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(54) SENSOR ELEMENT FOR A MICROWAVE DEVICE, AND MICROWAVE DEVICE FOR HEATING COMESTIBLE

(57) The invention relates to a sensor element (1) for a microwave device (2), comprising at least one sensor cell (3) for detecting property values of the comestibles (4) and a data transmitter (5), and
the data transmitter (5) is set up to transmit data from an inside of a cooking chamber (6) of a microwave device (2), defined by an shielding member preventing a microwave radiation from exiting the cooking chamber (6) from the inside to an outside, to a control unit (7) arranged on the outside of the cooking chamber. The sensor element (1) is characterised in particular by the fact that the sensor element (1) is suitable for simultaneously measuring respective property values of the comestibles (4) at spaced measuring points (8).

The sensor element, the microwave design and the method shown here make it possible to detect property values of comestibles within the microwave device and use them for a user-friendly and high quality preparation of a comestible.

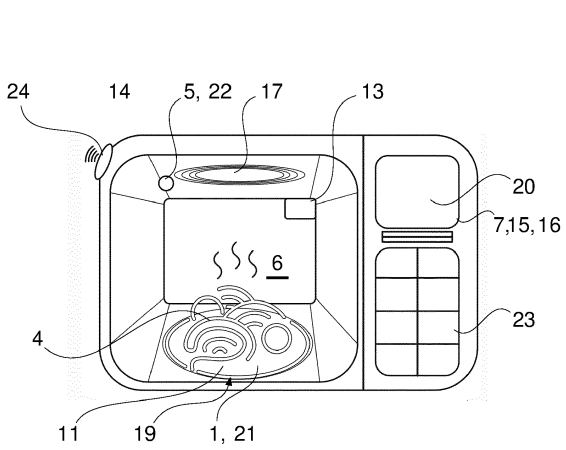

Fig. 1

EP 4 290 981 A1

Description

[0001] The invention relates to a sensor element for a microwave device, a microwave device for heating comestible, and a method with such a microwave device for preparing comestible by means of a microwave device.

[0002] Known microwaves or microwave devices generate microwave radiation by using a magnetron. The microwave radiation is sent into a cooking chamber to heat a comestible there. To shield the environment from the microwave radiation, the cooking chamber is provided with a shielding member that forms a Faraday cage against microwave radiation. Such a Faraday cage prevents the use of classic wireless sensors in the cooking chamber.

[0003] However, newer sensors are known from EP3527042B1 which, for example, can transmit the measured values of the sensors out of the Faraday cage via optical signals. For example, a glass panel with a metal grid can be provided, which shields the radiation in the wavelength range of microwave radiation but is permeable to radiation in other wavelength ranges, for example in the range of optically perceptible light or infrared radiation. This allows a user or photocell to receive the light signal.

[0004] The present invention is based on the task of at least partially overcoming the disadvantages known from the prior art. The features according to the invention result from the independent claims, for which advantageous embodiments are shown in the dependent claims. The features of the claims can be combined in any technically sensible manner, wherein the explanations from the following description as well as features from the figures, which comprise supplementary embodiments of the invention, can also be consulted for this purpose.

[0005] The invention relates to a sensor element for a microwave device, comprising at least one sensor cell for detecting property values of a comestible and a data transmitter,
wherein the data transmitter configured to transmit data from an inside of a cooking chamber of a microwave device, defined by an shielding member preventing a microwave radiation from exiting the cooking chamber from the inside to an outside, to a control unit arranged on the outside of the cooking chamber.

[0006] The sensor element is characterised in particular by the fact that the sensor element is suitable for simultaneously measuring respective property values of the comestible at measuring points spaced apart from one another.

[0007] Unless explicitly stated to the contrary, ordinal numbers used in the preceding and following descriptions are merely for the purpose of unambiguous distinguishability and do not reflect any order or ranking of the designated components. An ordinal number greater than one does not imply that another such component must necessarily be present.

[0008] The sensor element according to the invention is designed for use in the cooking chamber of a microwave device in order to measure property values of a comestible during operation of the microwave device, for example while microwave radiation is being applied to the comestible, and to transmit them to the control unit. The sensor element is designed, for example, to come into direct contact with the comestible, for example to be pushed into the comestible. Alternatively or additionally, the sensor element is designed to detect property values of the comestible in the cooking chamber (for example without direct contact with the comestible). For example, the sensor element is configured to be positioned in the ambient air of the comestible, preferably inside a comestible container, or in contact with the comestible container, for example below the comestible container. In a further embodiment, the sensor element is configured be positioned in contact with steam or water emerging from the comestible or in a cooking medium such as cooking water (for example in a collecting container provided for this purpose). Furthermore, in one embodiment, the sensor element is integrated in a comestible container, preferably in a base, a lid and/or a wall of the comestible container.

[0009] According to one example, the sensor element has one or more sensor cells to determine one or more different property values of the comestibles. Preferably, at least one of the sensor cells is a temperature sensor. Alternatively or additionally, the sensor element comprises other sensor cells, for example, moisture sensors, pressure sensors, sensors for detecting a viscosity, the colour, the electrical resistance and/or the chemical properties of the comestibles.

[0010] The property values of one or more comestibles in the cooking chamber of the microwave device can be detected by using the sensor element. The comestibles are, for example, liquid, comprise a low or high viscosity or are solid, have a homogeneous or heterogeneous composition and are positioned, for example, in a comestible container with or without a cooking medium (for example, water) in the cooking chamber. In one example, such a comestible is potatoes, fish, meat, vegetables or a frozen dish (for example a lasagne or a burger patty). The comestible container is either open (for example a plate or a can that is open at the top) or closed (for example a can with a lid, preferably with a hole or valve). The data transmitter is wireless or wired. For example, the data transmitter is configured of providing a signal that is significantly different from the wavelength of the radiation used in the microwave device and that passes through the shielding member that shields the microwave radiation. For example, the signal is an optical signal in the visible or infrared wavelength range.

[0011] Preferably the shielding member prevents at least radiation with a wavelength of more than 0.1 mm (zero-point-one millimetre), more preferably more than 1 mm (one millimetre) from exiting the cooking chamber. Preferably the wireless data transmitter provides a signal

with a wavelength of less than 10 pm (ten micrometre), e.g., an infrared signal. More preferably the wireless data transmitter provides a signal with a wavelength of less than 1 μm (one micrometre) or less than 700 nm (nanometre), e.g., in the visible or ultraviolet spectrum.

[0012] Preferably, the data transmitter comprises a first transmitting section in a (relative to the microwave device) freely movable sensor body, in which the at least one sensor cell is also arranged, and a second transmitting section which is fixed to the microwave device in the cooking chamber. Preferably, the first transmitting section and the second transmitting section are communicatively connected (in a data connection) with each other in such a way that a corresponding signal for transmitting the data can be sent through the comestibles and/or comestible containers, and the second transmitting section is connected to a control unit outside the cooking chamber using the (for example optical) data connection described above which functions through the shielding member of the cooking chamber. For this purpose, for example, a transparent section made of transparent plastic or glass (for example with a metal grid for shielding the microwave radiation) can be arranged in a cooking chamber wall (the shielding member respectively), through which a signal for the data connection can be sent from the data transmitter or the second transmission section of the data transmitter to the control unit. In one example, the data transmitter is also a data receiver for receiving data from the control unit or the sensor element comprises an additional data receiver for that purpose.

