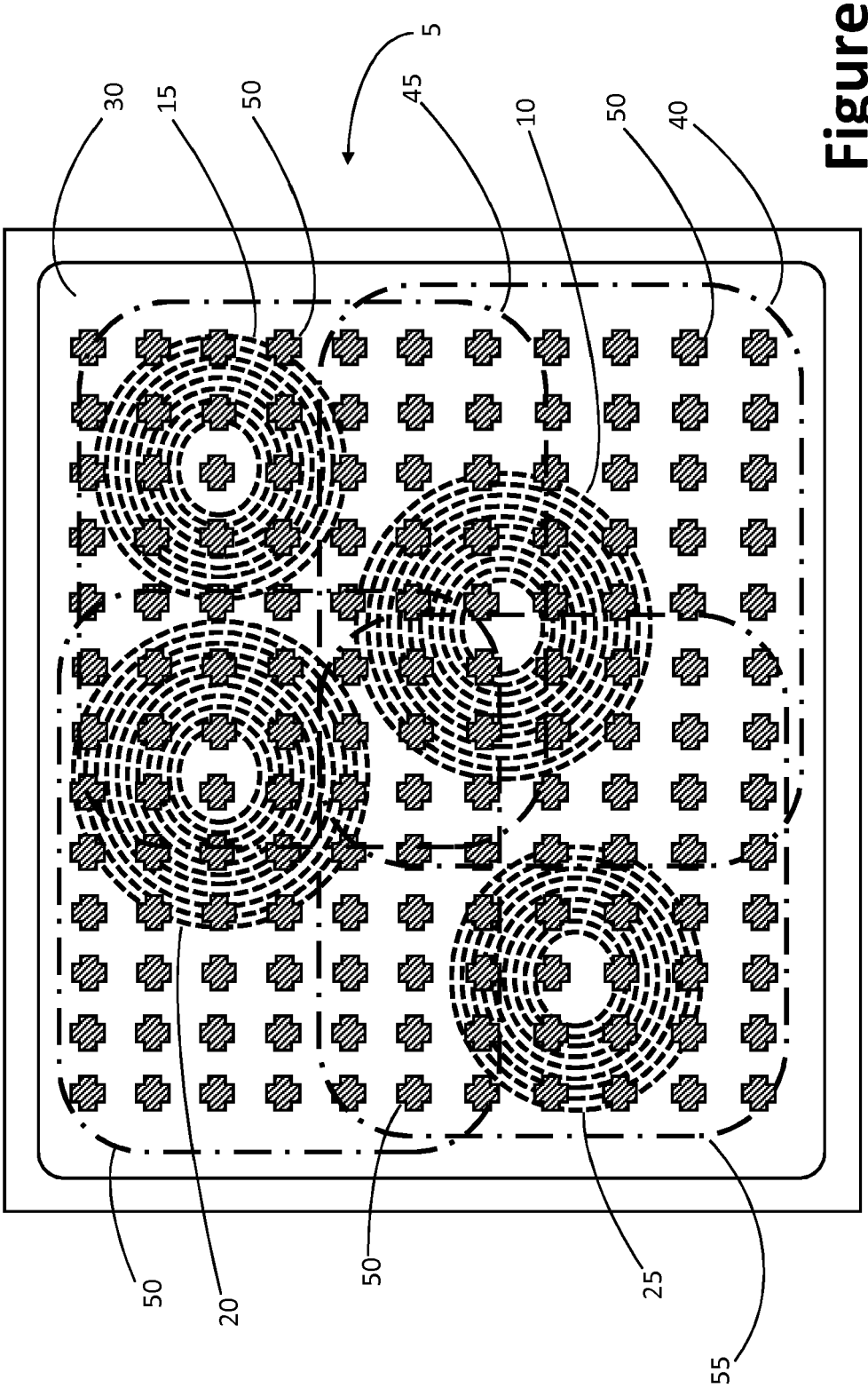


Figure 2

Figure 3



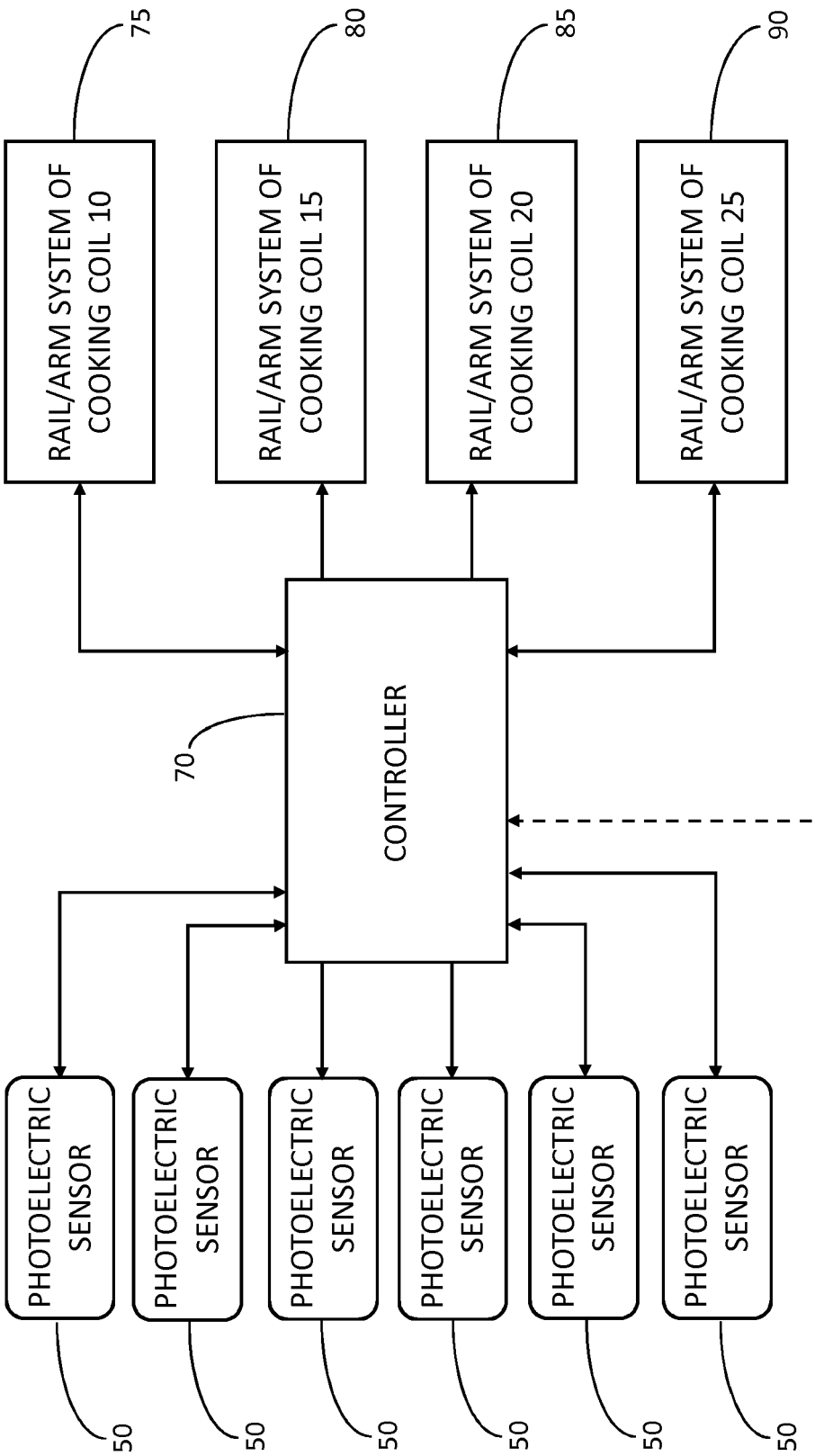
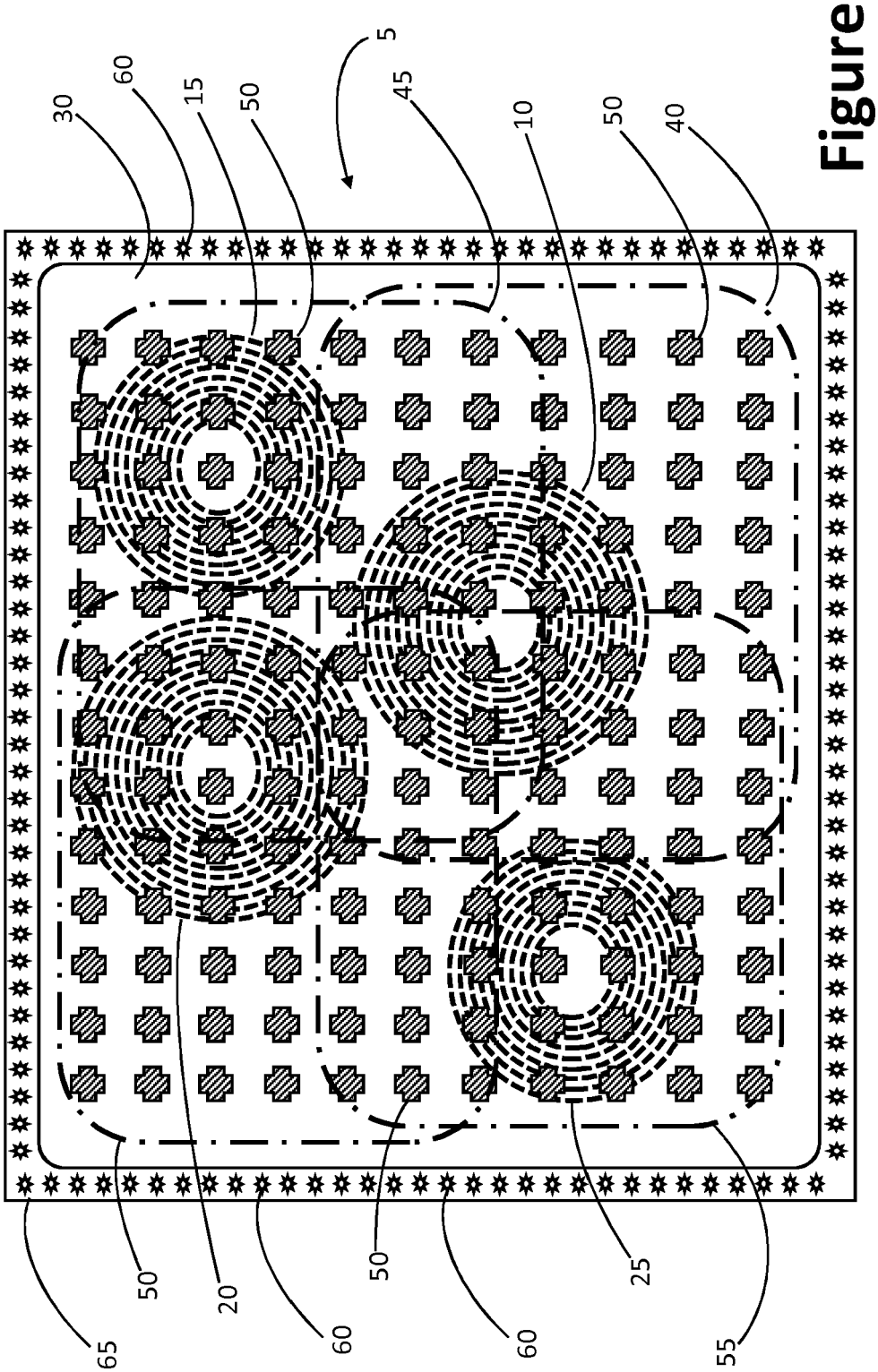

RAIL/ARM SYSTEM OF COOKING COIL 10
RAIL/ARM SYSTEM OF COOKING COIL 15
RAIL/ARM SYSTEM OF COOKING COIL 20
RAIL/ARM SYSTEM OF COOKING COIL 25
75
80
85
90
CONTROLLER
70
PHOTOELECTRIC SENSOR
50

Figure 4

Figure 5



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EUROPEAN SEARCH REPORT

Application Number
EP 17 20 3147

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	14 May 2018	Pierron, Christophe

CATEGORY OF CITED DOCUMENTS

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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