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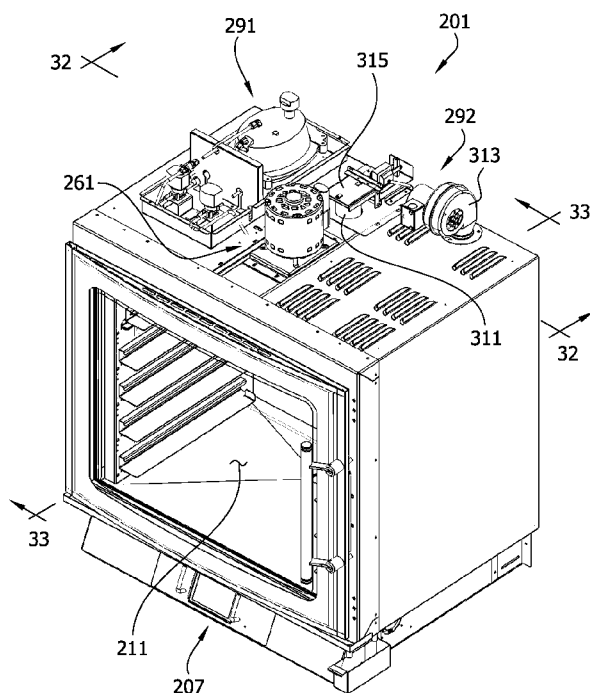
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[Continued on next page]

(54) Title: FOOD PREPARATION APPARATUS AND METHODS

FIG. 31



(57) Abstract: An oven for proofing and baking dough and associated methods. Proofing and baking can be done in sequence in the same cooking chamber of the oven. One or more venting or temperature ramping steps may be used for transitioning from the proofing step to the baking step. An oven configured for venting gas out of a cooking chamber and associated methods are also disclosed.



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FOOD PREPARATION APPARATUS AND METHODS

FIELD OF THE INVENTION

[0001] The present invention generally relates to recipe-implementing apparatus and more particularly to apparatus for preparing food, such as an oven, and associated user interfaces and methods.

BACKGROUND

[0002] Certain types of food products are especially difficult to cook quickly and uniformly. Bread is one such product. Retarding, proofing, and baking are three operations commonly used in bread making to achieve desired bread characteristics. As known in the field of baking, "retarding" dough causes a slower fermentation, or "rise," of the dough. Dough may be retarded to increase the flavor of the bread when baked and to give the crust a darker color. For example, frozen dough may be kept in a refrigerator overnight to retard it. After the dough is retarded, it may be proofed before baking. "Proofing" is a continuation of the process of yeast fermentation which increases the volume or "rise" of the shaped dough, and an oven used to "proof" bread is often referred to as a "proofer" or "proofer oven." After the dough is proofed, it may be removed from the proofer and then baked into bread. For example, an oven may include separate proofing and baking cavities such that the dough may be proofed in the proofer cavity before being moved to and baked in the baking cavity. Retarding, proofing, and baking recipes may include various operations such as temperature control, relative humidity control, and air circulation.

SUMMARY

[0003] In one aspect, the present invention is directed to a convection oven including an oven chamber for receiving food

to be cooked therein. The oven includes at least one first outlet for delivering gas to the oven chamber. The oven includes at least one first exhaust for exhausting gas from the oven chamber. The oven includes re-circulation ducting defining a re-circulation gas flow path for flow of gas from the at least one first exhaust to the at least one first outlet for re-circulating gas from the oven chamber back to the oven chamber. The oven includes a blower for moving gas in the re-circulation ducting from the at least one first exhaust to the at least one first outlet. The oven includes a heater for heating the re-circulating gas. The oven includes a vent fan for delivering gas to the oven chamber for creating positive gas pressure in the oven chamber. The oven includes at least one second outlet downstream from the vent fan for delivering gas from the vent fan to the oven chamber. The at least one second outlet is connected to the oven chamber for gas flow from the at least one second outlet directly to the oven chamber. The oven includes vent ducting defining a vent gas flow path from the vent fan to the at least one second outlet. The vent gas flow path is separate from the re-circulation gas flow path.

[0004] In another aspect, the present invention is directed to a method of operating a convection oven. The method includes exhausting gas from an oven chamber holding food through at least one first exhaust. The method includes heating the exhausted gas and operating a re-circulation blower to blow the exhausted gas along a re-circulation flow path in the oven from the at least one first exhaust to at least one first outlet for entering the cooking chamber. The method includes operating a vent fan to blow gas into the oven chamber through at least one second outlet. The at least one second outlet is connected to the oven chamber for gas flow directly to the oven chamber from the at least one second outlet. The method includes venting gas from the oven chamber through a vent flue by gas pressure created by the vent fan blowing the gas into the oven chamber

through the at least one second outlet. Blowing the gas into the oven chamber through the at least one second outlet includes operating the vent fan to blow gas along a vent flow path extending from the vent fan to the at least one second opening separate from the re-circulation flow path.

[0005] In another aspect, the present invention is directed to a convection oven for proofing and baking dough. The oven includes a cooking chamber sized and shaped for receiving dough to be proofed and baked. The oven includes a convection system including a blower and a heater for receiving gas from the cooking chamber and delivering heated gas to the cooking chamber. The oven includes a vent system including a fan for actively venting moisture laden gas out of the cooking chamber. The oven includes an oven controller for controlling operation of the convection system and the vent system to proof and bake dough in sequence in the cooking chamber. The oven includes a tangible storage medium having oven controller executable instructions for executing a proof and bake operation in the cooking chamber including: a proofing step during which the convection system maintains a proofing temperature in the cooking chamber for proofing the dough, a baking step after the proofing step during which the convection system maintains a baking temperature in the cooking chamber for baking the dough, and a transition phase between the proofing and baking steps including: a first active venting step during which the venting system actively vents moisture laden gas out of the cooking chamber for decreasing the humidity in the cooking chamber, a temperature ramping step during which the convection system increases the temperature in the cooking chamber to a maximum temperature greater than the proofing temperature, and a second active venting step during which the venting system actively vents moisture laden gas out of the cooking chamber for decreasing the humidity in the cooking chamber.

[0006] In another aspect, the present invention is directed to a method of proofing and baking dough in sequence in the same cooking chamber. The method includes executing a proofing step during which a proofing temperature is maintained in the cooking chamber for proofing the dough. The method includes executing a baking step after the proofing step during which a baking temperature is maintained in the cooking chamber for baking the dough. The method includes executing a transition phase between the proofing and baking steps including: executing a first active venting step during which moisture laden gas is actively vented out of the cooking chamber for decreasing the humidity in the cooking chamber, executing a temperature ramping step during which the temperature in the cooking chamber is increased to a maximum temperature greater than the proofing temperature, and executing a second active venting step during which moisture laden gas is actively vented out of the cooking chamber for decreasing the humidity in the cooking chamber.

[0007] In another aspect, the present invention is directed to a convection oven for proofing and baking dough. The oven includes a cooking chamber sized and shaped for receiving dough to be proofed and baked. The oven includes a convection system including a blower and a heater arranged for receiving gas from the cooking chamber and delivering heated gas to the cooking chamber. The oven includes a vent system including a fan arranged for actively venting gas out of the cooking chamber. The oven includes an oven controller adapted for controlling operation of the convection system and the vent system to proof and bake dough in sequence in the cooking chamber. The oven includes a tangible storage medium having oven controller executable instructions for executing a proof and bake operation in the cooking chamber including: a proofing step during which the convection system maintains a proofing temperature in the cooking chamber for proofing the dough, a baking step after the proofing step during which the convection system maintains a

baking temperature in the cooking chamber for baking the dough, and a transition phase between the proofing and baking steps including: a first temperature ramping step during which the convection system increases the temperature in the cooking chamber to a maximum temperature greater than the proofing temperature, an active venting step during which the venting system actively vents moisture laden gas out of the cooking chamber for decreasing the humidity in the cooking chamber, and a second temperature ramping step during which the convection system increases the temperature in the cooking chamber to a maximum temperature greater than the maximum temperature of the first temperature ramping step.