[0013] In one example, the control unit is connected to a user interface and a microwave source. The user interface comprises, for example, a display to provide information to a user based on the property values of the comestible detected by the sensor element. Furthermore, the microwave source for heating the comestible is controllable, for example, using the control unit based on the detected property values of the comestible.

[0014] According to the invention, the sensor element is now suitable for simultaneously measuring (detecting) respective property values of the comestible at measuring points spaced apart from one another. The sensor element can be configured to measure different or several of the same type of property values. Preferably, the sensor element is configured to measure the temperature of the comestible simultaneously at several points. In this case, simultaneous means that the sensor element does not have to be moved from one location to another in order to detect the respective property value at both locations (measuring points).

[0015] Preferably, the sensor element comprises several sensor cells, each of which is configured to detect a property value of the comestible at a measuring point. For example, each sensor cell can be used to detect a different property value (for example, one is a temperature measuring cell and one is a moisture measuring cell) or the same property value can be detected using several or all sensor cells (for example, all sensor cells are temperature measuring cells). Alternatively, one sensor cell is suitable for detecting property values at several measuring points at the same time.

[0016] By detecting the property values of the comestible at several measuring points, it is possible to obtain a realistic impression of the properties of the comestible even if the heating of the comestible is uneven (for example, because the comestible is heterogeneous or because of intensity maxima and minima of the microwave radiation applied to the comestible) and to control the microwave device accordingly.

[0017] It is further proposed in an advantageous embodiment of the sensor element that a base body is made of a flexible material, preferably silicone.

[0018] According to this embodiment, the sensor element comprises a base body made of flexible material. The at least one sensor cell is embedded in the base body. The flexible material enables elastic deformation of the base body, so that the base body or the sensor element can be inserted into different comestible containers, for example, by elastically deforming the base body during insertion. For example, the base body is made of silicone.

[0019] This allows a flexible use of the sensor element. At the same time, the base body is preferably heat-resistant.

[0020] It is further proposed in an advantageous embodiment of the sensor element that a support surface for the comestible or a comestible container is formed by the sensor element.

[0021] According to this embodiment, the sensor element preferably has a flat basic shape. A comestible or comestible container can be placed on the contact surface formed by the sensor element. In one example, the sensor element can be positioned on a plate or in another comestible container below the comestible. Alternatively, such a sensor element can be placed on the comestible, or a comestible container can be covered with it.

[0022] Further, such a sensor element preferably comprises (as described above) an elastic base body, too, and forms a flexible mat. Alternatively, such a sensor element is rigid and forms, for example, a plate, a turntable in the microwave device or another comestible container. Preferably, using such a sensor element, several measuring points are formed along a transverse direction and several measuring points along a longitudinal direction of the sensor element. Especially preferably, the multiple sensor cells are arranged along the longitudinal direction and multiple sensor cells along the transverse direction.

[0023] This embodiment offers the advantage that the property values of the comestible (for example the temperature) can be measured over an area (for example a surface) and the sensor element can be used flexibly in many applications.

[0024] In an alternative embodiment, the sensor element is designed, for example, as a rod. The rod preferably has a tip at one end for easier insertion into the

comestible. Preferably, the rod forms several measuring points along its longitudinal direction, particularly preferably it has several sensor cells arranged along the longitudinal direction. The rod is preferably flexible, with an elastic base body (as described above) or rigid, so that it can be easily inserted into solid comestibles.

[0025] It is further proposed in an advantageous embodiment of the sensor element that at least one recess for receiving and/or transporting away liquids emerging from the comestible is arranged in the support surface.

[0026] According to this embodiment at least one recess, for example in the form of a groove, a passage opening or a collecting recess is provided in the sensor element. When a comestible rests on the sensor element, liquid that emerges from the comestible can be transported away from it. The liquid is preferably collected in a recess of the sensor element or in a collecting container (which is formed by the comestible container, for example) arranged below or next to it.

[0027] A sensor element according to this embodiment is particularly advantageous when comestibles are to be defrosted, comestibles with a high water content are to be prepared and/or the comestibles are to be given a firm/crunchy consistency.

[0028] Preferably the sensor cells are arranged in the sensor element so that they are (in a use case) in direct contact to the comestible or separated from it solely by a protection layer, which has a high permeability for heat and/or humidity. More preferably the recess is leading the liquid away from the sensor cells, so that the temperature (or other properties) of the comestible is measured (not of the emerging liquid). In one alternative the recess is provided in a support surface separate from the sensor element, and leading away the liquids form the sensor element.

[0029] According to a further aspect, a microwave device for heating comestibles is proposed, comprising

- a microwave source;
- a cooking chamber for receiving comestible defined by a shielding member, electromagnetically shielding an inside of the cooking chamber (6) from an outside (environment);
- a user interface;
- a sensor element, preferably according to an embodiment as described above, with at least one sensor cell for detecting property values of the comestibles; and
- a control unit which is connected to the microwave source and the user interface communicatively.

[0030] The microwave device is characterised by the fact that the sensor element is communicatively connected to the control unit, and
the microwave source is controllable via the control unit based on sensor data from the sensor element and entry data from the user interface.

[0031] Such a microwave device is commonly used for heating comestibles. This includes, for example, defrosting, cooking, heating, baking, grilling, boiling or roasting comestibles.

[0032] Comestibles are for example liquid, comestibles with a low or high viscosity or solid, have a homogeneous or heterogeneous composition and are for example positioned in a comestible container with or without cooking medium (for example water) in the cooking chamber. For example, such a comestible is potatoes, fish, meat, vegetables or a frozen dish (for example a lasagne or a burger patty). The comestible container is open (for example a plate or a can that is open at the top) or closed (for example a can with a lid, preferably with a hole or valve). The microwave device has at least one microwave source, using which heat can be applied to the comestible.

[0033] The microwave source is arranged to emit microwaves into the cooking chamber of the microwave device. The cooking chamber of the microwave device is formed by a housing, preferably made of sheet metal. The walls of the cooking chamber form a shielding member for the microwave radiation and prevent it from escaping from the cooking chamber to the outside. On a user side of the cooking chamber, there is an input opening which can be closed using a door and through which a user can insert a comestible into the cooking chamber. Preferably, the door has a panel of transparent plastic or glass with a metal grid to shield the microwave radiation.

[0034] Furthermore, the microwave device has a user interface. The user interface comprises, for example, a display using which information can be communicated to a user. The display is for example a touch screen which allows the user to make inputs. Alternatively or additionally, the user interface comprises a keyboard.

[0035] The microwave device has a sensor element for detecting property values of comestibles. For this purpose, the sensor element has at least one sensor cell. Preferably, the sensor element is a sensor element according one of the embodiments according to the first aspect of the invention.

[0036] Such a sensor element is designed for use in the cooking chamber of a microwave device in order to measure property values of a comestible during operation of the microwave device, for example while microwave radiation is being applied to the comestible, and to transmit them to the control unit. The sensor element is designed, for example, to come into direct contact with the comestible, for example to be pushed into the comestible. Alternatively or additionally, the sensor element is designed to detect property values of the comestible in the cooking chamber (for example without direct contact with the comestible). For example, the sensor element can be positioned in the ambient air of the comestible, preferably inside the or in contact with the comestible container, for example below the comestible container. In another embodiment, the sensor element is designed be positioned in contact with steam or water emerging from the comestible or in a cooking medium

such as cooking water (for example in a collection container provided for this purpose). Furthermore, in one embodiment, the sensor element is integrated into a comestible container, preferably into a base, a lid and/or a wall of the comestible container.

