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## Temperature controlled accessory for countertop cooking system


### Abstract

A cooking system is provided. The cooking system includes a housing, a heating elements, a cooking accessory, a temperature sensor, and a controller. The housing has an internal heating compartment, where the heating element is positioned therein. The cooking accessory has a cooking surface and is configured to be receivable within the internal heating compartment. The temperature sensor is positioned within the internal heating compartment and configured to measure a temperature of the cooking accessory. The controller is configured to operate an output of the heating element. The output of the heating element is related to the measured temperature of the cooking accessory and independent of an air temperature of the internal heating compartment.



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## Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS (1) This application claims priority to U.S. Provisional Patent Application No. 63/210,322 filed Jun. 14, 2021 and entitled "TEMPERATURE CONTROLLED ACCESSORY FOR COUNTERTOP COOKING SYSTEM," and U.S. Provisional Patent Application No. 63/249,988 filed Sep. 29, 2021 and entitled "TEMPERATURE CONTROLLED ACCESSORY FOR COUNTERTOP COOKING SYSTEM," the entire contents of which are hereby expressly incorporated by reference herein.

FIELD

(1) The present disclosure relates generally to a cooking system, and more particularly, to a temperature-controlled cooking surface arranged within an internal cooking chamber of a countertop cooking system.

BACKGROUND

(2) Existing countertop cooking systems, such as toaster ovens for example, may be used to conveniently warm or cook food in place of a larger wall mounted oven or a range for example. In conventional countertop cooking systems, food is typically positioned on a thin plate arranged within an internal chamber of the cooking system. However, these thin plates typically do not provide good contact to sear the food being cooked due to one or more of poor heat distribution, poor heat storage, and poor temperature regulation. The use of a thicker plate is sufficient to overcome some of these issues, such as heat storage and distribution. However, after the initial food load is applied, the temperature of the plate drops significantly, and the cooking system is unable to effectively monitor or regulate the plate temperature.

(3) Accordingly, there is a need to regulate a temperature of both the cooking chamber of the countertop cooking system and the temperature of the plate or cooking surface. Because the temperature of the cooking chamber is related to the temperature of the plate, it can be difficult to independently control these temperatures. For example, by heating one region, another region may be inadvertently overheated. This may result in food being burned on the bottom while undercooked on top, or alternatively, a raw bottom, and an overcooked top.

SUMMARY

(4) Cooking systems having a temperature-controlled cooking surface arranged within an internal cooking chamber for cooking food are provided.

(5) In one embodiment, a cooking system is provided having a housing, a heating element, a cooking accessory, a temperature sensor, and a controller. The housing can have an internal heating compartment. The heating element can be positioned within the internal heating compartment. The cooking accessory can have a cooking surface and can be configured to be received within the internal heating compartment. The temperature sensor can be positioned within the internal heating compartment and can be configured to measure a temperature of the cooking accessory. The controller can be configured to operate an output of the heating element. The output of the heating element can be related to the measured temperature of the cooking accessory and independent of an air temperature of the internal heating compartment.

(6) In some embodiments, the heating element can be positioned vertically between a bottom surface of the internal heating compartment and the cooking accessory.

(7) In some embodiments, a second temperature sensor can be positioned within the internal heating compartment and it can be configured to measure the air temperature of the internal heating compartment. In other embodiments, a second heating element can be positioned within the internal heating compartment and vertically above the cooking accessory. In certain embodiments, an output of the second heating element can be related to the measured air temperature of the internal heating compartment. In other embodiments, the output of the first heating element can be independent from the output of the second heating element.

(8) The temperature sensor can have a variety of configurations. For example, in some embodiments, the temperature sensor can be mounted within an aperture positioned in a rear wall of the internal heating compartment. In some embodiments, the temperature sensor can be movable relative to the internal heating compartment. In other embodiments, the temperature sensor can be movably biased in a first direction. In certain embodiments, the cooking accessory can be configured to be inserted into the internal heating compartment in a second direction, opposite the first direction. In other embodiments, the cooking accessory can be configured to directly contact the temperature sensor when inserted into the internal cooking compartment. In certain embodiments, the temperature sensor can be configured to move relative to the internal heating and remain in contact with the cooking accessory.

(9) In another embodiment, a cooking system is provided having a housing having an internal heating compartment. A cooking accessory can have a cooking surface and can be configured to be received within the internal heating compartment. A first heating element can be positioned within the internal heating compartment below the cooking accessory. A second heating element can be positioned within the internal heating compartment above the cooking accessory. A first temperature sensor can be positioned within the internal heating compartment and it can be configured to directly contact and measure a temperature of the cooking accessory. A second temperature sensor can be positioned within the internal heating compartment and it can be configured to measure an air temperature of the internal heating compartment. A controller can be configured to operate an output of the first heating element and an output of the second heating element. The output of the first heating element can be related to the measured temperature of the cooking accessory, and the output of the second heating element can be related to the measured air temperature of the internal heating compartment.

(10) In some embodiments, the output of the first heating element can be independent of the output of the second heating element.

(11) In some embodiments, the first temperature sensor can be aligned with the cooking accessory along an insertion axis of the cooking accessory.