[0008] In yet another aspect, the present invention is directed to a method of proofing and baking dough in sequence in the same cooking chamber. The method includes executing a proofing step during which a proofing temperature is maintained in the cooking chamber for proofing the dough. The method includes executing a baking step after the proofing step during which a baking temperature is maintained in the cooking chamber for baking the dough. The method includes executing a transition phase between the proofing and baking steps including: executing a first temperature ramping step during which the temperature in the cooking chamber is increased to a maximum temperature greater than the proofing temperature, executing an active venting step during which moisture laden gas is actively vented out of the cooking chamber for decreasing the humidity in the cooking chamber, and executing a second temperature ramping step during which the temperature in the cooking chamber is increased to a maximum temperature greater than the maximum temperature of the first temperature ramping step.

[0009] Other objects and features will be in part apparent and in part pointed out hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Fig. 1 is a perspective of an oven of the present invention;

[0011] Fig. 2 is a perspective of an upper section of the oven, shrouds and covers of the upper section not being shown;

[0012] Fig. 3 is a vertical section of the upper section of Fig. 1 taken along the width of the upper section;

[0013] Fig. 3A is a view similar to Fig. 3 but showing an alternative embodiment of a steam injection system;

[0014] Fig. 4 is a vertical section of the upper section taken along the width of the upper section;

[0015] Fig. 5 is a rear perspective of the upper section;

[0016] Fig. 6 is an enlarged view of a portion of the section of Fig. 4 showing a flue valve in an open position;

[0017] Fig. 7 is a view similar to Fig. 6 but showing the flue valve in a closed position;

[0018] Fig. 8 is a horizontal section of the upper section taken along the depth of the upper section through an upper portion of a conduit system;

[0019] Fig. 9 is a schematic of a refrigeration system of the upper section;

[0020] Fig. 10 is a schematic of a control system for the oven;

[0021] Fig. 11 is a photograph of a screenshot of a user interface of the oven showing a recipe menu home screen;

[0022] Fig. 12 is a photograph of a screenshot of the user interface showing a recipe edit home screen;

[0023] Fig. 13 is a photograph of a screenshot of the user interface showing a retard recipe program screen;

[0024] Fig. 14 is a photograph of a screenshot of the user interface showing a proof recipe program screen;

[0025] Fig. 15 is a photograph of a screenshot of the user interface showing a bread recipe program screen;

[0026] Fig. 16 is a photograph of a screenshot of the user interface showing a retard recipe ready screen;

[0027] Fig. 17 is a photograph of a screenshot of the user interface showing a retard recipe run screen;

[0028] Fig. 18 is a photograph of a screenshot of the user interface showing a proof recipe ready screen;

[0029] Fig. 19 is a photograph of a screenshot of the user interface showing a proof recipe run screen;

[0030] Fig. 20 is a photograph of a screenshot of the user interface showing a bread recipe ready screen;

[0031] Figs. 21-28 are photographs of screenshots of the user interface showing a bread recipe run screen at various stages of executing the bread recipe, with Vent Open, Steam Cycle, and Auxiliary Heat operational status indicators being shown in various states;

[0032] Fig. 29 is a photograph of a screenshot of the user interface showing the bread recipe program screen with an alternative recipe;

[0033] Fig. 30 is a photograph of a screenshot of the user interface showing the bread recipe program screen with another alternative recipe;

[0034] Fig. 31 is a perspective of a second embodiment of an oven of the present invention;

[0035] Fig. 32 is a vertical section of the oven of Fig. 31 taken along the width of the oven; and

[0036] Fig. 33 is a vertical section of the oven of Fig. 31 taken along the depth of the oven.

[0037] Corresponding reference characters indicate corresponding parts throughout the drawings.

DETAILED DESCRIPTION

[0038] Referring to the drawings, Fig. 1 illustrates one embodiment of an oven according to the present invention, indicated generally by the reference number 1. The oven 1 may

be used for cooking or baking food products, such as bread, among other things. As will become apparent, the oven 1 has customizable, independently programmable parameters permitting precise tailoring and testing of various recipes for retarding, proofing, and/or baking dough.

[0039] The oven 1 illustrated in Fig. 1 includes a cabinet, generally designated by the reference number 5, having an upper section 5A and a lower section 5B. The oven 1 includes a user interface 7 positioned between the upper and lower sections 5A, 5B for controlling oven operation. The upper section 5A is adapted for retarding, proofing, and/or baking dough. The upper section 5A will be described in further detail hereafter, with the understanding that the lower section 5B can include its own components or components shared with the upper section configured for executing the same or different operations in the lower section as in the upper section, using a shared controller or separate controllers. Both of the sections 5A and 5B may be configured for retarding, proofing, and/or baking dough, or any combination thereof. Alternatively, for example, the lower section 5B may be adapted for retarding and/or proofing, and the upper section 5A may be adapted for proofing and/or baking. Other configurations may be used without departing from the scope of the present invention. Moreover, the cabinet 5 may include more (e.g., three, four, etc.) or fewer (e.g., one) sections without departing from the scope of the present invention. For example, the oven may comprise a single chamber (e.g., sized for receiving about 10 pans) without departing from the scope of the present invention.

[0040] Referring to Figs. 2-5, the upper section 5A is shown separated from the lower section 5B and having covers, shrouds, and other parts removed to expose various components. As shown in Figs. 2 and 3, the upper section 5A comprises a chamber 11 defined by a top wall, a bottom wall, opposite side walls, and a back wall. The chamber 11 is accessible by opening

a door 25 which closes the front of the chamber. The door 25 is shown in Fig. 1 but is removed from the upper section 5A in the remainder of the figures. One or more rack supports 29 are secured to the side walls of the chamber 11 for supporting a number of food racks (not shown) in the chamber. Each rack is sized to hold a number of pans of bread dough. It will be understood that the number and size of the racks can vary without departing from the scope of this invention. The chamber 11 is surrounded by an upper housing, generally designated 41 in Fig. 3, having a top wall, a bottom wall, opposite side walls, and a back wall. The top and side walls of the housing 41 are spaced from respective walls of the cooking chamber 11 to provide a conduit system or flow path 53 for circulating air (or other gas) to, through and from the cooking chamber 11. As shown in Fig. 3, the conduit system 53 comprises an upper portion 53A above the cooking chamber 11 and side portions 53B at opposite sides of the cooking chamber 11. Other flow path configurations may be used without departing from the scope of the present invention.