[0037] For example, the sensor element has one or more sensor cells to detect one or more property values of the comestibles. Preferably, at least one of the sensor cells is a temperature sensor. Alternatively or additionally, the sensor element comprises other sensor cells, for example, moisture sensors, pressure sensors, sensors for detecting a viscosity, the colour, the electrical resistance and/or the chemical properties of the comestibles.

[0038] Preferably, the sensor element is suitable for simultaneously measuring/detecting respective property values of the comestible at measuring points that are spaced apart from each other. Thus, the sensor element is designed to measure different or several of the same type of property values. Especially preferably, the temperature of the comestible can be measured simultaneously at several points using the sensor element. In this case, simultaneous means that the sensor element does not have to be moved from one location to another in order to detect the respective property value at both locations/ measuring points. In this case, the sensor element preferably comprises several sensor cells, each of which is designed to detect a property value of the comestible at a measuring point. For example, each sensor cell is configured to be used detecting a different property value (for example, one temperature value and one moisture value) or several or all sensor cells are configured to be used to detecting the same property value (e.g., the temperature). Alternatively, at least one sensor cell is suitable for detecting property values at several measuring points at the same time.

[0039] By detecting the property values of the comestible at several measuring points, it is possible to obtain a realistic impression of the properties of the comestible, even if the heating of the comestible is uneven (for example, because it is heterogeneous or due to intensity maxima and minima of the microwave radiation applied on the comestible) and to control the microwave device accordingly.

[0040] The microwave device further comprises a control unit which is communicatively connected to the microwave source and the user interface. Preferably, the control unit is connected to the microwave source and the user interface via a cable connection. Alternatively, the control unit is wirelessly connected to the microwave source and the user interface. The control unit is preferably integrated as a processor in the microwave device. Alternatively, a part of the control unit is out-sourced from the microwave device, for example the control unit is a mobile terminal or another external computer. In such an embodiment, at least one communication unit of the control unit is integrated in the microwave device (for example, to receive and transmit the data from the external part of the control unit).

[0041] According to the invention, the sensor element is connected to the control unit in a communicating manner. For this purpose, the sensor element has, for example, a data transmitter which is set up to transmit data (the sensor data) from inside of the cooking chamber of the microwave device (with the shielding member) to the control unit arranged outside the cooking chamber. The Sensor data contains the property values of the comestible detected by the sensor element.

[0042] The data transmitter of the sensor element is wireless or wired. For example, the data transmitter is configured to provide a signal that is significantly different from the wavelength of the radiation used in the microwave device and penetrates through the cooking chamber shielding member that shields the microwave radiation. For example, the signal is an optical signal in the visible or infrared wavelength range. For example, the microwave device comprises a transparent panel to the cooking chamber through which the optical signal can be transmitted. In this regard, it referred to the description of the first aspect of the invention.

[0043] Preferably, the data transmitter comprises a first transmitting section in a (relative to the microwave device) freely movable sensor body, in which the at least one sensor cell is also arranged, and a second transmitting section which is fixed to the microwave device in the cooking chamber. Whereby preferably the first transmitting section and the second transmitting section are communicatively connected (in a data connection) with each other in such a way that a corresponding signal for transmitting the data can be sent through the comestibles and/or comestible containers, and the second transmitting section is connected to a control unit outside the cooking chamber using the (for example optical) data connection described above which functions through the shielding of the cooking chamber. For this purpose, a transparent section made of transparent plastic or glass (for example, with a metal grid for shielding the microwave radiation) is preferably arranged in a cooking chamber wall, through which a signal for the data connection can be sent from the data transmitter or the second transmission section of the data transmitter to the control unit. For example, the data transmitter is also a data receiver for receiving data from the control unit or the sensor element comprises an additional data receiver.

[0044] In one example, the control unit comprises a receiving unit which is configured to receive the data sent from the data transmitter from the cooking chamber. For example, the receiving unit is a photocell to receive optical signals from the data transmitter. In a further embodiment, the control unit additionally comprises a means for sending data to the data transmitter/data receiver of the sensor element.

[0045] The microwave source is controllable via the control unit based on sensor data from the sensor element and input data from the user interface. Since the control unit is connected to a sensor element in the cook-

ing chamber and the microwave source, the microwave device has a control loop. Thus, using the control unit, heating of a comestible can be controlled by means of the microwave source depending on the property values of the comestible measured in the cooking chamber. Using the control unit, the user interface can be used, for example, to transmit confirmation queries for control steps, information about the preparation process of the comestible and instructions for suggested actions to the user and to receive responses from the user.

[0046] The microwave device according to the invention offers the advantage that comestible can be prepared particularly well, as the microwave device can control the microwave source depending on the property values of the comestible. Thus, the microwave device can further be operated in a highly automated manner and is therefore particularly user-friendly.

[0047] It is further proposed in an advantageous embodiment of the microwave device that it further comprises a memory which is communicatively connected to the control unit and on which operating parameters for the microwave source are stored, and wherein in each case one or more operating parameters are assigned to an operating mode.

[0048] According to this embodiment, the microwave device has a memory. The memory is connected to the control unit. Operating parameters for the microwave source are stored in the memory and can be used by the control unit to control the microwave source. The operating parameters can be retrieved from the memory by the control unit. The memory is, for example, a hardware component integrated into the microwave device or an external memory, for example on an external server. One, preferably several operating parameters are assigned to an operating mode. An operating mode preferably comprises operating parameters of various components of the microwave device, time intervals, progressions of operating parameters over time or set values for the property values of the comestibles determined using the sensor element. A microwave device according to this embodiment provides the advantage, that operating parameters can be stored in advanced or stored during time to achieve a learning effect. Thus, such a device is particularly user-friendly.

[0049] It is further proposed in an advantageous embodiment of the microwave device that the operating parameters comprise at least one of the following:

- a power of the microwave source;
- a power of a further heating element;
- a power of a fan;
- a power of a drive unit for moving comestibles in the cooking chamber;
- a desired value for at least one property value of the comestible; and
- user information to be displayed on the user interface.

[0050] According to such an embodiment, a power of the microwave source, a power of another heating element, a power of a fan, a power of a drive unit for moving comestible in the cooking chamber, a desired value for at least one property value of the comestibles; and/or user information to be displayed on the user interface are the operating parameters and the operating modes comprise at least one, preferably several, of said operating parameters.

[0051] The further heating element is, for example, a heating element to provide a grill function.

[0052] For example, the fan is arranged to remove exhaust air (such as water vapour) from the microwave device. An alternative or additional fan is a component for swirling the microwave radiation to avoid local temperature minimums or peaks in the comestible during heating.

[0053] For example, the drive unit is set up to drive a turntable to rotate the comestible in the cooking chamber to avoid local temperature minima or maxima in the comestible during heating.

[0054] User information to be displayed on the user interface can be, for example, suggested actions for the user. For example, the user can be suggested to perform a preparation step (such as adding or pouring water, adding oil, spices or other ingredients, covering or uncovering the comestible and/or manually changing an operating parameter). A microwave device according to this embodiment provides the advantage, that several operating parameters can be controlled according to one user entry and/or the measured property values. Thus, a high qualitive preparation of comestibles is achieved in a user-friendly manner.