(12) In some embodiments, the first temperature sensor can be movable relative to the internal heating compartment.

(13) In another embodiment, a method of operating a cooking system is provided. The method can include measuring a surface temperature of a cooking accessory arranged within an internal heating compartment of a housing by a first temperature sensor, measuring an air temperature of the internal heating compartment of the cooking system by a second temperature sensor, the monitoring of the surface temperature of the cooking accessory being independent from the monitoring of the air temperature of the internal heating compartment, and controlling a present surface temperature of the cooking accessory in response to the measured surface temperature of the cooking accessory independent of the measured air temperature of the internal heating compartment.
(14) In some embodiments, the method can further include directly contacting the first temperature sensor with the cooking accessory. In some embodiments, the method can further include controlling a present air temperature of the internal heating compartment in response to the measured air temperature of the internal heating compartment independent of the measured surface temperature of the cooking accessory.
(15) In some embodiments, the controlling of the temperature of the cooking accessory can further include adjusting an output of a first heating element arranged between the cooking accessory and a bottom surface of the internal heating compartment.

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## Description

BRIEF DESCRIPTION OF THE FIGURES
(1) These and other features will be more readily understood from the following detailed description taken in conjunction with the accompanying drawings, in which:
(2) FIG. **1** is a front perspective view of one embodiment of a cooking system;
(3) FIG. **2** is a front perspective view of the cooking system of FIG. **1** with a door in an open position;
(4) FIG. **3** is a cross-sectional front view of the cooking system of FIG. **1** with a cooking accessory arranged therein;
(5) FIG. **4** is a schematic diagram of a control system of the cooking system of FIG. **1**;
(6) FIG. **5** is a side cross-sectional view of the cooking system of FIG. **1**;
(7) FIG. **5**A is a detailed cross-sectional view of a temperature sensor and the cooking accessory of FIG. **5**; and
(8) FIG. **6** is a front perspective view of the cooking system of FIG. **5** with the cooking accessory partially inserted.
(9) It is noted that the drawings are not necessarily to scale. The drawings are intended to depict only typical aspects of the subject matter disclosed herein, and therefore should not be considered as limiting the scope of the disclosure.
DETAILED DESCRIPTION
(10) Certain exemplary embodiments will now be described to provide an overall understanding of the principles of the structure, function, manufacture, and use of the devices and methods disclosed herein. One or more examples of these embodiments are illustrated in the accompanying drawings. Those skilled in the art will understand that the devices and methods specifically described herein and illustrated in the accompanying drawings are non-limiting exemplary embodiments and that the scope of the present invention is defined solely by the claims. The features illustrated or described in connection with one exemplary embodiment may be combined with the features of other embodiments. Such modifications and variations are intended to be included within the scope of the present invention.
(11) A cooking device is provided having multiple temperature sensors and heaters in order to achieve multiple cooking modes. In an exemplary embodiment, the cooking device includes air

frying, sear crisping, rapid baking, air roasting, and broiling cooking modes, where each mode can require a different conductive cooking surface temperature and convective air temperature in order to achieve a desired result. Therefore, the present invention includes temperature regulation within the cooking device for both air and cooking surface temperatures, compared to a traditional oven where air temperature and cooking surface temperature are linked together and cannot be independently controlled. The lack of independent control of both conductive and convective heating can lead to the under-heating of one region while overheating of another region, leading to a food product burning on the bottom while the top is undercooked, or a raw bottom with charred top. The present invention solves these issues by not only having independent temperature control of different heating elements, but also being able to precisely monitor the cooking surface and air temperatures independently, and then adjusting the heating output in only regions where it is needed. It is important monitor the temperatures within the cooking device consistently not only to achieve a desired result, but also to increase a cooking process efficiency and to reduce smoke generation within the cooking device. Accordingly, the cooking device can independently monitor and control different cooking region to precisely provide precise conduction and convection heating to a food product.

(12) FIGS. **1** and **2** illustrate one exemplary embodiment of a cooking system **20** configured to be positioned on a support surface **22**, such as a countertop. The cooking system **20** generally includes a thermally insulated housing **24** that defines an internal heating compartment or cooking volume **26**. The housing **24** can be formed from a left exterior sidewall **28**, a right exterior sidewall **30**, a top exterior wall **32**, a bottom exterior wall **34**, and a rear exterior wall **36**. The exterior walls **28**, **30**, **32**, **32**, and **36** can be connected to form of a hollow box, where the internal heating compartment **26** is defined therein. In one aspect, the exterior walls **28**, **30**, **32**, **32**, and **36** can be formed from stamped sheet metal secured together.

(13) The housing **24** can include traditional support feet arranged on the bottom exterior wall **34**, where the cooking system **20** remains in an operational position at all times. However, in one aspect, as illustrated in FIG. **1**, a base **25** and support feet **27** can be arranged on the exterior of the housing **24**. The housing **24** can pivot about the base **25** in order to lift the feet **27** of the housing **24** off the support surface **22**. This pivoting action allows the housing **24** to be moved to a vertical orientation, thus allowing a user to reduce the occupied space of the cooking system **20** when not in use.