[0041] A blower, generally indicated at 61 in Fig. 3, is mounted in the upper portion 53A of the conduit system 53, adjacent the top of the upper section 5A of the oven, for circulating air (or other gas) through the conduit system. In the illustrated embodiment, air enters the cooking chamber 11 through a plurality of entry openings 65 in the side walls of the chamber (see Figs. 2 and 4) and exits the chamber through an exhaust opening 69 in the top wall of the chamber below the blower 61. The blower 61 comprises a blower motor 101 and a blower wheel 121. The blower motor 101 is mounted on a top wall of the oven. The blower motor 101 drives rotation of the blower wheel 121 via output shaft 111, which rotates in a bearing about a generally vertical axis. The blower wheel 121 is located in the upper portion 53A of the air conduit system 53 adjacent (e.g., immediately above) the exhaust opening 69 in the top wall

of the cooking chamber 11. The blower motor 101 is operable to rotate the blower wheel 121 to circulate air through the conduit system 53 and cooking chamber 11 at velocities and flow rates suitable for retarding, proofing, and/or baking dough. Exemplary velocities include 0-600 ft/min. The blower motor 101 may rotate the blower wheel 121 in constant or pulsed manners (e.g., blower energized for time periods separated by time periods of the blower not being energized), as needed. Rotation of the blower wheel 121 creates suction at the suction side of the blower wheel (i.e., the lower portion of the blower wheel adjacent the exhaust opening 69) to pull gas from the cooking chamber 11 through the exhaust opening 69. Gas is expelled from the blower wheel 121 at the output (exhaust) side of the blower wheel (i.e., the left and right sides of the blower wheel as shown in Fig. 3) to circulate air through the conduit system 53 to the cooking chamber 11. The blower 61 may be a variable-speed, reversible blower. More specifically, the blower motor 101 may be adapted to rotate the blower wheel 121 at variable rates and may be adapted to rotate the blower wheel in forward and reverse directions. Such a blower is disclosed in further detail in U.S. Patent No. 8,378,265, which is hereby incorporated by reference in its entirety. For example, the oven 1 may be programmed to operate the blower 61 at different speeds for different recipes (e.g., faster or slower for bread recipe as compared to cookie recipe).

[0042] A heating system 71 is provided for heating the air being circulated. The heating system 71 heats the air in the conduit system 53 after it leaves the chamber 11 and before it is re-circulated back to the chamber via the conduit system. By way of example, the heating system 71 may comprise one or more electric resistance heating elements in the upper portion 53A of the conduit system 53 located adjacent the top wall of the chamber 11. In the illustrated embodiment, the heating system 71 includes a primary heater 73 including first and second

heating elements 73A, 73B on opposite sides of the blower wheel 121 and a secondary or auxiliary heater 75 including third and fourth heating elements 75A, 75B on opposite sides of the blower wheel adjacent the first and second heating elements, respectively. Other forms of primary and auxiliary heaters may be used without departing from the scope of the present invention. As will become apparent, the heaters 73, 75 may be operated at the same or different times, for the same or different durations, and/or at the same or different duty cycles. For example, the primary heater 73 may be operated as the main heater for heating the circulating air, and the auxiliary heater 75 may be used at times when it is desired to rapidly increase the temperature of the circulating air (e.g., during pre-heat, temperature ramp up to start of bake recipe, etc.). The auxiliary heater 75 may be programmable to operate at duty cycles ranging from 0-100 percent at 1 percent increments. Other heating system configurations may be used without departing from the scope of the present invention. For example, the auxiliary heater 75 may be omitted. Variations in heat output may be achieved by varying the duty cycle of the primary heater 73. For high heat output, the duty cycle may be increased, and for lower heat output, the duty cycle may be decreased. For example, the duty cycle for the primary heater 73 may be programmed differently for different recipes (e.g., higher duty cycle and thus higher heat for ciabatta bread bake recipe than bake recipes for other types of bread). The auxiliary heater 75 and/or higher duty cycle of the primary heater 73 may be used for rapid recovery to temperature set point following a loss of temperature in the chamber 11 due to a door cycle open/close or food loading.

[0043] The oven 1 may include various sensors for indicating to control system of the oven relevant aspects of the retarding, proofing, and/or baking operations. For example, a temperature sensor 77 (Figs. 3 and 4) is provided in the chamber

11 for sensing the temperature in the chamber and indicating the sensed temperature to a control system of the oven. A relative humidity sensor 79 is provided in the chamber 11 for sensing and communicating to the control system the relative humidity in the chamber. In the illustrated embodiment, the head or tip 79A of the humidity sensor is covered by a shield 81 to shield it from direct flow of a steam injection system, described in further detail below, to prevent artificially high relative humidity readings. The chamber 11 is selectively illuminated by lights 83 mounted on the back wall of the chamber 11.

[0044] Referring to Fig. 5, the oven 1 includes a steam injection system, generally indicated by the reference number 91 adapted for introducing steam into the chamber 11. As explained in further detail below, the steam injection system 91 may be used in operations such as bread baking to improve the color, texture, or crunchiness of the crust of the baked bread. For example, steam may be injected in the chamber 11 at the beginning of a bake recipe, after the beginning of a bake recipe, and/or intermittently during a bake recipe. Condensation of the steam on the outside or "skin" of the bread and subsequent baking may provide the desirable characteristics noted above. Moreover, the steam injection system may be used in controlling the humidity in the chamber 11 during recipes calling for humidity (e.g., during a proof recipe).

[0045] The steam injection system 91 includes a source of steam 93 supported on the oven 1 and a steam delivery conduit 95 extending between the source of steam and the chamber 11. In the illustrated embodiment, the source of steam 93 is a steam generator vessel which generates and holds a supply of steam in a reservoir. A solenoid valve 97 is positioned downstream from the steam generator 93 and upstream from the chamber 11 for selectively permitting steam injection into the chamber. The solenoid valve 97 has an open position in which it permits steam to enter the chamber 11 and a closed position in which it blocks

steam from entering the chamber. As shown in Fig. 3, the steam delivery conduit 95 extends from behind the chamber 11 into the rear of the chamber, where the conduit is connected to two steam distribution conduits 99 that extend outwardly and downwardly inside the chamber along its rear wall. Steam is introduced into the chamber 11 through the ends of the steam distribution conduits 99. Other sources of steam, other steam delivery and distribution conduits, and other valves may be used without departing from the scope of the present invention. For example, the steam delivery conduits 99 may be arranged to distribute steam more evenly in the chamber to the various tray levels. Moreover, components of the steam injection system 91, such as the valve 93, may be omitted without departing from the scope of the present invention. For example, the source of steam 93 may produce steam "on demand" such that a valve is not required. When steam is needed, the steam is generated. An amount of water needed to produce the desired amount of steam may be introduced into the steam generator when called for by the control system such that a valve is not required to prevent excess steam from entering the chamber 11. As another example, steam may be generated by introducing water onto the blower 61, such as disclosed in U.S. Patent No. 8,378,265, which is hereby incorporated by reference in its entirety.

[0046] As shown in an alternative embodiment, illustrated in Fig. 3A, the steam injection system 91' may include steam outlet portions (e.g., one or more holes 100') positioned for delivering steam above each of the trays when held by the tray supports 29'. The injection system 91' includes a steam delivery conduit 95' and steam distribution conduits 99' having steam outlet openings 100' positioned above each set of rack supports 29' for introducing steam to the region above each of the trays. The number of steam outlet portions corresponds generally to the number of levels of rack supports 29', and the vertical position of the steam outlet portions is offset above

respective tray supports 29' for delivering steam to food on each of the trays supported on the tray supports.