[0055] It is further proposed in an advantageous embodiment of the microwave device that at least one recipe is stored in the memory, each comprising at least one operating mode, preferably multiple operating modes.

[0056] According to such an embodiment, at least one, preferably several, recipes are stored on the memory. A recipe preferably comprises several operating modes. By means of a user input using the user interface, a recognition of a comestible or a property value detected by means of the sensor element, a recipe is selected by means of the control unit and the operating mode(s) is/are retrieved.

[0057] Using the control unit, for example, the components of the microwave device can be controlled in each operating mode with certain operating parameters or operating parameter sequences until a time interval has elapsed or a desired value for one or more property values has been reached. Subsequently, the control unit can be used to automatically change to another operating mode or to request such a change from the user via the user interface. Thus, this embodiment allows a user-friendly use of the microwave device.

[0058] It is further proposed in an advantageous embodiment of the microwave device that the control unit is configured to perform a comestible recognition to automatically select one of the operating modes based on

the comestible recognition, wherein preferably the comestible recognition is performed by means of a least one of: a photo recognition, a numerical query, a QR code or a bar code.

[0059] According to such an embodiment the control unit is configured to recognize a comestible. The recognition is based, for example, on a photo of the comestible, a numerical entry, a QR code and/or a bar code. For example, a user can use the camera of a mobile device or a recognition unit (optical or magnetic) in the microwave device to record the comestible. A list of recognisable comestibles is preferably stored in the memory. One or more recipes, operating modes or operating parameters are assigned to each recognisable and stored comestible. This embodiment of the microwave device provides the advantage of being particularly user-friendly.

[0060] It is further proposed in an advantageous embodiment of the microwave device that the user interface is a screen integrated in the microwave device and/or an external mobile device.

[0061] According to this embodiment, the user interface is either integrated into the microwave device, for example in the form of a screen, and/or implemented externally, for example in the form of a mobile device. If it is integrated, the user interface preferably comprises a touch screen, using which information can be transmitted from the control unit to the user and input from the user can be transmitted to the control unit. Alternatively or additionally, an integrated user interface comprises an input unit, for example a keyboard. An additional or alternatively available external user interface is, for example, a smartphone, a tablet or a remote control (for example for a smart home).

[0062] According to a further aspect, a method for preparing a comestible using a microwave device according to an embodiment as described above is proposed, comprising at least the following steps:

a. Placing a sensor element in the cooking chamber of the microwave device for detecting property values of a comestible to be prepared;
b. by means of the sensor element, detecting a property value of the comestible and transmitting the property value to the control unit;
c. by means of the control unit, determining at least one operating parameter of the microwave transmitter based on the property value transmitted in step **b.;** and
d. by means of the control unit, operating the microwave device with the at least one operating parameter.

[0063] The method proposed here is suitable for preparing a comestible in a microwave device. Such a microwave device is preferably designed according to the foregoing description.

[0064] Such a microwave device has a microwave source. The microwave source is arranged to emit microwaves into the cooking chamber of the microwave device. The cooking chamber of the microwave device is formed by a housing, preferably essentially made of sheet metal. The walls of the cooking chamber form a shielding member for the microwave radiation and prevent it from escaping from the cooking chamber to the outside. On a user-side of the cooking chamber, an input opening is provided which can be closed using a door and through which a user can introduce a comestible into the cooking chamber. Preferably, the door has a panel of transparent plastic or glass with a metal grid to shield the microwave radiation.

[0065] Furthermore, the microwave device has a user interface. The user interface comprises, for example, a display using which information can be communicated to a user. The display is for example a touch screen using which the user can make inputs. Alternatively or additionally, the user interface comprises a keyboard.

[0066] The method comprises the step **a.** of placing a sensor element in the cooking chamber of the microwave device for detecting property values of a comestible to be prepared. For example, the sensor element is inserted into the comestible, brought into contact with the comestible or the comestible container by placing it on or underneath, brought into contact with the ambient air of the comestible or a medium such as water or water vapour emerging from the comestible, or integrated into the comestible container. The sensor element is either introduced into or placed on the comestible before the comestible is placed in the cooking chamber or afterwards.

[0067] Such a sensor element is designed for use in the cooking chamber of a microwave device in order to measure property values of a comestible during operation of the microwave device, for example while microwave radiation is being transmitted into the cooking chamber, and to transmit them to the control unit. For example, the sensor element has one or more sensor cells to determine one or more property values of the comestibles.

[0068] In step **b.** of the method, the property values of the comestible are detected using the sensor element. Preferably, the temperature is detected as a property value at least at one measuring point, particularly preferably at several measuring points.

[0069] Preferably, at least one of the sensor cells is used to detect a temperature value of the comestible detectable. Alternatively or additionally, the sensor element has other sensor cells, for example, moisture sensors, pressure sensors, sensors for detecting viscosity, colour, electrical resistance and/or chemical properties of the comestibles, using which the corresponding property values are detected in step b. For example, using the sensor element, property values can be measured/detected simultaneously at measuring points spaced apart from one another. In this case, different or several of the same type of property values can be measured. Preferably, the temperature of the comestible can be measured simultaneously at several points using the sensor element. In this

case, simultaneous means that the sensor element does not have to be moved from one location to another location in order to detect the respective property value at both locations. Preferably, the sensor element comprises several sensor cells, each of which is designed to detect a property value of the comestible at a measuring point. For example, each sensor cell can be used to detect a different property value (for example, one temperature value and one humidity value) or the same property value can be detected using several or all sensor cells (for example, the temperature in each case). Alternatively, using one sensor cell, property values can be detected at several measuring points at the same time.

[0070] In step **c.** of the method, at least one operating parameter of the microwave source is determined using the control unit on the basis of the property value transmitted in step **b.** For example, the operating parameters are retrieved from a memory or calculated. As operating parameters, for example, a power of the microwave source, a power of a further heating element, a power of a fan, a power of a drive unit for moving comestibles in the cooking chamber, a desired value for at least one property value of a comestible; time intervals and/or display information (for example, suggested actions for the user, which comprise, for example, the addition of further ingredients) for display on the user interface are determined.

[0071] In step **d.** of the method, the control unit is used to operate the microwave device in accordance with the at least one operating parameter.

[0072] Using the control unit, for example, a voltage is determined which is applied to the microwave source or another component of the microwave device in order to operate it with a certain power.

[0073] It is further proposed in an advantageous embodiment of the method that the method further comprises the steps:

> **e.** by means of the control unit, selecting an operating mode stored on a memory based on the entry values determined by means of the user interface and the property values determined by means of the sensor element; and
> **f.** by means of the control unit, retrieving those operating parameters associated with the selected operating mode on the memory.

[0074] According to such an embodiment, one or preferably several operating parameters are assigned to an operating mode. Preferably, several operating modes are stored in the memory and at least one of these is selected by the control unit based on the detected property values and the input values of a user input. For example, a temperature of a frozen comestible is detected using the sensor element. The user enters, for example via the user interface, which type of preparation he wants or which final temperature the comestible should have. The control unit receives this information as an input value. The control unit then uses the input value and the property value to determine operating parameters, for example a power for the microwave source and a time interval for defrosting and heating, which are stored in an operating mode on the memory.

