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(54) A METHOD FOR OPERATING A COOKER, A COOKER, A CONTROLLER FOR A COOKER AND A COMPUTER PROGRAM

(57) A method is provided for operating a cooker having at least one overflow sensing element associated with a heating element of the cooker, the at least one overflow sensing element having a measurable characteristic. The method comprises:
(i) making measurements of the measurable characteristic for the at least one overflow sensing element;
(ii) determining, using measurements made at (i) during a calibration period, a reference value for the characteristic for the at least one overflow sensing element;
(iii) comparing a subsequent measurement made at (i) with the respective reference value for the characteristic thereby to identify an overflow event if a determined difference between the subsequent measurement and the respective reference value of the characteristic exceeds a predetermined threshold; and
(iv) if an overflow event is identified at (iii), generating a warning for a user.

The invention extends to a cooker, a cooker controller and a computer program.

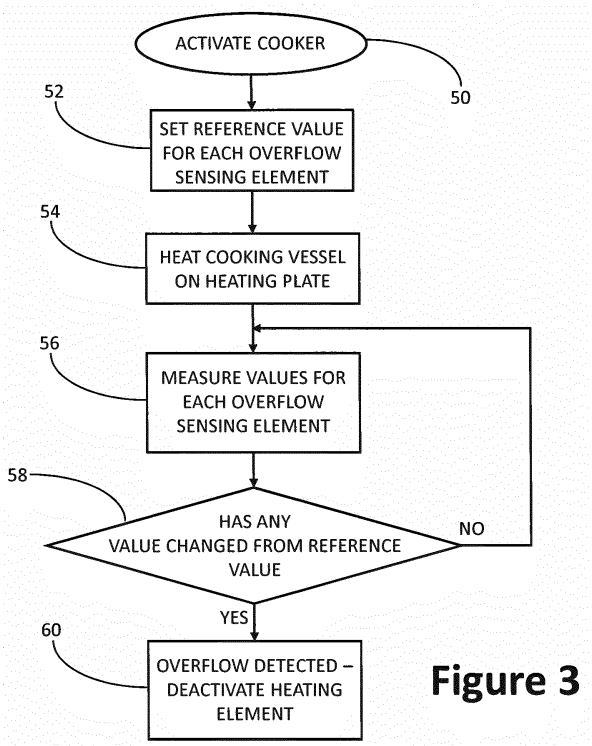

Figure 3

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Description

Technical Field

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

Background

[0002] It is known to provide touch-sensitive control elements in induction cooker surfaces, for example. In particular, it is known to provide capacitive touch sense elements which operate, in one example, by sensing a change in the capacitive coupling between conducting elements caused by the proximity of a user's finger to enable the user to control the induction cooker. However, capacitive touch sense elements may also be used to detect contaminants falling onto or forming on the cooking surface in close proximity to a touch sense element, such as a liquid spilt from a cooking vessel.

[0003] CN 202432566 U describes the use of a capacitive cooker overflow detection device, for an induction cooker in particular, surrounding a heating area of a cooker surface onto which a cooking vessel would be placed. In this way, a dedicated overflow detection arrangement is provided separately from a touch-sensitive cooker control panel.

[0004] US 2008/0150705 A1 describes a capacitive contamination detection element provided in addition to, but normally isolated from, a capacitive touch sense element on a cooking surface, for example. Detection of an overflow from a cooking vessel comprises detecting a coupling of signals from the touch sense element to the contamination detection element or vice-versa, caused by a contaminant overlaying both elements, as may typically occur with an overflow.

Summary

[0005] According to a first aspect disclosed herein, there is provided a method for operating a cooker having at least one overflow sensing element associated with a heating element of the cooker, the at least one overflow sensing element having a measurable characteristic, the method comprising:

(i) making measurements of the measurable characteristic for the at least one overflow sensing element;
(ii) determining, using measurements made at (i) during a calibration period, a reference value for the characteristic for the at least one overflow sensing element;
(iii) comparing a subsequent measurement made at (i) with the respective reference value for the characteristic thereby to identify an overflow event if a determined difference between the subsequent measurement and the respective reference value of the characteristic exceeds a predetermined threshold; and
(iv) if an overflow event is identified at (iii), generating a warning for a user.