[0047] Referring to Figs. 2, 4, and 5, the oven includes a vent conduit or flue 111 for permitting gas to escape from the chamber 11 to ambient. The chamber 11 and air conduit system 53 is generally a closed system in which substantially the same air re-circulates over and over. However, at various times, it may be desired to passively or actively vent the chamber 11. As shown in closer detail in Figs. 6 and 7, the flue 111 extends from an inlet end communicating with the air conduit system 53 to an outlet end above the chamber. By way of example, the opening may be a 0.375-in. diameter opening. A fan 113 is provided at an intermediate portion of the flue 111 between the inlet and outlet ends for actively exhausting gas from the chamber 11 via the flue. The flue 111 includes a valve or cap 115 adjacent its outlet end adapted for sealing the outlet of the flue to prevent venting. The valve 115 includes a valve member 115A selectively movable by a solenoid 115B for moving the valve member between an open position (e.g., Fig. 6) in which the valve member permits flow through the flue 111 and a closed position (e.g., Fig. 7) in which the valve member blocks fluid flow through the flue. In the illustrated embodiment, the valve member 115A includes a gasket 115C comprising resiliently compressible material which is compressed when pressed against the outlet end of the flue 111 for forming a suitable seal. For example, it may be desirable while injecting steam into the chamber 11 to close the flue 111 to prevent steam from escaping the chamber. Moreover, when a high-humidity operation such as proofing is finished, it may be desirable to actively vent the chamber 11 using the fan 113 to prepare for the baking cycle. With less relative humidity in the chamber 11, it requires less energy to heat the gas in the chamber to the higher baking temperature.

[0048] Referring to Figs. 2 and 4, the chamber 11 includes a sloped floor 131 and drain 133 for collecting and draining condensed liquid from the bottom of the chamber 11. For example, some of the steam injected by the steam injection system 91 into the chamber 11 may condense inside the chamber. The sloped floor 131 of the chamber 11 promotes draining of the condensed liquid by gravity to the drain 133. In the illustrated embodiment, the floor includes front, rear, left and right sections 131A-131D sloping toward a central region of the floor to an inlet 133A of the drain 133. The drain 133 extends from the drain inlet 133A to a drain outlet 133B positioned for delivery of the drained condensate outside of the chamber 11 (e.g., to a catch basin). The drain 133 includes a valve 133C (Fig. 4) having an open position in which the valve permits flow of liquid through the drain and a closed position in which the valve blocks flow of liquid (and gas) through the drain. The valve 133C may be closed at various stages of recipes or for entire recipes, depending on whether it is desired to prevent liquid from draining from the chamber 11 and/or to prevent gas from entering the chamber through the drain. Generally speaking, the drain 133 may be closed by the valve 133C at the same times the flue 111 is closed by the valve 115. Sloped chamber floors having other configurations (e.g., primarily toward a rear of the chamber rather than the center of the chamber) and other types of drains may be used without departing from the scope of the present invention. For example, the drain inlet 133A may serve as a steam injection port into the chamber 11. The steam delivery conduit 95 may be in communication with the drain inlet 133A via a three-way valve having a first open position in which steam is permitted to flow into the chamber 11 from the steam delivery conduit 95, a second open position in which liquid from the chamber 11 is permitted to enter the drain 133A, and a third closed position in which the valve blocks flow of steam and condensate.

[0049] As shown in Figs. 4, 5, and 9, the oven 1 includes a refrigeration system 141 that may be used for a retarding operation in the same chamber 11 in which the dough is proofed and/or baked. In addition, the refrigeration system may be used during other recipes, such as for proofing or baking recipes, or between recipes to rapidly cool the chamber to prepare for a recipe calling for a lesser temperature than a previously executed recipe. The refrigeration system 141 is supported on the oven 1, and more particularly in a housing 143 on the rear side of the upper section 5A. Example refrigeration system components which may be supported in the housing 143 are shown schematically in Fig. 9. For example, the refrigeration system 141 may include a compressor 145, a condenser 147, a refrigerant receiver 149, an expansion valve 151, and an evaporator 153. Persons having ordinary skill in the art will understand air blown over the evaporator 153 (e.g., by a fan 155) will be cooled. The cooled air is delivered from the refrigeration system 141 via a cool air conduit 157 having an inlet end 157A connected to the refrigeration housing 143 and an outlet end 157B in communication with the rear, upper portion of the duct system 53 above the chamber 11. The cool air moves through the duct system 53 and enters the chamber 11 via the outlet openings 65 in the sides of the chamber. Accordingly, dough may be placed in the chamber 11 to be held in refrigerated conditions in a retarding operation (e.g., prior to proofing and baking the dough in the same chamber). Moreover, the dough may be held in a frozen or slacked state for a period of time prior to a retarding operation. In addition, the refrigeration system 141 may be used to rapidly cool the chamber 11 between baking and proofing operations, or to rapidly cool the chamber at or near an end of a bake operation to permit the bread to be served for consumption more quickly. Refrigeration systems having other configurations may be used without departing from the scope of the present invention. For example, the refrigeration system

141 may include a warm air return from the chamber 11 to the refrigeration housing 143. Moreover, refrigeration systems other than vapor-compression refrigeration systems may be used. For example, the refrigeration system may include a heat pump, Peltier device, solid state refrigerator, or thermoelectric cooler.

[0050] As is now apparent, the oven 1 includes suitable components and systems such that the chamber 11 may be used for retarding, proofing, and baking, if desired. Ovens not having all of these capabilities (e.g., capable of only proofing and baking, or only baking) may be used without departing from the scope of the present invention. For example, the refrigeration system 141 may be omitted.

[0051] As shown schematically in Fig. 10, a control system 161 for the oven may include a central processing unit (CPU) 163, a tangible storage medium 165 (e.g., including forms of storage such as software 165A and firmware 165B), and the user interface 7. The CPU 163 may be a microprocessor or the like. The control system 161 includes interconnection electronics 167 that operatively connect the various components of the control system with other components of the oven, such as the refrigeration system 141, steam injection system 91, flue valve 115, blower 61, heating system 71, and temperature and relative humidity sensors 77, 79. The CPU 163 is adapted for reading and executing instructions stored in the storage medium 165, and is responsive to the user interface 7, for controlling the various components and systems of the oven 1. A user can enter or modify instructions stored on the storage medium 165 via the user interface 7. In the illustrated embodiment, the user interface 7 is a touch screen, as explained in further detail below. Other types of user interfaces may be used without departing from the present invention. The user interface 7 provides command signals via the interconnection electronics 167 to the CPU 163. The command signals can include changes to the

parameters (e.g., time, temperature, humidity, etc.) stored in the tangible storage medium 165. The CPU 163 responds to the command signals and provides control signals corresponding thereto via the interconnection electronics 167 to the various components and systems of the oven 1. For example, the interconnection electronics 167 may include electrical or fiber optic lines or wireless communication devices.

[0052] As will be described with reference to Figs. 11-15, 29, and 30, the user interface 7 is adapted for permitting a user to program various retarding, proofing, and baking recipes. The user interface 7 provides the user the ability to program individual aspects of retarding, proofing, and baking recipes independently of each other. For example, start times and durations of various stages of a baking recipe can be customized and defined with respect to a recipe time (e.g., countdown time). The user interface 7 illustrates to the user in graphical format the programmed parameters of a recipe for enhanced user understanding of the programmed parameters. This may be particularly useful when a recipe such as a baking recipe includes various functions such as steam injection and venting which may include stages having overlapping durations.

[0053] Referring to Fig. 11, the user interface 7, being a touch screen, includes both a user input 7A and a display 7B. The display 7B includes a color liquid crystal display screen, and the user input 7A includes a touch-sensitive panel overlaying the display screen. The touch screen 7 defines "actuators" at various areas of the touch screen where the touch screen is responsive to the touch of a user. The "actuators" may be identifiable to the user by text or graphic information on the display 7B underlying respective areas of the touch sensitive panel 7A. Other types of user interfaces may be used without departing from the present invention. For example, the display and user input may be separate from one another. The display may include other types of screens or indicators.