[0075] Preferably, the preparation of the comestible according to the method comprises several phases. For example, the preparation begins with a first operating mode for defrosting with a first power of the microwave source and a first time interval and, after the time interval has elapsed, changes to a second operating mode for heating with a second power of the microwave source and a second time interval.

[0076] This method allows a closed loop control of the microwave design depending on the property values of the comestible measured inside the cooking chamber. Thus, a high quality preparation of the comestible is possible in a user-friendly manner.

[0077] In an advantageous embodiment of the method, it is further proposed that after a predetermined time interval has elapsed or a desired value of property value has been reached, one of the following is done:

- changing to a different operating mode;
- switching to at least one changed operating parameter; or
- the preparation of the comestible by means of the microwave device is terminated.

[0078] According to this embodiment, the process comprises one or more phases with different operating modes or operating parameters that are executed before the process is terminated. For example, the preparation starts with a first operating mode of defrosting with a first power of the microwave source and a first time interval, and after the time interval has elapsed, changes to a second operating mode of heating with a second power of the microwave source and a second time interval.

[0079] In an advantageous embodiment of the method, it is comprising the steps:

> **g.** by means of the control unit, receiving a recipe selected by a user via the user interface; and
> **h.** by the control unit, selecting one of the operating parameters and one of the operating modes, respectively, based on the selected recipe.

[0080] According to such an embodiment, at least one, preferably several, recipes are stored on the memory. A recipe preferably comprises several operating modes. By means of a user input using the user interface, a recognition of a comestible or a property value detected by means of the sensor element a recipe is selected by means of the control unit and the operating mode(s) is/are thus retrieved from the memory.

[0081] Using the control unit the components of the microwave device can be controlled in each operating mode with specific operating parameters or operating pa-

rameter sequences until a time interval has elapsed or a setpoint value for one or more property values has been reached. Subsequently, the control unit can be used to automatically switch to a further operating mode or to request such a switch from the user via the user interface.

[0082] It is further proposed in an advantageous embodiment of the method that in step **i.** by means of the user interface, displaying suggestions for action to the user.

[0083] Using the user interface, suggestions for action are displayed to the user. The suggested actions include, for example, adding or pouring water, adding oil, spices or other ingredients, covering or uncovering the comestible and/or manually changing an operating parameter. The user's attention can be drawn to the suggested action by means of a visual or acoustic signal, for example.

[0084] It is further proposed in an advantageous embodiment of the method that in step **j.** by means of the control unit or the mobile device, recognizing the comestible to be prepared based on a photo, a QR-code recognition, a bar-code recognition, or a numerical query.

[0085] According to this embodiment, the comestible is automatically recognised by the microwave device, for example to automatically select operating modes, operating parameters or recipes. For this purpose, the user takes a photo with a smartphone or another mobile device, scans a QR code or bar code or enters or scans a sequence of digits. Alternatively or additionally, the recognition of the photo, QR code or bar code is also possible using a recognition device provided for this purpose in or on the microwave device. For example, a list of comestibles is stored in the memory, to each of which one or more recipes, operating modes or operating parameters are assigned.

[0086] The invention described above is explained in detail below against the relevant technical background with reference to the accompanying drawings, which show preferred embodiments. The invention is in no way limited by the purely schematic drawings, it being noted that the drawings are not dimensionally accurate and are not suitable for defining dimensional relationships. It is illustrated in

Fig. 1: a microwave device with a cooking chamber in a schematic front view;
Fig. 2: a sensor element with a contact surface;
Fig. 3: a sensor element in a flexible main body;
Fig. 4: A flowchart of a method for preparing a comestible using a microwave device.
Fig. 5: A flowchart of another example of a method of preparing a comestible using a microwave device; and
Fig. 6: A flowchart of another example of a method for preparing a comestible using a microwave device.

[0087] Fig. 1 shows a microwave device **2** according to an exemplary embodiment. The microwave device **2** encloses a cooking chamber **6** which is surrounded by walls. Towards the front, for example towards a user side, a door is provided (not shown here), using which the cooking chamber **6** can be opened or closed. The walls and the door each form a shielding member against microwave radiation, so that a closed cooking chamber **6** is sealed off in such a way that microwave radiation cannot penetrate out of the cooking chamber **6** and thus the environment **14** is shielded against microwave radiation.

[0088] The cooking chamber **6** shows a comestible **4** which is heated using the microwave device **2.** For this purpose, the comestible **4** is exposed to microwaves using a microwave source **13.** Furthermore, one or more further heating elements **17** can be provided, by means of which, for example, a grilling function can be provided.

[0089] The comestible **4** is positioned on a turntable. The turntable can be driven in rotation by a drive unit, which is not shown. This prevents uneven heating of the comestible **4** with local temperature maxima and minima.

[0090] In the exemplary embodiment shown, a sensor element **1** is provided for detecting or measuring property values of the comestible **4** (as shown in more detail in Fig. 2 and Fig. 3). The sensor element **1** is preferably suitable for measuring at least one temperature value as a property value of the comestible **4.**

[0091] In order to transmit the detected property values (for example the temperature values) to the control unit **7,** the sensor element **1** is in a communicating connection with a control unit **7** of the microwave device **2.** For this purpose, the sensor element **1** has a data transmitter **5.** The data transmitter **5** comprises a first transmitting section **21** and a second transmitting section **22.** The first transmitting section **2** is structurally integrated into the sensor element **1** or the turntable. The second transmitter section **22** is arranged in a fixed position within the cooking chamber **6** and is wirelessly connected to the first transmitter section **21** for data transmission. Preferably, the data is transmitted between the first transmitting section **21** and the second transmitting section **22** with a wavelength for which the comestible **4** or a comestible container **11** is permeable.

[0092] The second transmitting section **22** is arranged on a wall section of the cooking chamber **6,** which is transparent to a wavelength of a further data signal between the second transmitting section **22** and the control unit **7.** For example, the data is transmitted using a signal in the wavelength range of visible light or in the infrared range. For this purpose, the wall section is made of transparent plastic or glass, for example, in which a metal grid is integrated to ensure the shielding of the microwave radiation. Alternatively, the second transmitting section **22** is connected to the control unit **7** via a cable.

[0093] In an alternative embodiment, the sensor element **1** has only one transmitting section **21,** which is structurally integrated into the sensor element **1,** for example, and is connected directly to the control unit **7** in a communicating manner. This can be done wirelessly or by cable, for example by the one transmitting section

21 emitting a data signal for which at least a corresponding part of the cooking chamber wall is transparent.

[0094] For receiving data from the sensor element **1,** the control unit **7** comprises a receiving unit. In addition, the sensor element **1** and the control unit **7** can also be set up to transmit data in the opposite direction, for example from the control unit **7** to the sensor element **1.**

[0095] Furthermore, the microwave device **2** comprises a user interface **15** for communication with a user. The user interface **15** as shown comprises a screen **20** and a keypad/ keyboard **23.**

[0096] The screen **20** can be used, for example, to display information about the preparation process of the comestible **4** or suggestions for a user-action. For example, a user can be shown information about the current temperature of the comestible **4,** the outstanding time required for the preparation process, a current operating mode, or similar. Furthermore, confirmation for suggested recipes, changes of operating modes or operating parameters or further wishes for the preparation can be requested from the user via the keypad. Furthermore, action steps can be displayed to the user as suggestions. Selections, confirmations or other settings can be entered by the user, for example, via the keypad **23.**

[0097] Furthermore, the microwave device **2** comprises a further acoustic and/or optical signal transmitter **24** which is set up to draw the user's attention, for example because a suggested action is displayed or the preparation of the comestible **4** is finished.