[0006] In this way, the effect on an overflow sensing element of any contaminant or other substance, including a cooking vessel, that has formed or been placed on a cooking surface in the vicinity of the at least one overflow sensing element before a vessel is heated, is taken into account. That is, only contaminants additional to those present at the start of a cooking process are detected by an overflow sensing element when identifying an overflow event. This makes for a more reliable detection of an overflow event.

[0007] In an example, (iv) comprises deactivating the associated heating element of the cooker if an overflow event is identified. That is, when an overflow event is detected, the heating element of the cooker is automatically deactivated.

[0008] In an example, the at least one overflow sensing element comprises a capacitive touch sense element and (i) comprises making measurements of capacitance of the capacitive touch sense element or making measurements of a value indicative of said capacitance.

[0009] In an example, (ii) comprises using two or more measurements of the characteristic of the at least one overflow sensing element made at (i) during the calibration period and determining the reference value of the characteristic therefrom. This has the advantage that a stable measurement of the characteristic may be selected as the reference value, based upon multiple measurements over a measurement period, allowing for natural fluctuations in the measurable characteristic on first activating the cooker.

[0010] In an example, the at least one overflow sensing element comprises at least two overflow sensing elements and, at (iii), identifying an overflow event comprises determining that a difference between the subsequent measurements of the characteristic of the at least two overflow sensing elements and the respective reference values of the characteristic exceed a predetermined threshold. This provides a further level of confirmation that an overflow event has been identified.

[0011] In an example, (ii) comprises determining, using measurements made at (i) before activation of the associated heating element or made at another time selected by the user, a reference value for the characteristic for the at least one overflow sensing element. This ensures that the reference value is determined before there has been any opportunity of an overflow due to cooking. However, the reference value may alternatively be determined or renewed at any time selected by the user.

[0012] According to a second aspect disclosed herein, there is provided a cooker, comprising:

a cooking surface;

at least one overflow sensing element associated with the cooking surface; and
a controller being arranged:

(i) to make measurements of a characteristic of the at least one overflow sensing element;
(ii) to determine, using at least one measurement made at (i) during a calibration period, a reference value for the characteristic for the at least one overflow sensing element;
(iii) to compare a subsequent measurement made at (i) with the respective reference value for the characteristic thereby to identify an overflow event if a determined difference between the subsequent measurement and the respective reference value of the characteristic exceeds a predetermined threshold; and
(iv) if an overflow event is identified at (iii), to generate a warning for a user.

[0013] In an example of the cooker, the controller is arranged, at (iv), to deactivate a heating element of the cooker if an overflow event is identified.

[0014] In an example of the cooker, the at least one overflow sensing element comprises a capacitive touch sense element and the controller is arranged, at (i), to make measurements of capacitance of the capacitive touch sense element or to make measurements of a value indicative of said capacitance.

[0015] In an example of the cooker, the controller is arranged, at (ii), to use two or more measurements of the characteristic of the at least one overflow sensing element made at (i) during the calibration period and determining the reference value of the characteristic therefrom.

[0016] In an example of the cooker the at least one overflow sensing element comprises at least two overflow sensing elements and the controller is arranged, at (iii), to identify an overflow event if a difference between the subsequent measurements of the characteristic of the at least two overflow sensing elements and the respective reference values of the characteristic exceed a predetermined threshold.

[0017] According to a third aspect disclosed herein, there is provided a controller for a cooker, the cooker having at least one overflow sensing element associated with a cooking surface, the at least one overflow sensing element having a measurable characteristic, the controller being arranged:

(i) to make measurements of the measurable characteristic of the at least one overflow sensing element;
(ii) to determine, using at least one measurement made at (i) during a calibration period, a reference value for the characteristic for the at least one overflow sensing element;
(iii) to compare a subsequent measurement made at (i) with the respective reference value for the characteristic thereby to identify an overflow event if a determined difference between the subsequent measurement and the respective reference value of the characteristic exceeds a predetermined threshold; and
(iv) if an overflow event is identified at (iii), to generate a warning for a user.

[0018] In an example, the controller is arranged at (iv) to deactivate an associated heating element of the cooker if an overflow event is identified.

[0019] In an example, the at least one overflow sensing element comprises a capacitive touch sense element and the controller is arranged, at (i), to make measurements of capacitance of the capacitive touch sense element or to make measurements of a value indicative of said capacitance.