(14) As mentioned above, the housing **24** forms an internal heating compartment **26** which is accessible through an opening **46** in the housing **24**. In order to seal the opening **46** of the internal heating compartment **26** for thermal efficiency, the housing **24** includes a front wall **38** through which the internal heating compartment **26** is accessed by a user. The front wall **38** of the housing **24** may be formed as a moveable door **40** that is movable relative to the remainder of the housing **24** to selectively provide access to the internal heating compartment **26**. The illustrated door **40** is a rectangular plate mounted in overlapping arrangement with the opening **46** in the housing **24** to seal the internal heating compartment **26**. In one aspect, the door **40** can include a transparent plate, e.g., glass, arranged within a frame such that a user can see into the internal heating compartment **26** during operation of the cooking system **20**. In order to further seal the internal heating compartment, gaskets **40***a*, **40***b* (shown in FIG. **2**) can be arranged on the inside surface of the door and can contact the housing **24** when the door **40** is in the closed positon.

(15) The door **40** is hinged to the housing **24** along a bottom edge **42** thereof for rotation about a hinge axis X between an open position (shown in FIG. **2**) and a closed position (shown in FIG. **1**). Although the hinge axis X is illustrated as being located at a bottom edge **42** of the door **40**, in other embodiments the hinge axis X can be positioned at an upper edge or a side edge of the door **40**. The door **40** may include a handle **41** arranged on the door **40** to facilitate movement of the door **40** relative to the housing **24** by a user. In one aspect, the handle **41** is illustrated at a left side of the door **40**. However, embodiments where the handle **41** is arranged at another location about

the door **40**, such as a top edge thereof for example, are also within the scope of the disclosure. Further, although the door **40** is described as being pivotable about a hinge axis X, it should be understood that embodiments where the door **40** is configured to translate relative to the housing **24**, or where the door **40** is removably coupled to the housing **24** are also contemplated herein.

(16) In certain aspects, the movable door **40** may be replaced by a slidable or drawer-like mechanism that is receivable within the interior of the housing **24**. In other aspects, the housing **24** may have an open top surface and a lid movable to selectively close and/or seal the open top surface. However, it should be understood that embodiments where the housing **24** does not include a front wall **38** and the internal heating compartment **26** is open to the environment are also within the scope of the disclosure.

(17) In certain aspects, the door **40** may define the entire front wall **38** of the housing **24**. However, in other aspects, the door **40** may define only a portion of the front wall **38**, and the front wall **38** may further include a panel **44** located adjacent to one or more sides of the door **40**. As illustrated in FIGS. **1** and **2**, the panel **44** may be positioned adjacent the right exterior sidewall **30**, and can extend between the top and bottom exterior walls **32**, **34**, respectively of the housing **24**. It should be understood that the panel **44** can be located anywhere on the housing **24**.

(18) As illustrated in FIGS. **1**, **2**, and **4**, arranged on the panel **44** is a user interface **66** for operating the cooking system **20**. The user interface **66** is part of a control system **70** that is electrically connected to various powered components within the cooking device. The illustrated user interface **66** includes one or more inputs **72** associated with operating the cooking system **20** and for selecting various modes of operation of the cooking system **20**. One or more of the inputs **72** may include a light or other indicator to show that the respective input **72** has been selected. The user interface **66** may additionally include a display **74** separate from and associated with the at least one input **72**. However, embodiments where the display **74** is integrated into the at least one input **72** are also contemplated herein. Also arranged on the panel **44** is a dial **43** which can be configured to input user selections.

(19) In one aspect, at least one input **72** on the user interface **66** is an on/off button or switch which allows the user to activate or deactivate the user interface **66**. When the user interface **66** is deactivated, none of the heating elements or air movement device are energized. The at least one input **72** may include a distinct start button intended to initiate operation in a desired mode, a distinct stop button to cease all operation, or a stop/start button intended to initiate and cease functions. Alternatively, the cooking system **20** may be operable to automatically start operation after a predetermined time has elapsed once an input has been selected and any necessary information has been provided to the user interface **66**. One or more of the other inputs **72**, such as the dial **43**, may be operable, such as by pushing the dial **43** towards the user interface **66**, to start and stop operation of the cooking system **20**, regardless of whether the cooking system **20** is following a stored sequence or is in a manual mode.

(20) The one or more inputs **72** are operable to initiate operation of the cooking system **20** in a plurality of cooking modes. Examples of modes of operation of the cooking system **20** include, but are not limited to, toast, bake, broil, grill, warm, reheat, and steam cook. As explained in detail below, independent control of heating elements allows a user to configure a cooking/heating cycle based on the type of food item positioned within the internal heating compartment **26**.

(21) Additionally, the at least one input **72** is operable to select one or more manual modes of operation of at least one of the heating elements. Alternatively, or in addition, the at least one input **72** is operable to select a stored sequence of operation of at least one heating element. In some cases, the stored sequences may be particularly well suited for a given method of food preparation and/or for particular ingredients or types of ingredients. The plurality of stored sequences associated with the at least one input **72** may be stored within a memory accessible by the processor **76**. Alternatively, the plurality of stored sequences may be stored remotely from the cooking system **20**, and may be accessed by the processor **76**, such as via wireless communication.