Moreover, the user input may comprise other types of actuators, such as keyboards, mice, buttons, switches, or even microphones for receiving information from the user.

[0054] As shown in Fig. 11, a Recipe Menu Home Screen is displayed on the touch screen 7. The screen is divided into upper and lower sections corresponding to the upper and lower sections of the oven 1. The lower section is shown as being configured as a proofer and having corresponding controls. Operation of the upper section will be described in further detail hereafter, with the understanding that the lower section could be configured to execute the same or different operations as the upper section, as explained above. The upper section of the screen includes an icon representative of the upper section of the oven to indicate to the user that the controls relate to the upper oven section. On this screen, the user has the option of selecting from a plurality of recipes stored on the tangible storage medium. As illustrated, three recipes are displayed, including Retard, Proof, and Bread (Bake). The user could begin execution of one of these recipes by pressing the respective actuator. Other recipes could be accessed by using Page Left or Page Right actuators.

[0055] If it is desired to program a new recipe or modify an existing recipe, the user may press the actuator at the top right of the screen represented by an exclamation point. This brings the user to a Recipe Edit Home Screen, as shown in Fig. 12. The Recipe Edit Home Screen provides a list of all recipes stored in the tangible storage medium 165. The list of recipes includes the Retard, Proof, and Bread (Bake) recipes displayed previously on the Recipe Menu Home Screen (Fig. 11). The user may select any of the recipes by pressing the respective actuator.

[0056] For example, pressing the Retard actuator causes the display to show the Retard Recipe Program Screen of Fig. 13. The recipe being programmed is indicated by the word "RETARD"

displayed at the top of the screen. The screen lists several parameters which may be programmed in a given recipe. For example, the parameters include Recipe Time, Recipe Set Point (temperature), Oven Humidity, Steam Cycle Start, Steam Delay, Steam On Time, Vent Close Delay, and Vent Close Time. Each of the parameters includes a value display (i.e., indicating the programmed value for the respective parameter) and an actuator permitting the user to change the displayed value. In the illustrated case, the actuators each include plus and minus buttons for increasing or decreasing the programmed value. In the Retard recipe as displayed, the Recipe Time is 60:00 minutes and the Recipe Set Point (temperature) is 38 degrees F. All of the other programmable parameters are not used or set to zero. The screen includes a graphical representation of the programmed recipe in the form of a two-dimensional bar graph adjacent the bottom of the screen. Colors used in the bar graph correspond to colors of parameter color indicators (i.e., colored boxes) adjacent each programmable parameter label. The bar graph represents the recipe according to the parameters displayed by the screen as a function of time (horizontal axis). The recipe has a beginning at the left side of the bar graph, an end at the right side of the bar graph, and a duration extending between the two ends. In this case, the graph is a solid red bar extending from the left to the right. The red color of the graph corresponds to the red color of the indicator next to the Recipe Time parameter label. The user can select whether to "chain" a second recipe to the recipe being programmed such that the control system operates the chained recipe automatically after execution of the displayed recipe. In the illustrated case, the Proof recipe is chained to the Retard recipe, as indicated by the arrow and word "PROOF" displayed at the top right of the screen. The chained recipe can be changed by adjusting the Chain parameter using the chain actuator (i.e., plus or minus actuators) on the left side of the screen. The

Proof recipe is the fourth recipe listed on the Recipe Edit Screen (Fig. 12). Accordingly, a number 4 is displayed in the value display of the Chain parameter. When the recipe is programmed as desired, the recipe is saved to the tangible memory by pressing the save actuator represented by the arrow at the bottom right of the screen. Pressing the back arrow actuator at the bottom left of the screen brings the user back to the Recipe Edit Home Screen, where the user can then select a different recipe to be programmed.

[0057] Fig. 14 shows a Proof Recipe Program Screen including similar parameters as listed on the Retard Recipe Program Screen. In this case, the Proof recipe parameters include a Recipe Time of 60:00 minutes, a Recipe Set Point (temperature) of 105 degrees F, and an Oven Humidity of 80%. All of the other parameters are turned off or set to zero. The graphical representation of the recipe at the bottom of the screen is similar to the bar graph representing the Retard recipe. The chained recipe in this case is the Bread (Bake) recipe. After the Proof recipe is programmed as desired, it is saved to the tangible storage medium.

[0058] Fig. 15 shows a Bread Program Recipe Screen including similar parameters as listed on the prior recipe program screens. The chained recipe is programmed for "off," such that no recipe will be automatically executed following the Bread recipe, and an alarm will sound at the end of the recipe, as indicated by the word "ALARM" at the top right of the screen. For the Bread recipe, the parameter Aux Heat Duty Cycle is provided in place of Oven Humidity. Moreover, all of the available parameters are used as part of the recipe, including steam cycle parameters Steam Delay, Steam On Time, Vent Close Delay, and Vent Close Time. As explained above, a steam cycle may be advantageous in a bake recipe to improve the color, taste, and/or texture of the bread crust. The programmed parameters for the displayed recipe include Recipe Time at 12:00

minutes, Recipe Set Point (temperature) at 350 degrees F, Aux Heat Duty Cycle at 60%, Steam Cycle Start at 1:00 minute, Steam Delay at 1:00 minute, Steam On Time at 1:30 minutes, Vent Close Delay at 0:30 minute, and Vent Close Time at 3:00 minutes.

[0059] The graphical representation of the recipe displayed at the bottom of the screen includes several colors for this recipe. The horizontal scale of the bar graph is set by the recipe time of 12:00 minutes. The other programmed parameters are displayed with respect to one another as a function of time along the bar graph in proportion to the scale of the recipe time. For example, at the left side of the bar graph, a blue bar corresponds to the light blue colored parameter indicator of Steam Cycle Start and has a length extending from the left to the right corresponding to the programmed 1:00 minute and shown in proportion to the 12:00 minute length of the red bar indicating the Recipe Time. The Steam Cycle Start has a beginning, an end, and a duration, as with the other parameters displayed on the bar graph. The Steam Cycle Start represents a delay in the start of the steam cycle. During the Steam Cycle Start, the chamber 11 may be heated at the Recipe Set Point as a "pre-bake" before the beginning of the steam cycle. The blower 61 and heating system 71 may operate to maintain the set point temperature in the chamber 11. At the end of the Steam Cycle Start, the steam cycle begins. The blower 61 and heating system 71 may be de-energized or turned off during the steam cycle and re-energized after the steam cycle is finished. Alternatively, the blower 61 may operate at a low speed or may be pulsed to provide gentle gas flow during the steam cycle. As shown in the graph, the steam cycle includes a beginning and an end indicated by vertically extending orange bars. The duration of the steam cycle extends between the vertical bars and includes colored bars representative of different stages of the steam cycle. The steam cycle includes a first or steaming function and a second or venting function. The two functions are displayed on the bar

graph in two rows, one on top of the other. The steaming function is indicated by the top row on the graph and includes the stages Steam Delay and Steam On Time. The Steam Delay is indicated by a dark green bar corresponding to the dark green parameter indicator next to the Steam Delay parameter label. The Steam On Time is indicated by a yellow bar corresponding to the yellow parameter indicator next to the Steam On Time parameter label. The venting function is indicated by the bottom row on the graph and includes stages Vent Close Delay and Vent Close Time. The Vent Close Delay and Vent Close Time are indicated by blue and light green bars, respectively, corresponding to the blue and light green parameter indicators next to the Vent Close Delay and Vent Close Time parameter labels. Accordingly, the stages of the two functions of the steam cycle are displayed with respect to each other as a function of time. The graphical representation of the programmed steam cycle permits a user to quickly and conveniently understand how the beginning, end, and duration of each of the functions and their stages relate to each other. For example, it is readily apparent by comparison of the beginning of the light green bar at the bottom of the graph to the beginning of the yellow bar at the top of the graph that the steam injection (Steam On Time) is programmed to begin after the flue valve 115 is closed (Vent Close Time). The graph permits the user to rapidly understand how adjustment of one or more parameters affects the recipe as a whole. The programmed parameters are saved to the tangible storage medium.