[0020] In an example, the controller is arranged at (ii) to use two or more measurements of the characteristic of the at least one overflow sensing element made at (i) during the calibration period and to determine the reference value of the characteristic therefrom.

[0021] According to a fourth aspect disclosed herein, there is provided a computer program which when installed and executed by a digital processor causes the digital processor to implement the method according to examples of the first aspect described above.

Brief Description of the Drawings

[0022] 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 an example of a cooking surface according to the present disclosure;

Figure 2 shows schematically an example of two capacitive overflow sensing elements as may be used in examples in the present disclosure; and

Figure 3 is a flow chart showing an example of a process for operating a cooker according to the present disclosure.

Detailed Description

[0023] An example implementation of the present invention will be described in the context of an induction cooker or other type of cooker having a flat glass or ceramic cooking surface. Such cooking surfaces are often provided with touch sense elements for use in controlling features of the cooker. These touch sense elements are typically of the capacitive type and used with a multi-channel touch sense microcontroller unit (MCU) and/or a main controller of the cooker arranged to detected

changes in capacitance of each touch sense element and thereby sense a touch by a user.

[0024] It is known to provide capacitive touch sense elements in regions of a cooking surface for the purpose of detecting an overflow of liquid or other cooking ingredients from a cooking vessel, for example. However, such regions of a cooking surface may also be likely to accumulate other contaminants such as moisture or limescale which reduces the reliability of detecting an overflow by those elements.

[0025] A failure to detect an overflow and to take action to switch off the respective heating element and warn the user may result in the cooking vessel overheating and spoilage or messing of the cooking surface. Furthermore, any touch-sensitive controls provided to control functions of the cooker may also be over-run by an overflowing liquid before any action can be taken by the user to disable the heating elements of the cooker, with unpredictable and potentially dangerous results.

[0026] It would therefore be beneficial to have a reliable way to detect an overflow of liquid from a cooking vessel, preferably before the liquid reaches the touch-sensitive controls for the cooker.

[0027] Examples of the present invention provide a configurable overflow detection system more able to distinguish an overflow of liquid from the presence of a contaminant such as moisture, steam or limescale. However, the present invention may be applied to any touch sense control arrangement and is not limited to overflow detection, as will be apparent from the description that follows. An example will now be described, initially with reference to Figure 1.

[0028] Referring to Figure 1, a cooking surface 10 of an induction cooker, for example, is shown schematically in a plan view. The cooking surface includes four heating regions 12, 14, 16 and 18 for placing cooking vessels to be heated. A region of touch-sensitive cooker controls 20 is also provided. Each of the regions 12-18 for placing cooking vessels is surrounded by a respective group of one or more capacitive overflow sensing elements 22, 24, 26 and 28 intended to detect an overflow from a cooking vessel placed on the respective heating area 12-18. Each of the groups of elements 22-28 may be connected to a respective multi-channel touch sense microcontroller unit (MCU), in this example an MCU having at least eight touch sense channels. The touch sense MCU may for example be of a charge-timing capacitance to digital converter (CDC CT) type or a relaxation-oscillator (RO) converter type.

[0029] Referring additionally to Figure 2, two overflow sensing elements 22-28 are shown, each comprising a pair of electrodes 30, 32 and 34, 36 for use in sensing the presence of an overflow liquid 38 by a mutual capacitance sensing method. An MCU 40 is arranged to measure mutual capacitance of each pair of electrodes 30, 32 and 34, 36 of the overflow sensing elements 22-28, or a parameter indicative of mutual capacitance, and to output the measurements for each of the overflow sensing elements 22-28 in a group to a cooker controller 42. Such data may be used by a cooker controller 42, as will be described below with reference to Figure 3 according to an example, to determine whether there has been a change in mutual capacitance indicative of an overflow of liquid or other substance onto the respective region of the cooking surface 10. Alternatively, a different type of sensing element 22-28 may be provided for sensing an overflow liquid 38 by the self-capacitance sensing method.

[0030] In an alternative implementation, the functionality of the MCU 40 described above may be included within the functionality of the cooker controller 42 such that the functionality to be described below with reference to Figure 3 may be implemented entirely by the cooker controller 42.