(22) In addition, a user may be able to enter or select a time associated with operation of the cooking system **20** in a desired manual mode. The time may be entered via the same input **72**, or a separate input **72** as used to select a mode of operation. Where the cooking system **20** is in a mode configured to perform a stored sequence in response to selection of one of the inputs, the display **74** may indicate a time remaining on the display **74**. Temperature or other parameters, such as toasting color for example, may also be entered via inputs **72**.
(23) Since the user interface **66** is configured to receive multiple user inputs, the inputs **72** and display **74** are communicatively coupled to the processor **76**. As shown in FIG. **4**, the control system **70** includes a controller or processor **76** for controlling operation of heating elements **60**, **62**, an air movement assembly **90** including a fan **64**, and sensors S**1**, S**2**, which will be explained in detail below. These components operate in response to a user input provided via the one or more inputs **72** and use algorithms to execute stored sequences of heating operations. A heating output of one or more of the heating elements **60**, **62** is controlled by the processor **76** and may be variable in response to the power supplied to the heating elements **60**, **62**. In certain aspects where the cooking system **20** includes a plurality of heating elements **60**, **62**, the heating elements **60**, **62** may be independently operable. The sensors S**1**, S**2** are also arranged in communication with the processor **76** and operable to monitor one or more parameters, for example a temperature within the internal heating compartment **26** or a cooking surface temperature.
(24) With reference now to FIG. **3**, the internal heating compartment **26** includes inner sidewalls **37**, **39**, and a rear inner wall **58**. The inner sidewalls **37**, **39** and the rear wall **58** are spaced apart from the exterior walls **28**, **30**, **32** in order to provide an insulating area between the internal heating compartment **26** and the exterior walls **28**, **30**, **32**. A support assembly **47***a* is arranged on the inner sidewall **37** and is formed from projections **48***a* extending inward to the internal heating compartment **26** from the inner sidewall **37** and extending along the length of the inner sidewall **37** from the front to the back of the device. Similar to the support assembly **47***a*, the inner sidewall **39** includes a support assembly **47***b*, formed from projections **48***b* extending inward to the internal heating compartment **26** from the inner sidewall **39**. Formed between the projections **48***a*, **48***b* are channels **49***a*, **49***b* arranged at different height levels within the internal heating compartment **26**. The support assemblies **47***a*, **47***b* may be integrally formed with the inner sidewalls **37**, **39**, such as the projections **48***a*, **48***b* being stamped directly in the sheet forming the inner sidewalls **37**, **39**.
(25) The support assemblies **47***a*, **47***b* are positioned to support one or more cooking accessories **50**, such as a removable cooking rack G (shown in FIG. **2**), a basket, a spit, a drip tray, or a griddle (shown in FIG. **3**) for example, at a desired position within the internal heating compartment **26**. The support assemblies **47***a*, **47***b* may support the cooking accessories directly or indirectly, such as if the cooking accessory is arranged within a movable cooking container that is also receivable within the internal heating compartment **26** of the housing **24**. In one aspect, multiple cooking accessories can be supported within the channels **49***a*, **49***b* of the support assemblies **47***a*, **47***b* at different heights. However, any type of fixture capable of supporting a cooking accessory within the internal heating compartment **26** is contemplated herein.
(26) As stated above, the internal heating compartment **26** of the housing **24** is heated by at least one heating element. In an aspect, the cooking system **20** includes at least one first heating element **60** positioned within the internal heating compartment **26**, for example adjacent the top wall **32** of the housing **24**. As illustrated in FIG. **5**, the cooking system **20** includes a plurality of first heating elements **60**, such as three first heating elements, oriented generally parallel to the hinge axis X and spaced across a depth of the top wall **32** of the housing **24** or internal heating compartment **26**. It should be understood that any number of first heating elements **60** and any configuration of the first heating elements **60** are contemplated herein. Alternatively, or in addition, at least one second heating element **62** may be positioned within the internal heating compartment **26**, for example adjacent the bottom **34** of the housing **24**. The illustrated cooking system **20** includes a plurality of second heating elements **62**, such as three second heating elements, oriented generally parallel to

the hinge axis X and spaced across a depth of the bottom **34** of the housing **24** or internal heating compartment **26**. The first heating elements **60** and the second heating elements **62** may be generally aligned or may be staggered relative to one another. It should be understood that although the heating elements **60**, **62** of the cooking system **20** are illustrated and described as being positioned generally adjacent the top wall **32** and bottom wall **34** of the housing **24**, respectively, embodiments where the cooking system **20** alternatively or additionally includes one or more heating elements (not shown) located adjacent one or more lateral sides of the internal heating compartment **26** and/or within a center of the internal heating compartment **26** are also contemplated herein.

(27) As further shown, guards **63**, **65** can be positioned about the length of each of the heating elements **60**, **62** and they can be configured to protect the heating elements **60**, **62** from food product which may fall from a cooking accessory. The guards **63**, **65** can include apertures and slots to ensure infrared heat is able to pass around the guards **63**, **65** and properly heat the air within the internal heating compartment **26** and a cooking accessory.