[0060] As noted herein, the screen includes a graphical representation of the recipe according to the parameters displayed by the screen. When a user touches the screen and changes one of the parameters, the touch screen provides command signals indicative of the changed parameter to the CPU 163, which responds by providing corresponding control signals to the affected components and systems of the oven 1. The CPU 163

stores the parameter changes in the tangible storage medium 165. In addition, the CPU 163 responds to the parameter changes stored in the medium by revising the graphical representation of the programmed recipe illustrated on the screen to reflect the changed parameters. Thus, the screen illustrates in real time as a bar graph the recipe according to the parameters displayed by the screen. Other graphical representations of the recipe may be displayed by the screen without departing from the scope of the present invention.

[0061] It will be appreciated that the programmable parameters shown in the recipe program screens of Figs. 13, 14, and 15, are provided by example without limitation. For example, the user interface 7 may be configured, for retard, proof, bake, or other recipes, to permit the user to program other functions such as various temperature set points at different times of a recipe, start times and run durations for the blower and/or flue vent fan, open times and durations for the flue valve and drain valve, start and run durations for the refrigeration system, and/or other parameters. This would provide the user with increased adjustability for tailoring recipes to achieve desired characteristics. Moreover, it will be understood that these parameters may be displayed in a graphical representation like the parameters discussed above. For example, if the user interface 7 permitted the user to define the start time and run duration of the blower that parameter could be displayed on the bar graph in the form of a third function including a suitable bar or bars (e.g., positioned above or below the illustrated function bars).

[0062] An example operation of the oven will now be described with respect to the user interface views of Figs. 11 and 16-28. Referring again to Fig. 11, a programmed recipe may be selected for execution from the Recipe Menu Home Screen. Assuming the user pressed the Retard actuator, the Retard Recipe Ready Screen of Fig. 16 would be shown. This screen includes

recipe set point indicators along the top of the screen indicating the 0% Oven Humidity, 38 degrees F Recipe Set Point, and 60:00 minute Recipe Time previously programmed. Below the recipe set point indicators, the screen indicates the "chained" recipe by the text "Next Recipe: PROOF," which was previously programmed. The screen also includes a time bar, a start actuator represented by an arrow outlined in green, and a series of status indicators relating to the programmed parameters, including Vent Open, Steam Cycle, and Auxiliary Heater. The status indicators are shown as active (illuminated) or inactive (dark), and may show different active colors, depending on the status of the respective parameter at any given time during execution of the recipe. The colors shown on the active indicators when illuminated may correspond to the colors of the parameter designators next to the parameter labels on the recipe program screen.

[0063] After the user presses the start actuator, the oven will begin executing the recipe and the screen will change to the Retard Recipe Run Screen shown in Fig. 17. As the Retard recipe runs, the screen will look substantially the same as that displayed in Fig. 17 for the duration of the recipe, except the time bar and countdown timer will be continuously updated to indicate the passage of recipe time. The Vent Open status indicator will be dark to indicate the flue valve 115 is closed. The refrigeration system 141 will be operated to maintain the 38 degrees F set point for 60 minutes. The blower 61 may be off or operated in a relatively slow or pulsed fashion.

[0064] At the end of the Retard recipe, the chained Proof recipe will begin automatically, and the Proof Recipe Run Screen of Fig. 19 will be shown. If the Proof recipe were not chained to start automatically, the user could navigate to the Proof Recipe Ready Screen shown in Fig. 18 and press the start actuator to initiate the Proof recipe. As the Proof recipe runs, the screen will look substantially the same as that

displayed in Fig. 19 for the duration of the recipe, except the time bar and countdown timer will be continuously updated to indicate the passage of recipe time. The Vent Open status indicator is dark to indicate the flue valve is closed. The blower 61 and heating system 71 will operate to maintain the 105 degree F set point, and the steam injection system 91 will operate as needed to maintain the 80% relative humidity set point for 60 minutes. Alternatively, a humidification system separate from the steam injection system 91 may be used in maintaining the 80% relative humidity set point. The blower 61 may be off or operated in a relatively slow or pulsed fashion.

[0065] At the end of the Proof recipe, the chained Bread (bake) recipe will begin automatically, and the Bread Recipe Run Screen of Fig. 21 will be shown. If the Bread recipe were not chained to start automatically, the user could navigate to the Bread Recipe Ready Screen shown in Fig. 20 and press the start actuator to initiate the Bread recipe. As the Bread recipe runs, the time bar and countdown timer will be continuously updated to indicate the passage of recipe time, and the parameter status indicators will be lit and unlit based on the status of the respective parameters. Between countdown times 12:00 and 11:00 (e.g., at countdown time 11:45 as shown in Fig. 21), the Vent Open status indicator will be illuminated because the flue valve 115 will be open during the pre-bake before the steam cycle. Between countdown times 11:00 and 10:30 (e.g., at countdown time 10:50 as shown in Fig. 22), the Steam Cycle status indicator will be illuminated to show the steam cycle has begun. The status indicator will be illuminated in blue to indicate delay before injecting steam. The blower 61 and heating system 71 may be de-energized at the beginning of the steam cycle (i.e., at the beginning of the Steam Delay stage). Desirably, this provides the blower 61 with sufficient time to "spin down" or stop rotating before steam injection begins. The Vent Open indicator is still illuminated. Between countdown

times 10:30 and 10:00 (e.g., at countdown time 10:02 shown in Fig. 23), the Vent Open indicator will be dark indicating the flue valve 115 is closed. The flue valve 115 is closed before steam injection so steam is not lost out of the flue when it is injected into the chamber. The Steam Cycle indicator is still illuminated in blue to indicate delay before steam injection. Presumably, the blower 61 has stopped or almost stopped spinning by now. Between countdown times 10:00 and 8:30 (e.g., at countdown time 9:30 as shown in Fig. 24), the Vent Open indicator will remain dark, and the Steam Cycle indicator will be illuminated in yellow to indicate steam is being injected into the chamber 11. The yellow color corresponds to the yellow parameter indicator next to the Steam On Time parameter label on the Bread Recipe Program Screen. The blower 61 and heating system 71 may remain off, or they may be pulsed. For example, the blower 61 may be pulsed to provide minimal gas circulation in the chamber 11 to cause steam in the chamber to flow into contact with the dough. Between countdown times 8:30 and 7:30 (e.g., at countdown time 8:15 as shown in Fig. 25), the Steam Cycle indicator will be illuminated in blue to indicate the steam injection has ended. The Vent Open indicator will remain dark until the end of the Vent Close Time (i.e., at countdown time 7:30). The flue valve 115 may be kept closed during this time to provide the injected steam with additional time to saturate the chamber 11 and contact the dough. At the end of the steam cycle (i.e., at countdown time 7:30), the blower 61 and heating system 71 may re-energize to bring the temperature in the chamber 11 back to the Recipe Set Point for the remainder of the recipe time. As shown in Fig. 26, the Auxiliary Heater indicator may be illuminated red for a period of time after the end of the steam cycle indicating that the auxiliary heater 75 is being used to assist the primary heater 73 in re-establishing the Recipe Set Point. The auxiliary heater 75 will be operated at the programmed Aux Heat Duty Cycle. After the Recipe Set

Point is achieved again in the chamber 11 (e.g., by countdown time 3:41 as shown in Fig. 27), the auxiliary heater 75 may be turned off, as indicated by the Auxiliary Heater status indicator being dark. The blower 61 and heating system 71 operate for the remainder of the countdown time to maintain the Recipe Set Point temperature. At the end of the recipe, the time bar has timed out, the countdown timer shows 0:00, and an alarm may sound.