[0031] Referring additionally to Figure 3, a flow chart is provided showing an example of steps in operating a cooker having overflow protection described herein, in particular a cooker having overflow sensing elements 22-28 shown in Figure 1. When activating the cooker, for example before or immediately after activating a particular heating element (12-18) of the cooker at STEP 50, the touch sense MCU 40 is triggered at STEP 52 to measure the mutual capacitance of each pair of electrodes 30, 32 and 34, 36 of each overflow sensing element 22-28 or to measure another parameter indicative of the mutual capacitance in the element. The MCU 40 is arranged to repeat the measurements for each overflow sensing element 22-28 in a cyclic manner and to output the measurements to the cooker controller 42. The cooker controller 42 is arranged, during a calibration period of predetermined length, to receive measurements output by the MCU 40 carried out over a number of cycles during the calibration period from activation of the cooker at STEP 50 or beginning at a time selected by a user. If the measured values for each overflow sensing element 22-28 are substantially equal for each cycle or at least remain within a predetermined range of values during the calibration period, then a single value or an average value is calculated for each overflow sensing element 22-28 and stored as a respective reference measurement. Each reference measurement implicitly takes account of the presence of any existing contaminant upon the cooking surface in the vicinity of the respective overflow sensing element 22-28 and its effect upon the measured or indicated mutual capacitance. Any subsequent variation in a measured value for one or more overflow sensing elements 22-28 in a particular group as compared with the respective stored reference value is likely to be due to the presence of a new contaminant on the cooking surface.

[0032] While heating a cooking vessel placed upon a heating region 12-18 of the cooking surface 10 at STEP 54, the MCU 40 is arranged at STEP 56 to make regular measurements of mutual capacitance of each overflow sensing element 22-28 in the respective group of elements, or optionally of all the overflow sensing elements

22-28 on the cooking surface 10, and to pass the measurements to the cooker controller 42. At STEP 58, the cooker controller 42 compares a latest measured value with the respective stored reference value for each overflow sensing element 22-28.

[0033] If, at STEP 58, the cooker controller 42 determines that the latest measured value for a given overflow sensing element 22-28 differs from the respective stored reference value by more than a predetermined threshold amount, then it is assumed that a different level of contamination is now upon the cooking surface 10 in the vicinity of the overflow sensing element 22-28. The cooker controller 42 may be programmed to determine that this difference for one overflow sensing element 22-28 is to be recognised as an overflow event. Alternatively, the cooker controller 42 may be programmed to determine that an overflow event is to be recognised only if at least two of the overflow sensing elements in a group of elements 22-28 indicates a different level of contamination over the reference level. If an overflow event is recognised at STEP 58 then, at STEP 60, the cooker controller 42 deactivates the respective heating element and/or generates a warning signal, for example, to alert a user of the cooker to the recognised overflow event.

[0034] If, at STEP 580, an overflow event is not detected, then the process returns to STEP 56 to continue the measurement of mutual capacitance for each overflow sensing element 22-28. The cycle continues until the cooker is deactivated by a user or as a result of the cooker controller 42 recognising an overflow event.

[0035] A benefit of the method described above with reference to Figure 3 is that if, for example, a cooking vessel is placed such that a part of the cooking vessel overlaps one or more of the overflow sensing elements 22-28 in a respective group, the presence of the cooking vessel will be taken into account when setting the reference measurement values. Any subsequent change, in particular any increase in a measured mutual capacitance value, for example in combination with a change to one or more adjacent overflow sensing elements 22-28 in the group, is therefore likely to be due to an overflow.

[0036] When comparing subsequently measured values at STEP 58 in Figure 3, account may be taken of whether the measured value increases or decreases as compared with the respective reference value. The cooker controller 42 is arranged to ignore any decrease in mutual capacitance for any given overflow sensing element 22-28 as compared with the reference value for the purposes of detecting an overflow on the basis that the mutual capacitance would be expected only to increase in the presence of an overflow or any other additional contaminant.

[0037] Whereas the description of embodiments of the present invention have been in the context of overflow sensing on a cooking surface, it would be clear to a notional skilled person that the present invention may be applied to touch sense controls generally. That is, by the techniques described above, the performance of touch sense controls may be improved if account is taken, when detecting a user's touch, of pre-existing contaminants on a surface in close proximity to the touch sense elements.