(28) In one aspect, the position of some or all of the heating elements **60**, **62** within the internal heating compartment **26** and the position at which a cooking accessory, such as the cooking accessory **50** shown in FIG. **5**, is received within the internal heating compartment **26**, in particular relative to one or more of the heating elements **60**, **62**, can be optimized. For example, the respective positions may be selected to balance the speed and efficiency of heat transfer from the heating elements **60**, **62** to the cooking accessory while maximizing the uniformity of temperature across the cooking surface **52** of the cooking accessory.

(29) The one or more heating elements **60**, **62** of the cooking system **20** may be selected to perform any suitable type of heating, including but not limited to, conduction, convection, radiation, and induction. Accordingly, the at least one heating element **60**, **62** may be any type of heating element, such as a tubular, quartz, tungsten, or halogen heating element for example. At least one of the plurality of heating elements **60**, **62** of the cooking system **20** may be a quartz infrared heating element. In an aspect, the cooking system **20** includes a plurality of second heating element **62** and all of the second heating elements **62** are quartz infrared heating elements. The at least one first heating element **60** may also be a quartz infrared heating element, or alternatively, may be another type of heating element, such as a calrod heating element for example. In operation, a quartz infrared heating element is configured to transfer a large portion or amount of energy via radiation and a smaller portion of energy via convection. This is distinguishable from other countertop cooking systems which commonly use heating elements, such as calrod heating elements for example, configured to transfer heat primarily via convection and secondarily via radiation. However, in one aspect, the use of calrods can be used and should be considered within the scope of this disclosure.

(30) It should be understood that in embodiments of the cooking system **20** having a plurality of heating elements **60**, **62** arranged at multiple locations within the internal heating compartment **26**, the plurality of heating elements **60**, **62** may be substantially identical, or alternatively, may be different, and further may be operable to perform similar or distinct types of heating. In an embodiment, both the first and second heating elements are radiant heating elements. However, heating elements operable to perform other combinations of heating are contemplated herein. Further, as stated above, the cooking system **20** may additionally include a fan **64** operable in conjunction with or independently of the heating elements **60**, **62** to circulate air or another fluid through the internal heating compartment **26**.

(31) As stated above, the cooking system **20** may include one or more sensors, such as a temperature sensor S**1**, S**2** for monitoring conditions within the internal heating compartment **26**. The temperature sensors S**1**, S**2** may be configured to communicate with the processor **76** either wirelessly or via one or more wires, such as embedded within the housing **24**, external to the internal heating compartment **26**. The illustrate cooking system **20** includes a first temperature

sensor S**1** configured to monitor a temperature of a cooking accessory **50** positioned within the internal heating compartment **26**, such as the cooking surface **52** of a cooking accessory **50**. In certain aspects, the temperature sensor S**1** may directly contact a surface of the cooking accessory to determine the temperature thereof. However, embodiments where the temperature sensor S**1** is configured to indirectly contact a surface of the cooking accessory **50** are also within the scope of the disclosure.

(32) As illustrated in FIG. **5**, the first temperature sensor S**1** is arranged at a rear inner wall **58** of the internal heating compartment **26**. Accordingly, as a cooking accessory is inserted into the internal heating compartment **26**, a portion of the cooking accessory, for example an edge, wall, cooking surface and/or bottom surface thereof, is configured to contact the temperature sensor S**1**. By contacting the temperature sensor S**1** directly, the temperature sensor S**1** can measure the temperature of the cooking accessory, which directly relates to a searing process of a food product arranged on the cooking accessory.

(33) In one aspect, the temperature sensor S**1** may be movably mounted with respect the internal heating compartment **26**. As illustrated in FIG. **5**A, the temperature sensor S**1** may be arranged within a housing **80** that extends through an aperture **59** arranged within the rear inner wall **58**. A sensor body **86** is arranged within the housing **80** and configured to contact the inside surface of the housing **80** such that there is a direct connection between the sensor body **86** and the cooking accessory **50** via the housing **80**. The sensor body **86** is held in place against the inner surface of the housing **80** by a bracket **87** and a bolt **88**. Additionally, a wire **89** connects the sensor body **86** to the processor **76**

(34) In order to protect the electronics of the temperature sensor S**1** and to ensure a good direct connection is made between the housing **80** and the cooking accessory **50**, the housing **80** can move relative to the rear inner wall **58** via at least one biasing mechanism **82**, such as a coil spring for example. As the cooking accessory **50** is installed within the internal heating compartment **26**, the cooking accessory **50** engages the housing **80** of the temperature sensor S**1**. As a result of this engagement, the temperature sensor S**1** and the cooking accessory **50** move in combination toward the rear exterior wall **36**, in a direction opposing the force of the biasing mechanism **82**. In one aspect, the biasing force is parallel to an insertion axis, which is perpendicular to the hinge axis X. The movement of the temperature sensor S**1** relative to the internal heating compartment **26** facilitates engagement with the cooking accessory **50** even when the cooking accessory **50** is not fully inserted into the compartment. Further, by allowing the temperature sensor S**1** to move relative to the internal heating compartment **26**, damage to a surface or coating applied to the cooking accessory **50** as a result of engagement with the temperature sensor S**1** may be avoided while also ensuring good thermal contact between the temperature sensor S**1** and the cooking accessory **50**. Embodiments of the cooking system **20** having a temperature sensor S**1** configured to monitor a temperature of the cooking surface **52**, but that is fixedly mounted and/or is arranged at another location within the internal heating compartment **26**, such as adjacent to one of the sidewalls **28**, **30** for example, are also within the scope of the disclosure.