[0066] Figures 29 and 30 illustrate alternative embodiments of Bread (Bake) recipes. The recipe of Fig. 29 includes similar parameters as the Bread recipe described above, except for the Steam Cycle Start parameter is 0:00, meaning the steam cycle will start at the beginning of the recipe rather than after a delay. The recipe of Fig. 30 includes similar parameters as the Bread recipe described above, except there is no delay before the start of the steam cycle, and the Steam Delay and Vent Close Delay parameters have the same values such that the steam injection begins at the same time as the flue valve 115 closes. Other recipes may be used without departing from the scope of the present invention. For example, the flue valve 115 may not be closed until after steam injection begins. It will be understood that the user interface permits custom tailoring of the respective variables such that recipes can be programmed by controlling parameters independently from each other.

[0067] It will be appreciated that the retard, proof, and bake recipes described above are provided by way of example without limitation. Other recipes may be used without departing from the scope of the present invention. For example, the storage medium 165 may include instructions for executing any one of the examples below or combinations thereof. A hold recipe may be used to hold dough in a frozen or slacked state before a retard recipe. The oven 1 may be programmed for holding food such as grilled chicken, fried chicken, hamburger patties, etc. in a cooked state prior to serving. The oven 1

may be programmed to execute a retard recipe in which the steam injection system 91 is used (e.g., delivers a small volume of steam) to introduce moisture into the chamber 11 to assist in the retard process. A retard recipe may be chained directly to a bake recipe such that the oven executes a bake recipe automatically after executing a retard recipe (no intermediate proof recipe). The refrigeration system 141 may be used in a bake recipe. For example, the refrigeration system 141 may be used at or near the end of a bake recipe to rapidly cool the chamber 11 so that less heat emits from the oven when opened by a user and/or so that the baked bread cools more rapidly and can be served for consumption more quickly. The active venting flue fan 113 and/or the refrigeration system 141 may be used at or near the end of a bake recipe and/or between a bake recipe and a proof recipe for rapidly cooling the chamber 11. Retard, proof, and/or bake recipes may include different temperature set points at various times of the recipe.

[0068] The following 60 minute retard recipes, which the storage medium 15 may include instructions for executing, are provided as additional examples, including various stages listed in order of execution: 1) 20 minutes at 35 degrees F, 20 minutes at 45 degrees F, and 20 minutes at 55 degrees F; 2) 20 minutes at 65 degrees F, 20 minutes at 60 degrees F, and 20 minutes at 50 degrees F; 3) 10 minutes at 100 degrees F, 20 minutes at 60 degrees F, and 30 minutes at 50 degrees F; 4) 20 minutes at 100 degrees F, 20 minutes at 40 degrees F, and 20 minutes at 65 degrees F; and 5) 20 minutes at 40 degrees F, 20 minutes at 100 degrees F, and 20 minutes at 50 degrees F. Accordingly, the oven 1 may be programmed with retard recipes in which there are multiple stages including differently programmed parameters, in which multiple stages include different durations, in which not only the refrigeration system but also the heating system is used, in which the recipe set point temperature increases over the recipe duration, in which the recipe set point temperature

decreases over the recipe duration, in which the recipe set point temperature increases then decreases over the recipe duration, and/or in which the recipe set point temperature decreases then increases over the recipe duration. Desirably, at the end of a retard recipe, the dough is about 50 to 55 degrees F. It may be desirable to heat the dough for a duration of the retard recipe to decrease the time required to bring the dough to such a temperature, or to bring the dough to such a temperature more evenly (i.e., inside and out). It will be appreciated that the 60 minute retard recipe time is provided as an example without limitation. The recipe times may be longer or shorter without departing from the scope of the present invention.

[0069] In an aspect of the present invention, the oven 1 may be programed to provide a user with a warning indication that the end of a recipe is upcoming. The warning indication may be an audio (e.g., an alarm such as a chirp or beep) and/or visual (e.g., flash of the lights 83 inside the chamber 11) indication. For example, the storage medium 165 may include instructions to provide a warning indication when there is 5, 4, 3, 2, and/or 1, etc. minutes remaining on a given recipe (e.g., retard, proof, or bake recipe). This may be useful to remind a user to check on the performance of a recipe while it is being executed and to prompt the user to determine whether the recipe should be altered before it ends. For example, as shown in Figs. 17, 19, and 21, the run screens for the retard, proof, and bake recipes each include, to the right of the countdown timer, a "plus one minute" actuator represented by "+1" outlined in blue. If a user notices that a certain execution of a recipe could benefit from additional time (e.g., bread not fully retarded, proofed, or baked), the user can press the "+1" actuator to lengthen the recipe in increments of one minute per press of the actuator. The warning indicator may be particularly helpful when recipes are chained together and the

user would like to modify (e.g., lengthen) the recipe being executed before the control system automatically starts the next recipe. The next recipe may include significantly different parameters (e.g., temperature, humidity, etc.) such that after the next recipe starts, it would be difficult for the user to quickly recreate the conditions in the chamber used for the previous recipe.

[0070] It will be appreciated that food preparation apparatus such as the oven 1 described herein may be used for programming and testing new food preparation recipes. For example, the oven 1 may be used to program retarding, proofing, and/or baking recipes thought to impart desirable characteristics (e.g., taste, texture, color) on baked bread. The graphic representation of the recipes provides convenient understanding of how the programmed relate to each other as a function of time and how modification of various parameters affects the recipe as a whole. The oven can be used to execute the programmed recipes, and if satisfactory, the tested recipes can be used to program production ovens. For example, the tested recipes may be copied from the tangible memory 165 to a USB flash drive (or other portable tangible memory) for uploading to other ovens (e.g., located in remote food service stores).

[0071] It will be understood that the user interface 7 disclosed herein has broader applicability than merely for food preparation apparatus such as the oven discussed herein. For example, the user interface 7 may be used in other recipe-implementing apparatus in which it may be desirable to display a graphic representation of a recipe with respect to time. For example without limitation, such a user interface 7 may be used in conjunction with a dish washer (ware washer), clothes washer, food holding cabinet, etc. Recipes having multiple functions and/or multiple stages can be shown graphically with respect to time to facilitate user comprehension of the recipes as

programmed. Recipe-implementing apparatus other than ovens or food preparation apparatus may be used without departing from the scope of the present invention.