[0098] Fig. 2 shows a sensor element **1** according to a preferred embodiment of the invention. The sensor element **1** has a base body **9** which is designed as a flexible mat and forms a support surface **10** for a comestible **4** or a comestible container **11** (not shown). The support surface **10** has recess **12** extending through the base body **9** in the form of a groove in order to guide liquid emerging from a comestible **4** away from the comestible **4.**

[0099] The sensor element **1** comprises numerus measuring cells which are evenly distributed over the base body **9** in order to be able to detect a property value of the comestible **4** at each measuring point **8.** The detected property values are transmitted by the data transmitter **5** to the control unit **7** of the microwave device **2.**

[0100] Preferably, the base body **9** is made of silicone, in which the sensor cells **3** and/or the data transmitter **5** are embedded.

[0101] Fig. 3 shows a rod-shaped sensor element 1. The sensor element **1** has a grip section **25** and a measuring section **26.** As shown, the data transmitter **5** is arranged on or in the grip section **25.** The measuring section **26** has several sensor cells **3,** using which a property value of a comestible **4** (for example, a temperature) can be measured at a respective measuring point **8.**

[0102] The measuring section **26** is either flexible or rigid. In a flexible embodiment, the base body **9** of the measuring section **26** can be made of silicone as explained regarding the embodiment shown in Fig. 2. In a rigid embodiment, the base body is preferably made of a hard plastic or metal.

[0103] The terms rigid and flexible are defined by whether the sensor element **1** can also be inserted into solid comestible **4** without deformation or whether the sensor element **1** can be elastically deformed during a manual insertion.

[0104] Fig. 4 shows an example of a preferred method for preparing a comestible **4,** for example, using a microwave device **2** described above.

[0105] In step **a.** the sensor element **1** is placed in the cooking chamber **6** of the microwave device **2.** For this purpose, the sensor element **1** is preferably inserted into the comestible **4,** brought into contact with a comestible container **11** or brought into contact with a medium emerging from the comestible **4,** such as water or steam. Before or after this, the comestible **4** is inserted into the cooking chamber **6.** The sensor is positioned accordingly in order to detect the property values of the comestible **4** to be prepared.

[0106] The user then closes the door of the microwave device **2** and prepares the comestible **4** by using of the microwave device **2,** for example using the user interface **15.**

[0107] In step **b.** during and/or before heating of the comestible **4** by means of the microwave device **2** begins, property values of the comestible **4** are detected using the sensor element **1** and transmitted to the control unit **7.** For this purpose, the property values (as explained for Fig. 1, Fig. 2 and Fig. 3) can be transmitted using the data transmitter **5.** Preferably, at least one property value is a temperature value. Particularly preferably, several temperature values are recorded simultaneously at different measuring points **8.** Alternatively or additionally, other property values of the comestibles **4** are recorded.

[0108] In a step **c.** at least one operating parameter of the microwave source **13** is determined using the control unit **7** on the basis of the property value transmitted in step **b.** This can be done by a calculation, a query from a memory **16** and/or a query to the user via the user interface **15.** For example, the control unit **7** can calculate a time interval or a desired temperature value for the comestible **4** and a power for the microwave source **13** as operating parameters or query them from the memory **16.** Furthermore, in step **c.** further operating parameters of other components of the microwave device **2** can be determined in order to control the microwave radiation, the power of other heating sources, fan power or a rotation of the comestible **4.**

[0109] In a step **d.** the control unit **7** controls corresponding components according to the determined operating parameters. In this way, a closed control loop is created in the microwave device **2.** For example, the control unit regulates the voltage applied to the microwave source **13** in order to control its power.

[0110] Fig. 5 shows a further embodiment of the method from Fig. 4. Here, a further step **e.** and **f.** are suggested, for example representing sub-steps of step **c.**

[0111] In step **e.** the control unit **7** selects an operating mode stored on a memory **16.** For this purpose, the control unit **7** uses input values from a user and the property values detected using the sensor element **1.** For example, an initial temperature of the comestible **4** can be determined using the sensor element **1** and a target temperature can be set by the user in order to select one or more operating modes. For example, first an operating mode for defrosting the comestible **4** and then another operating mode for further heating can be selected by the control unit **7.**

[0112] In step **f.** an operating parameter is retrieved by the control unit **7,** which is assigned to the selected operating mode on the memory **16.** For example, a power for the microwave source **13** and a time interval can be retrieved for each operating mode (defrosting and further heating).

[0113] Fig. 6 shows a further embodiment of the method from Fig. 4. Here, further intermediate steps **g.** and **h.** are provided, which, for example, represent sub-steps of step **c.** or steps **e.** and **f.**

[0114] In this embodiment, a recipe is first selected and the operating parameters according to Fig. 4 or Fig. 5 are selected based on this recipe. The recipe can be selected from a list by a user via the user interface **15,** for example.

[0115] The list of recipes can be suggested to the user, for example, based on a food recognition system. For example, in step **j.** at the beginning of the process, the control unit **7** determines which comestible **4** is to be prepared. For example, a QR code or a bar code is scanned in (by the user using a camera or another optical or magnetic means) or a photo of the comestible **4** is taken.

[0116] In step **i.,** the user is also optionally given suggestions for action. For example, it is indicated (preferably between two operating modes) via the display that a certain action should or can be taken by the user. Such an action is, for example, adding further ingredients or covering the comestible **4** in a comestible container **11.**

[0117] The sensor element, the microwave design and the method shown here make it possible to detect property values of comestibles within the microwave device and use them for a user-friendly and high quality preparation of a comestible.

List of reference numerals

[0118]

1	Sensor element
2	Microwave device
3	Sensor cell
4	comestible
5	Data transmitter
6	Cooking chamber
7	Control unit
8	Measuring point
9	Base body
10	Support surface
11	comestible container
12	recess
13	Microwave source
14	Environment/ outside
15	User interface
16	Memory
17	Heating element
20	Screen
21	first transmission segment
22	second transmission segment
23	Keypad/ Keyboard
24	Signal transmitter
25	Grip section
26	Measuring section

Claims

1. Sensor element (1) for a microwave device (2), comprising at least one sensor cell (3) for detecting property values of the comestible (4) and a data transmitter (5), and wherein the data transmitter (5) is set up to transmit data from an inside of a cooking chamber (6) of a microwave device (2), defined by an shielding member preventing a microwave radiation from exiting the cooking chamber from the inside to an outside, to a control unit (7) arranged on the outside of the cooking chamber,
characterized in that
the sensor element (1) is suitable for simultaneously measuring respective property values of the comestible (4) at measuring points (8) spaced apart from one another.

2. Sensor element (1) according to claim 1, comprising a base body (9) made of a flexible material, preferably silicone.

3. Sensor element (1) according to claim 1 or claim 2, wherein a support surface (10) for the comestible (4) or a comestible container (11) is formed by the sensor element (1).

4. Sensor element (1) according to claim 3, wherein at least one recess (12) for receiving and/or transporting away liquids emerging from the food (4) is arranged in the support surface (10).