(35) In addition to the one or more temperatures sensors S**1** used to monitor the temperature of the cooking accessory **50**, the cooking system **20** may further employ one or more additional temperature sensors S**2** to sense and communicate to the processor **76** the temperature of the environment or air within the internal heating compartment **26**. As illustrated in FIGS. **2** and **3**, the temperature sensor S**2** is arranged in the inner sidewall **37** of the internal heating compartment **26**. The temperature sensor S**2** can be configured to monitor the temperature of the environment of the internal heating compartment **26** and may be located at any suitable position within the internal heating compartment **26**, such as near a sidewall thereof, or near one or more of the heating elements **60**, **62**. In one aspect, the temperature sensor S**2** is arranged within a protective cage **29**, which protects the sensor S**2** from contact with food particles within the internal heating compartment **26** during a cooking operation. The cage **29** include apertures which allow air

circulating within the internal heating compartment **26** to pass into the cage **29** and contact the temperature sensor S**2**, thus allowing the temperature sensor S**2** to measure the temperature of the air within the internal heating compartment **26**. The temperature sensors S**1**, S**2** of the cooking system **20** can each be a negative temperature coefficient (NTC) temperature sensors. However, other types of temperature sensors are also contemplated herein.

(36) With continued reference to FIG. **3** and further reference to FIGS. **5-6**, an example of a cooking accessory **50**, specifically a griddle, cooking sheet, or tray, is illustrated in more detail. The cooking accessory **50** may be formed from a single piece of thin material, such as sheet metal for example, or alternatively, may be formed by affixing a plurality of individual pieces together. The cooking accessory **50** includes a cooking surface **52** and a plurality of sidewalls **54** extending generally vertically from the peripheral edges of the cooking surface **52**. Although the cooking accessory **50** is illustrated as having sidewalls **54** extending about the entire periphery of the cooking surface **52**, embodiments where sidewalls **54** are arranged at only a portion of the edges or sides of the cooking surface **52** are also contemplated herein.

(37) In order to position the cooking accessory properly within the internal heating volume, the cooking accessory **50** includes outwardly extending flanges **55***a*, **55***b* extending from opposite sides of the cooking accessory **50**. In one aspect, the outwardly extending flanges **55***a*, **55***b* are arranged at to extend from the sidewalls **54** towards the inner sidewalls **37**, **39**, when the cooking accessory **50** is installed into the internal heating compartment **26**. The flanges **55***a*, **55***b* may be configured to cooperate with the channels **49***a*, **49***b* of the support assemblies **47***a*, **47***b* to support the cooking accessory **50** at a desired position within the internal heating compartment **26**. As illustrated in FIGS. **3** and **6**, the flanges **55***a*, **55***b* are receivable within the channels **49***a*, **49***b* of the support assemblies **47***a*, **47***b*.

(38) As stated above, the cooking system **20** as illustrated and described herein provides enhanced temperature regulation. By including at least one temperature sensor S**1** configured to monitor a temperature of a cooking surface of a cooking accessory **50** and at least one temperature sensor S**2** configured to monitor a temperature of an environment within the internal heating compartment **26**, the temperatures of the cooking accessory **50** and the environment can be monitored independently. Further, the temperature of the cooking accessory and the environment can be controlled independently, allowing for heat to be delivered only to the portion or areas where needed.

(39) In one aspect, the cooking system **20** is configured to allocate portions of full power during a cooking process to the appropriate set of heating elements **60**, **62**, should only one sensor S**1**, S**2** be activated to monitor temperature levels. For example, if only temperature sensor S**1** is activated, the control algorithm diverts full power to the heating element **62**. As the cooking process continues, temperature sensor S**2** can be activated. The processor **76** is configured to redirect and split power between the heating elements **60**, **62** when both temperature sensors S**1**, S**2** are activated. This “power sharing” ensures the temperature of the cooking surface **52** or the heating compartment **26** is able to respond robustly to any impulses during the cooking process, such as food loads being added or the door **40** being opened while at least one of the heating elements **60**, **62** is active. In another aspect, information sensed by the temperature sensors S**1**, S**2** can be interpreted to ensure that an appropriate power level is delivered that does not increase the risk of burning or overcooking food arranged within the heating compartment **26**, while still optimizing performance of cooking the food.

(40) In one aspect, in order to achieve a varying and appropriate level of power in the heating elements **60**, **62**, the cooking system **20** includes a Proportional, Integral, and Derivate (PID) controller using the readings from the temperature sensors S**1**, S**2**. The use of a PID controller can ensure the cooking system **20** responds rapidly and efficiently to temperature changes within the heating compartment **26** with the optimal amount of power, and without causing undesirable behavior, such as unstable temperature oscillations or significant overshoot of a desired temperature within the heating compartment **26**.