[0038] It will also be clear to a notional skilled person in this field that where the detection based upon mutual capacitance has been described in the examples above, other capacitive sensing methods and electrode arrangements may be used. For example sensing of self-capacitance using a single electrode may be used as an alternative in particular applications of the present invention. The present invention may also be applied to other touch sense techniques and electrode arrangements likely to be exposed to pre-existing contaminants.

[0039] It will be understood that the MCU 40 and the cooker controller 42 may be implemented using a processor or processing system or circuitry 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).

[0040] Reference is made herein to data storage for storing reference measurement values. This may be provided by a single device or by plural devices. Suitable devices include for example a hard disk and non-volatile semiconductor memory.

[0041] 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, for example a floppy disk or hard disk; optical memory devices in general; etc.

[0042] The examples described herein are to be understood as illustrative examples of embodiments of the invention. Further embodiments and examples are en-

visaged. 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. A method for operating a cooker having at least one overflow sensing element associated with a heating element of the cooker, the at least one overflow sensing element having a measurable characteristic, the method comprising:

   (i) making measurements of the measurable characteristic for the at least one overflow sensing element;
   (ii) determining, using measurements made at (i) during a calibration period, a reference value for the characteristic for the at least one overflow sensing element;
   (iii) comparing a subsequent measurement made at (i) with the respective reference value for the characteristic thereby to identify an overflow event if a determined difference between the subsequent measurement and the respective reference value of the characteristic exceeds a predetermined threshold; and
   (iv) if an overflow event is identified at (iii), generating a warning for a user.

2. The method according to claim 1, wherein (iv) comprises deactivating the associated heating element of the cooker if an overflow event is identified.

3. The method according to claim 1 or claim 2, wherein the at least one overflow sensing element comprises a capacitive touch sense element and (i) comprises making measurements of capacitance of the capacitive touch sense element or making measurements of a value indicative of said capacitance.

4. The method according to any one of claims 1 to 3, wherein (ii) comprises using two or more measurements of the characteristic of the at least one overflow sensing element made at (i) during the calibration period and determining the reference value of the characteristic therefrom.

5. The method according to any one of claims 1 to 4, wherein the at least one overflow sensing element comprises at least two overflow sensing elements and, at (iii), identifying an overflow event comprises determining that a difference between the subsequent measurements of the characteristic of the at least two overflow sensing elements and the respective reference values of the characteristic exceed a predetermined threshold.

6. The method according to any one of claims 1 to 5, wherein (ii) comprises determining, using measurements made at (i) before activation of the associated heating element or made at another time selected by the user, a reference value for the characteristic for the at least one overflow sensing element.

7. A cooker, comprising:

   a cooking surface;
   at least one overflow sensing element associated with the cooking surface; and
   a controller being arranged:

   (i) to make measurements of a characteristic of the at least one overflow sensing element;
   (ii) to determine, using at least one measurement made at (i) during a calibration period, a reference value for the characteristic for the at least one overflow sensing element;
   (iii) to compare a subsequent measurement made at (i) with the respective reference value for the characteristic thereby to identify an overflow event if a determined difference between the subsequent measurement and the respective reference value of the characteristic exceeds a predetermined threshold; and
   (iv) if an overflow event is identified at (iii), to generate a warning for a user.

8. The cooker according to claim 7, wherein the controller is arranged, at (iv), to deactivate a heating element of the cooker if an overflow event is identified.

9. The cooker according to claim 7 or claim 8, wherein the at least one overflow sensing element comprises a capacitive touch sense element and the controller is arranged, at (i), to make measurements of capacitance of the capacitive touch sense element or to make measurements of a value indicative of said capacitance.

10. The cooker according to any one of claims 7 to 9, wherein the at least one overflow sensing element comprises at least two overflow sensing elements and the controller is arranged, at (iii), to identify an overflow event if a difference between the subse-

quent measurements of the characteristic of the at least two overflow sensing elements and the respective reference values of the characteristic exceed a predetermined threshold.

11. A controller for a cooker, the cooker having at least one overflow sensing element associated with a cooking surface, the at least one overflow sensing element having a measurable characteristic, the controller being arranged:

(i) to make measurements of the measurable characteristic of the at least one overflow sensing element;
(ii) to determine, using at least one measurement made at (i) during a calibration period, a reference value for the characteristic for the at least one overflow sensing element;
(iii) to compare a subsequent measurement made at (i) with the respective reference value for the characteristic thereby to identify an overflow event if a determined difference between the subsequent measurement and the respective reference value of the characteristic exceeds a predetermined threshold; and
(iv) if an overflow event is identified at (iii), to generate a warning for a user.