5. Microwave device (2) for heating food comprising

- a microwave source (13);
- a cooking chamber (6) for receiving food (4) defined by a shielding member, electromagnetically shielding an inside of the cooking chamber (6) from an outside (14);
- a user interface (15);
- a sensor element (1), preferably according to

one of the preceding claims, with at least one sensor cell (3) for detecting property values of the food (4); and
- a control unit (7) which is connected to the microwave source (13) and the user interface (15) communicatively, **characterized in that**

the sensor element (1) is communicatively connected to the control unit (7), and
the microwave source (13) is controllable via the control unit (7) based on sensor data from the sensor element (1) and entry data from the user interface (15).

6. Microwave device (2) according to claim 5, further comprising a memory (16) which is communicatively connected to the control unit (7) and on which operating parameters for the microwave source (13) are stored, and
wherein one or several operating parameters are assigned to one operating mode.

7. Microwave device (2) according to claim 6, wherein the operating parameters comprise at least one of the following:

- a power of the microwave source (13);
- a power of a further heating element (17);
- a power of a fan (18);
- a power of a drive unit (19) for moving comestible (4) in the cooking chamber (6);
- a desired value for at least one property value of the comestible (4); and
- user information to be displayed on the user interface (15).

8. Microwave device (2) according to any of the claims 5 to 7, wherein
at least one recipe is stored in the memory (16), and each recipe comprises at least one operating mode, preferably multiple operating modes.

9. Microwave device (2) according to any of the claims 5 to 8, wherein

the control unit (7) is configured to perform a comestible recognition to automatically select one of the operating modes based on the comestible recognition,
wherein preferably the food recognition is performed by means of a least one of: a photo recognition, a numerical query, a QR code or a bar code.

10. Microwave device (2) according to any one of the claims 5 to 9, wherein
the user interface (15) is a screen integrated in the microwave device (2) and/or an external mobile device.

11. Method for preparing a comestible (4) by means of a microwave device (2) according to any of claim 5 to claim 10, comprising at least the following steps:

a. Placing a sensor element (1) in the cooking chamber (6) of the microwave device (2) for detecting property values of a comestible (4) to be prepared;
b. by means of the sensor element (1), detecting a property value of the comestible (4) and transmitting the property value to the control unit (7);
c. by means of the control unit (7), determining at least one operating parameter of the microwave transmitter (13) based on the property value transmitted in step **b.;** and
d. by means of the control unit (7), operating the microwave device (2) with the at least one operating parameter.

12. Method according to claim 11, further comprising the steps:

e. by means of the control unit (7), selecting an operating mode stored on a memory (16) based on the entry values determined by means of the user interface (15) and the property values determined by means of the sensor element (1); and
f. by means of the control unit (7), retrieving those operating parameters associated with the selected operating mode on the memory (16).

13. Method according to claims 11 or 12, wherein
after a predetermined time interval has elapsed or a desired property value has been reached, one of the following is done:

- changing to a different operating mode;
- switching to at least one changed operating parameter; or
- the preparation of the comestible (4) by means of the microwave device (2) is terminated.

14. Method according to any of claims 11 to 13, further comprising the steps:

g. by means of the control unit (7), receiving a recipe selected by a user via the user interface (15); and
h. by the control unit (7), selecting one of the operating parameters and one of the operating modes, respectively, based on the selected recipe.

15. Method according to any of claim 11 to claim 14, further comprising the step of:

i. by means of the user interface (15), displaying suggested user operations to the user.

16. Method according to any of claims 11 to 15, comprising the step of:
j. by means of the control unit (7) or the mobile device, recognizing the comestible (4) to be prepared based on a photo, a QR-code recognition, a bar-code recognition, or a numerical query.