(41) One or more operating parameters of the cooking system **20** may be adjusted, via for example a control algorithm accessible by the processor **76**, in response to the temperature detected by the one or more temperature sensors S**1**, S**2**. For example, the power provided to one or more heating elements **60**, **62** may be increased or decreased to achieve a desired temperature. In an aspect, the temperature of the environment and the temperature of the cooking surface **52** may be controlled independently. The temperature of the environment within the internal heating compartment **26** may be predominantly controlled by operation of the at least one heating element **60**, and the temperature of the cooking surface **52** of the cooking accessory **50** may be primarily controlled by operation of the one or more heating elements **62**. However, embodiments where temperature of the environment is controlled predominantly by the at least one heating element **62** and the temperature of the cooking accessory **50** is controlled mainly by the one or more heating elements **60** or embodiments where both the environment and the cooking accessory **50** are controlled by a combination of heating elements **60**, **62** are also contemplated herein.
(42) During a cooking operation, the temperature of one or both of the environment and the temperature of the cooking surface **52** are continuously or intermittently sensed and communicated from the respective temperature sensors S**1**, S**2** to the processor **76**. Operation of the one or more heating elements **60** may be adjusted using the control algorithm in response to the temperature of the heated air, measured by the temperature sensor S**2** disposed in the environment of the internal temperature compartment. For example, power provided to one or more heating element **60** may be increased if the sensed air temperature is below a set point, and the power provided to one or more of the heating elements **60** may be reduced or ceased completely if the sensed air temperature is equal to or exceeds a set point, thereby allowing the internal heating compartment **26** to cool.
(43) When a food load is applied to the cooking surface **52**, such as when a food item is installed thereon, the temperature of the cooking surface **52**, and therefore the cooking accessory **50**, typically drops. Accordingly, the control algorithm may be configured to determine that a food has been positioned on the cooking surface **52** when the temperature of the cooking surface **52** and/or cooking accessory **50** as monitored by the at least one temperature sensor S**1** begins to decrease, but the temperature of the environment within the internal heating compartment **26** remains generally constant. In response to this determination, the control algorithm will adjust an operating parameter of one or more of the heating elements **62** located below the cooking accessory **50** to increase the temperature of the cooking surface **52**.
(44) In one aspect, the at least one temperature sensor S**1** configured to monitor a temperature of the cooking surface **52** is operable to provide smoke control and indicate when the temperature of the cooking surface **52** or of the cooking accessory **50** is approaching a temperature associated with the generation of smoke (also known as the smoke point). The smoke point will vary based on the type of food positioned within the internal heating compartment **26**. The at least one temperature sensor S**1** configured to monitor a temperature of the cooking surface **52** may additionally be configured to cooperate with the control system **70** to prevent damage to a coating material of the cooking accessory and/or to prevent over cooking or burning of food positioned on the cooking surface **52**. Based on the user selected air temperature (for specific cooking modes such as SearCrisp), the control algorithm can be configured to specify and maintain target temperatures for both of the heating elements **60**, **62** independently of one another to ensure an appropriate balance of seared and roasted results of the food within the heating compartment **26**.
(45) Certain exemplary implementations have been described to provide an overall understanding of the principles of the structure, function, manufacture, and use of the systems, devices, and methods disclosed herein. One or more examples of these implementations have been illustrated in the accompanying drawings. Those skilled in the art will understand that the systems, devices, and methods specifically described herein and illustrated in the accompanying drawings are non-limiting exemplary implementations and that the scope of the present invention is defined solely by the claims. The features illustrated or described in connection with one exemplary implementation

may be combined with the features of other implementations. Such modifications and variations are intended to be included within the scope of the present invention. Further, in the present disclosure, like-named components of the implementations generally have similar features, and thus within a particular implementation each feature of each like-named component is not necessarily fully elaborated upon.

(46) Approximating language, as used herein throughout the specification and claims, may be applied to modify any quantitative representation that could permissibly vary without resulting in a change in the basic function to which it is related. Accordingly, a value modified by a term or terms, such as “about,” “approximately,” and “substantially,” are not to be limited to the precise value specified. In at least some instances, the approximating language may correspond to the precision of an instrument for measuring the value. Here and throughout the specification and claims, range limitations may be combined and/or interchanged, such ranges are identified and include all the sub-ranges contained therein unless context or language indicates otherwise.

(47) One skilled in the art will appreciate further features and advantages of the invention based on the above-described implementations. Accordingly, the present application is not to be limited by what has been particularly shown and described, except as indicated by the appended claims. All publications and references cited herein are expressly incorporated by reference in their entirety.