12. The controller according to claim 11, arranged at (iv) to deactivate an associated heating element of the cooker if an overflow event is identified.

13. The controller according to claim 11 or claim 12, wherein the at least one overflow sensing element comprises a capacitive touch sense element and the controller is arranged, at (i), to make measurements of capacitance of the capacitive touch sense element or to make measurements of a value indicative of said capacitance.

14. The controller according to any one of claims 11 to 13, arranged at (ii) to use two or more measurements of the characteristic of the at least one overflow sensing element made at (i) during the calibration period and to determine the reference value of the characteristic therefrom.

15. A computer program which when installed and executed by a digital processor causes the digital processor to implement the method according to any one of claims 1 to 6.

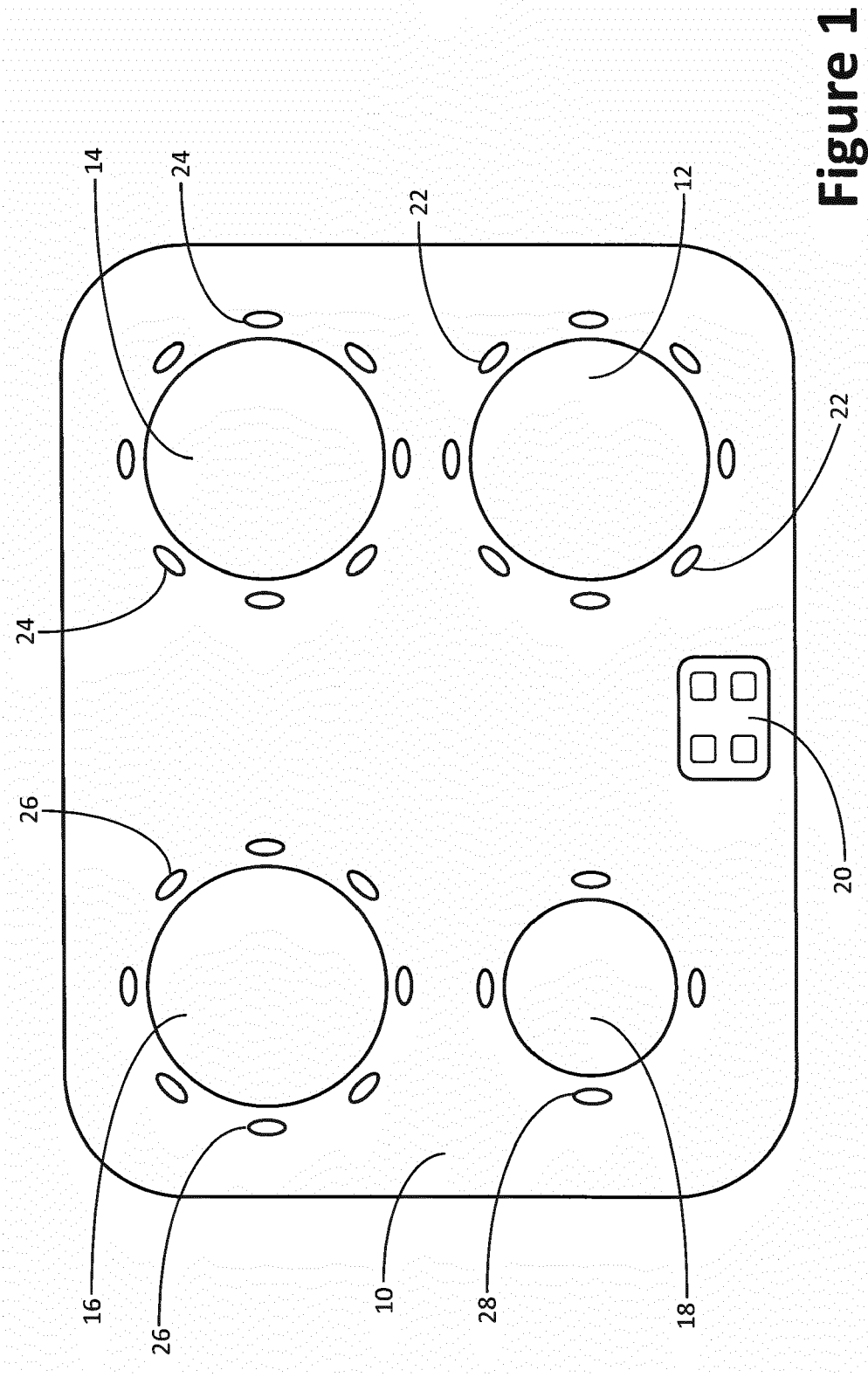

Figure 1

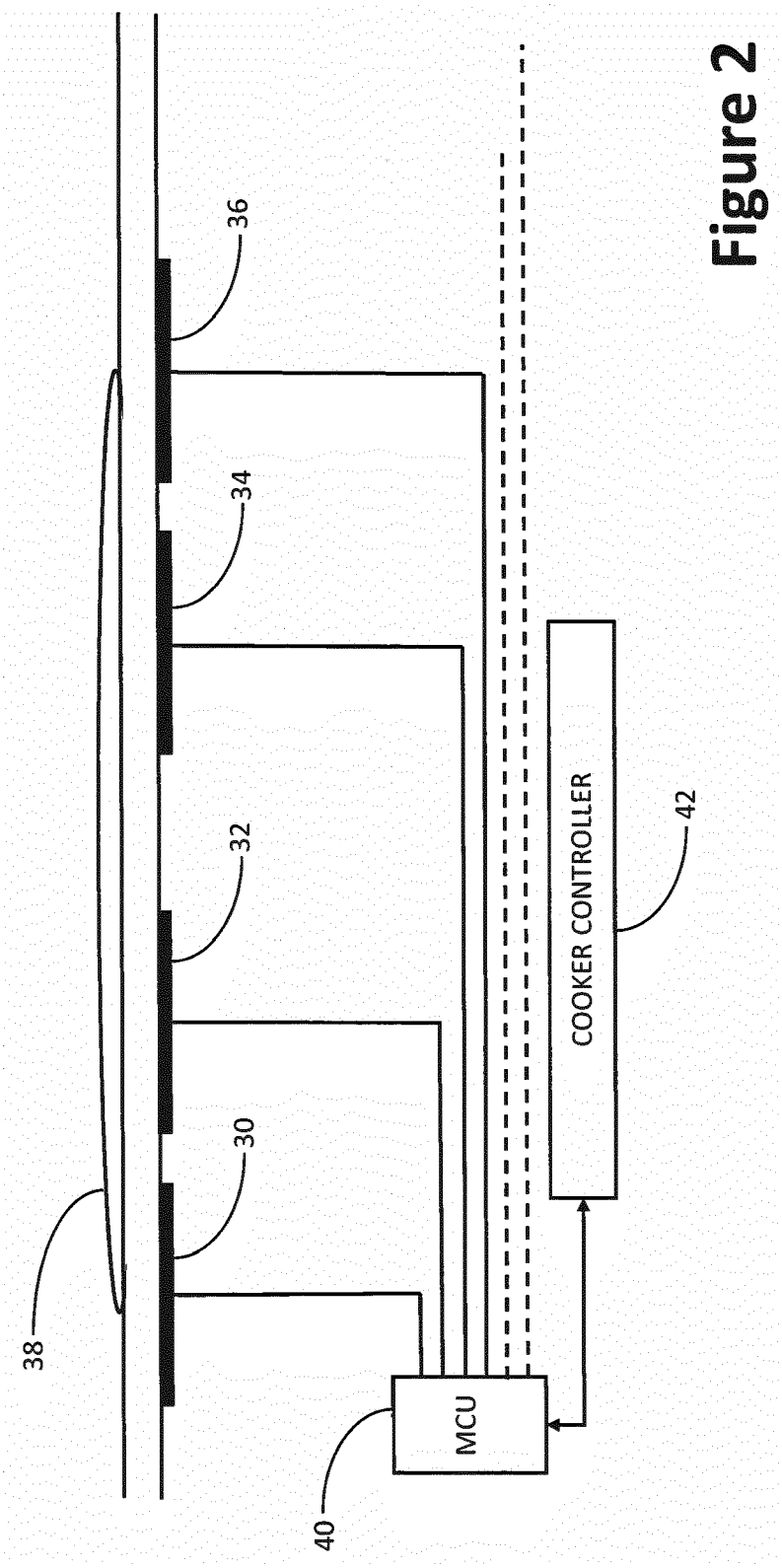

Figure 2

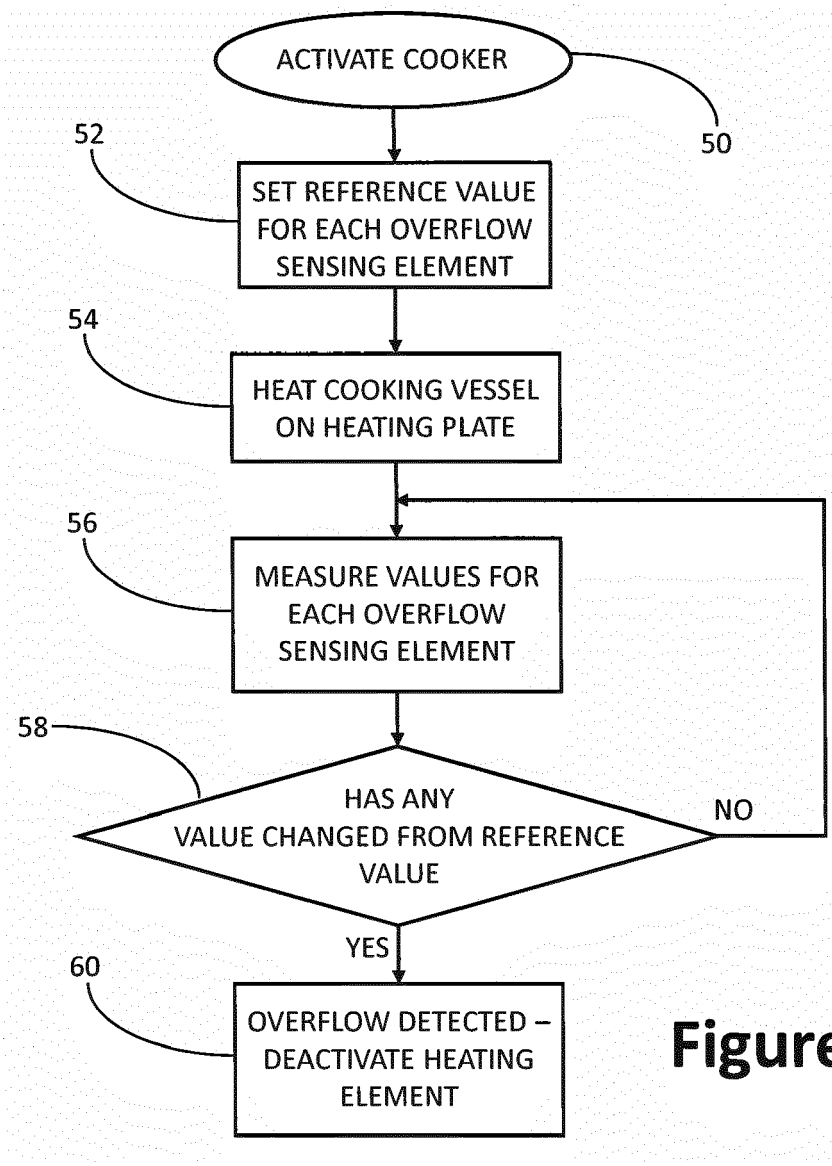
ACTIVATE COOKER
50
52
SET REFERENCE VALUE FOR EACH OVERFLOW SENSING ELEMENT
54
HEAT COOKING VESSEL ON HEATING PLATE
56
MEASURE VALUES FOR EACH OVERFLOW SENSING ELEMENT
58
HAS ANY VALUE CHANGED FROM REFERENCE VALUE
NO
YES
60
OVERFLOW DETECTED – DEACTIVATE HEATING ELEMENT

Figure 3

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EUROPEAN SEARCH REPORT

Application Number
EP 17 19 4222

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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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	16 March 2018	Pierron, Christophe

CATEGORY OF CITED DOCUMENTS

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16-03-2018

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

REFERENCES CITED IN THE DESCRIPTION

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