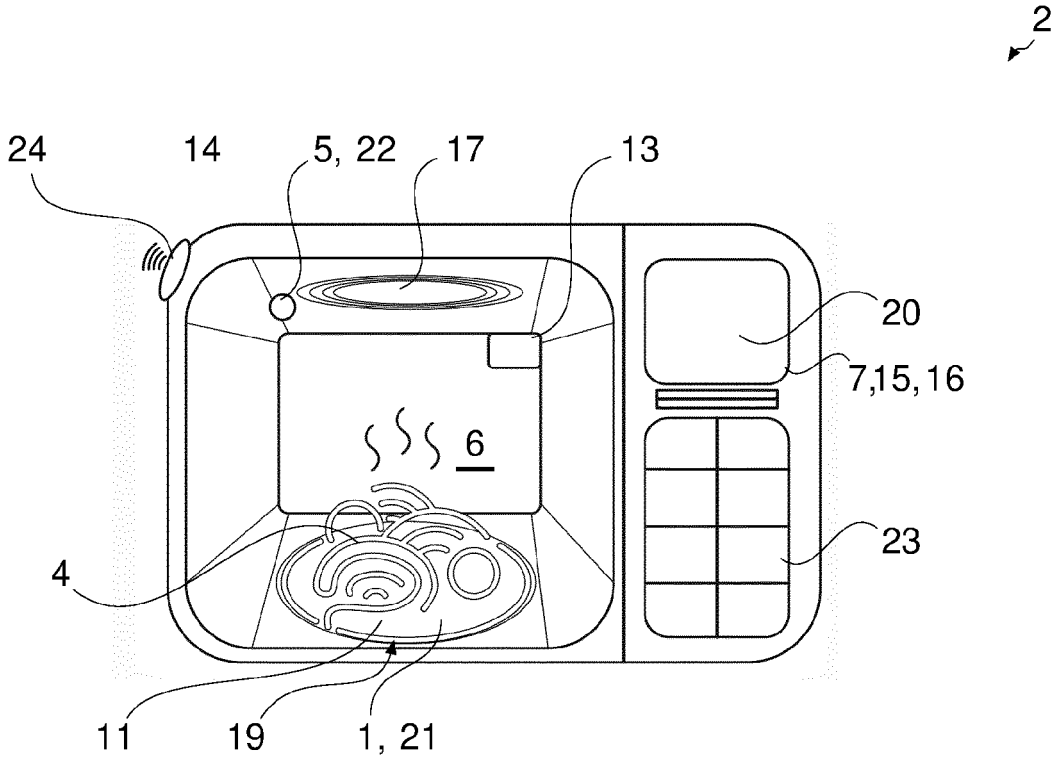

Fig. 1

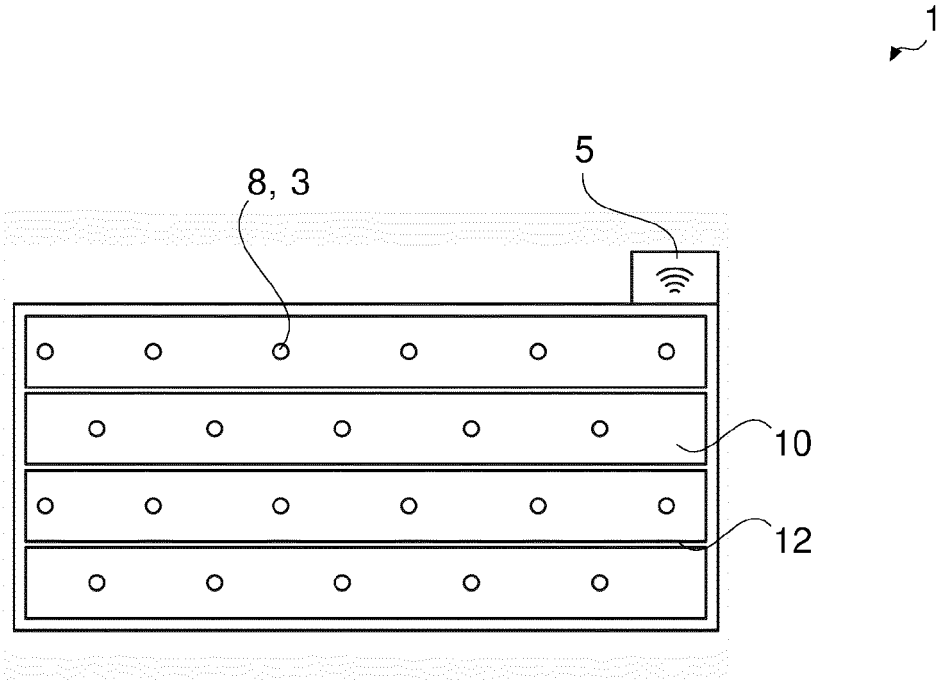

Fig. 2

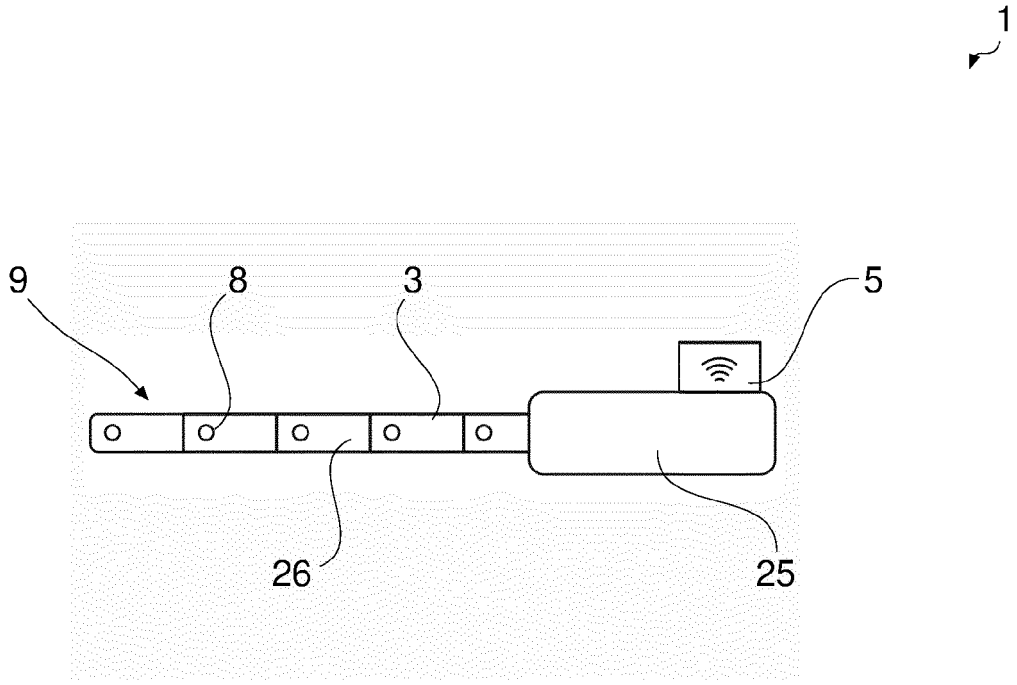

Fig. 3

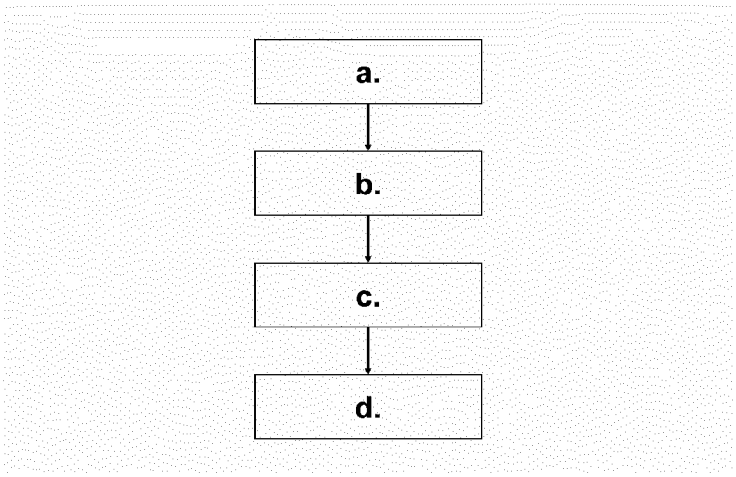

Fig. 4

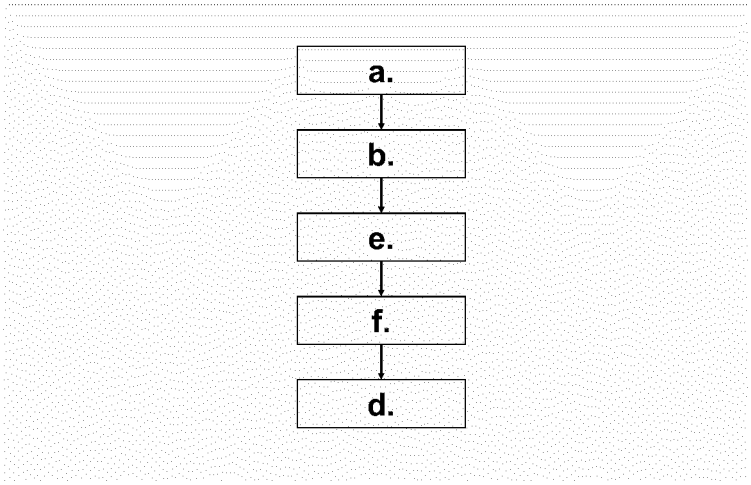

Fig. 5

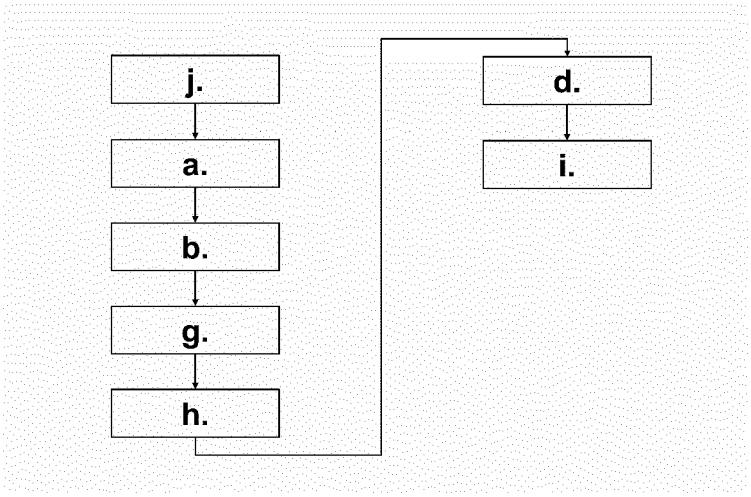

Fig. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 22 17 7960

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			H05B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	10 November 2022	Pierron, Christophe

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 22 17 7960

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