## Claims

1. A cooking system comprising: a housing having a front opening providing access to an internal heating compartment; a first heating element positioned in a bottom of the internal heating compartment; a second heating element positioned within the internal heating compartment; a cooking accessory having a cooking surface, the cooking accessory being configured to be received within the front opening and configured to move along an insertion axis extending from the front opening to a rear area of the internal heating compartment, the cooking accessory positioned above the first heating element of the internal heating compartment; a user interface configured to receive a cooking mode from among a plurality of predetermined cooking modes based on a user selection, each of the plurality of predetermined cooking modes being associated with a required cooking accessory surface temperature and a required air temperature; a first temperature sensor mounted in a wall of the internal heating compartment and aligned with the cooking accessory along the insertion axis, the first temperature sensor configured to contact the cooking accessory to measure a temperature of the cooking surface of the cooking accessory; a second temperature sensor positioned within the internal heating compartment, the second temperature sensor configured to measure an air temperature of the internal heating compartment in which the cooking accessory is positioned and the second heating element is positioned; and a controller configured to operate simultaneously: an output of the first heating element, based on the measured temperature of the cooking surface of the cooking accessory, to achieve the required cooking accessory surface temperature associated with the selected cooking mode, and an output of the second heating element, based on the measured air temperature of the internal heating compartment in which the cooking accessory is positioned and the second heating element is positioned, to achieve the required air temperature associated with the selected cooking mode.

2. The cooking system of claim 1, wherein the first heating element is positioned vertically between a bottom surface of the internal heating compartment and the cooking accessory.

3. The cooking system of claim 1, wherein the second heating element is positioned vertically above the cooking accessory.

4. The cooking system of claim 1, wherein the output of the second heating element is related to the measured air temperature of the internal heating compartment.

5. The cooking system of claim 1, wherein the output of the first heating element is independent from the output of the second heating element.

6. The cooking system of claim 1, wherein the wall of the internal heating compartment is a rear wall of the internal heating compartment, and the first temperature sensor is mounted within an aperture positioned in the rear wall of the internal heating compartment.
7. The cooking system of claim 1, wherein the first temperature sensor is movable relative to the internal heating compartment.
8. The cooking system of claim 1, wherein the first temperature sensor is movably biased in a first direction.
9. The cooking system of claim 8, wherein the cooking accessory is configured to be inserted into the internal heating compartment in a second direction, opposite the first direction.
10. The cooking system of claim 1, wherein the first temperature sensor is configured to move relative to the internal heating compartment and remain in contact with the cooking accessory.
11. The cooking system of claim 1, wherein the housing has a left exterior wall, a right exterior wall, a top exterior wall, a bottom exterior wall, and a rear exterior wall that define a hollow box; the front opening defines a front of the hollow box; and the hollow box defines the internal heating compartment.
12. The cooking system of claim 1, wherein the cooking accessory is configured to directly contact the first temperature sensor when inserted into the internal cooking compartment; and the first temperature sensor is configured to directly contact only one cooking accessory at a time.
13. The cooking system of claim 1, wherein the plurality of predetermined cooking modes includes toast, bake, broil, grill, warm, reheat, and steam cook.
14. The cooking system of claim 1, wherein the plurality of predetermined cooking modes includes air frying, sear crisping, rapid baking, air roasting, and broiling.
15. The cooking system of claim 1, wherein the controller is configured to operate the outputs of the first heating element and the second heating element such that the first heating element and the second heating element are simultaneously outputting heat that cooks a food product arranged on the cooking accessory and located in the internal heating compartment.
16. A cooking system comprising: a housing having an internal heating compartment; a cooking accessory having a cooking surface, the cooking accessory configured to be removably received within the internal heating compartment and configured to move along an insertion axis extending from a front opening of the internal heating compartment to a rear area of the internal heating compartment; a user interface configured to receive a cooking mode from among a plurality of predetermined cooking modes based on a user selection, each of the plurality of predetermined cooking modes being associated with a required cooking accessory surface temperature and being associated with a required air temperature; a first heating element positioned in a bottom of the internal heating compartment and, with the cooking accessory received within the internal heating compartment, below the cooking accessory; a second heating element positioned within the internal heating compartment and, with the cooking accessory received within the internal heating compartment, above the cooking accessory; a first temperature sensor mounted within a wall of the internal heating compartment and aligned with the cooking accessory along the insertion axis, the first temperature sensor configured to measure a temperature of the cooking surface of the cooking accessory; a second temperature sensor positioned within the internal heating compartment and configured to measure an air temperature of the internal heating compartment in which the cooking accessory is positioned and the first and second heating elements are positioned; and a controller configured to operate simultaneously: an output of the first heating element, based on the measured temperature of the cooking surface of the cooking accessory, to achieve the required cooking accessory surface temperature associated with the selected cooking mode, and an output of the second heating element, based on the measured air temperature of the internal heating compartment, to achieve the required air temperature associated with the selected cooking mode.
17. The cooking system of claim 16, wherein the output of the first heating element is independent of the output of the second heating element.

18. The cooking system of claim 16, wherein the first temperature sensor is movable relative to the internal heating compartment.

19. The cooking system of claim 16, wherein the first temperature sensor is configured to measure the temperature of and directly contact the cooking accessory; the first temperature sensor is configured to directly contact only one cooking accessory at a time; and the controller is configured to operate the outputs of the first heating element and the second heating element such that the first heating element and the second heating element are simultaneously outputting heat that cooks a food product arranged on the cooking accessory and located in the internal heating compartment.