[0072] Referring to Figs. 31-33, a second embodiment of a convection oven of the present invention is designated generally by the reference number 201. The oven is substantially the same as the oven 1 described above, and like parts are indicated by like reference numbers, plus 200. For example, the oven 201 includes a user interface 207, a cooking chamber 211, a steam injection system 291, a vent system 292, and a convection system including a blower 261 and a heating system 271 including one or more heaters. The oven 201 also includes an upper housing 241 spaced from respective walls of the cooking chamber 211 to provide a conduit system or flow path 253 for circulating air (or other gas) to, through and from the cooking chamber 211. The conduit system 253 comprises an upper portion 253A above the cooking chamber 211 and side portions 253B at opposite sides of the cooking chamber. The arrangement is such that air enters the cooking chamber 211 through a plurality of entry openings or outlets (broadly "first outlets") 265 (Fig. 33) in the side walls of the chamber and exits the chamber through an exhaust opening (broadly "first exhaust") 269 (Fig. 33) in the top wall of the chamber below the blower 261. As in the first embodiment, the blower 261 may be a single speed motor capable of operation in both constant and pulsed manners. Alternatively, the blower 261 may be a multiple speed motor that can be selectively controlled for varying the airflow CFM and velocity. Additionally, the exhaust opening 269 may be fitted with a plurality of return duct exhaust openings (broadly "first exhausts") to control the routing of air.

[0073] In this embodiment, the oven 201 does not include a refrigeration system, but such a system could be added as in the first embodiment without departing from the scope of the present invention. It will be understood that features discussed with

respect to the oven 1 may be used in the oven 201, and vice versa. For example, it will be understood the oven 201 includes a control system including a controller (e.g., CPU) and a tangible storage medium storing oven controller executable instructions for controlling the oven.

[0074] Referring to Figs. 32 and 33, the vent system 292 includes a vent conduit or flue 311 for permitting gas to escape from the chamber 211 to ambient. The chamber 211 and air conduit system (broadly "re-circulation ducting" defining a re-circulation gas flow path) 253 form a generally closed system in which substantially the same gas re-circulates over and over. However, at various times, it may be desired to passively or actively vent the chamber 211. As shown in closer detail in Fig. 32, the flue 311 extends from an inlet end connected to the air conduit system 253 (for direct gas flow therefrom) to an outlet end above the chamber. More specifically, the inlet end of the flue 311 is connected directly to the upper duct of the re-circulation ducting housing the wheel of the blower for receiving gas from the upper duct. The flue 311 includes a valve or cap 315 adjacent its outlet end adapted for selectively closing or opening the flue. For example, it may be desirable during proofing and/or baking operations, such as while injecting steam into the chamber 211, to close the flue 311 to prevent heat and/or moisture from escaping the chamber. The vent system 292 also includes a vent fan 313 mounted above the chamber 211. When the valve 315 is open to vent the chamber 211, the fan 313 may be used to increase the gas pressure inside the chamber to cause hot and/or moisture laden gas to exhaust through the flue 311. The fan 313 communicates with the chamber 211 via vent ducting (defining a vent gas flow path) including a first or supply duct 314 and a second or outlet plenum duct 316, which includes outlets (broadly "second outlets") 316A (Fig. 33) connected to the chamber 211 and arranged for introducing gas directly into the chamber relatively uniformly, and more

specifically at elevations above respective supports in the chamber for supporting pans. The supply duct 314 extends downward from the vent fan and is connected to a lower end of the outlet plenum 316 for delivering gas to the lower end of the outlet plenum. It will be appreciated that the outlets of the vent ducting are different than the outlets 265 and exhaust 269 of the re-circulation ducting, and the vent flow path is separate from the re-circulation flow path. For example, when a high-humidity operation such as proofing is finished, it may be desirable to actively vent the chamber 211 using the vent fan 313 and valve 315 for generating suitable conditions in the chamber for the baking cycle. It will be appreciated that arranging the fan 313 for use in pressurized venting provides the advantage that the fan does not need to be designed/rated for the high temperatures and moisture levels of the exhaust/outlet gas.

[0075] As is now apparent, the oven 201 includes suitable components and systems such that the chamber 211 may be used for proofing and/or baking, and desirably, for proofing and baking in sequence in the chamber 211. The oven may be used in other ways without departing from the scope of the present invention.

[0076] In use, the oven 201 may be programmed (e.g., the tangible storage medium can have suitable instructions stored thereon) to execute various recipes, as described above with respect to the first embodiment. In a recipe in which proofing and baking take place sequentially in the same chamber, such as described herein, it has been discovered that not appropriately managing for release of moisture from the dough can result in undesirable baked bread.

[0077] In a two-chamber bread making process, in which proofing and baking are performed in separate chambers, significant moisture escapes from the bread while being transferred from the proofing chamber to the baking chamber, and the chambers are more easily controlled at desired temperature

and humidity conditions. For example, in a two-chamber bread making process, retarded dough (e.g., dough at about 50–55 deg. F) is placed in a proofing chamber controlled to a set temperature and humidity (e.g., 105 deg. F and 80% RH). The dough may be proofed for approximately 60 minutes. After the proofing process is complete, the bread is manually transferred from the proofing cabinet to the baking cabinet, which may be preheated to a desired baking temperature (e.g., 350 deg. F). The bake cycle may have a duration of about 10–12 minutes dependent on personal preference of crust darkness, etc. A benefit of the two-chamber configuration is the two chambers can be controlled to the specific desired environments. The bread will experience a relatively instant change in environment when transferred to the baking chamber. This is beneficial in drying the very warm, moist bread, setting the skin/crust, and assisting in driving the excess moisture out of the core of the bread.

[0078] A fundamental difference of the two-chamber proof/bake process from the same-chamber proof/bake process is that the bread is loaded into the chamber to begin the proof cycle and, after the proof cycle, the bread remains in the same chamber for the bake cycle, and the oven adjusts the environment as desired for the bake cycle. There needs to be an appropriate transition from the proofing environment to the baking environment. Maintaining the bread in the same chamber (and without opening the door to the chamber), presents challenges in achieving desired temperature and humidity conditions in the chamber. For example, it has been found that operating the oven to proof then bake bread in the same chamber according to the same recipe used in a two-chamber proof/bake process (e.g., Proof: 105F/ 80%RH / 60 minutes; Bake: 350F / 15–20 minutes) results in an undesirable baked bread. In executing this recipe, it was attempted to transition from the proof cycle environment to the bake cycle environment as fast as possible

(i.e., with maximum available power). The following findings were made. (1) The moisture from the proof cycle was not released or baked out of the bread sufficiently. (2) The moisture was entrapped in the core of the bread when the outside of the bread (crust) was browned or over-browned. (3) The moisture was not released/removed out of the cavity via passive venting. (4) The resulting bread was either too wet or steamed. (5) The resulting bread exhibited collapse. Accordingly, the inventors sought to develop an improved same-chamber proof/bake recipe.

[0079] After detailed review of the above results, many variables were studied to determine the causes of the undesirable baked bread. The variables included: temperature and humidity set points, airflow CFM/impingement velocity, convection heating power/ramp rates, passive/active venting, etc. Furthermore, the bread process was evaluated based on many culinary attributes, including proofing, cell structure, moisture level, bottom browning, shrinking/collapse, bread size (height/width ratio), along with the mechanical system design and response.

An improved recipe was developed including a transition phase between proofing and baking. In an aspect of the present invention, an oven may be programmed to execute a same-chamber proof/bake recipe including: (1) a proofing step; (2) a first active venting step; (3) a first temperature ramp step; (4) a second active venting step; (5) a second temperature ramp step; and (6) a bake step. It will be appreciated this recipe may be modified without departing from the scope of the present invention. The recipe may include more or fewer steps. For example, either of the venting steps and/or either of the temperature ramp steps may be omitted.

[0080] The recipe outlined above has been developed based on an understanding of moisture in the bread and managing release of moisture from the bread. The bread itself contains a

lot of moisture, apart from humidity added to the cooking chamber as desired during proof/bake. Late in the proofing process, the bread releases a lot of moisture. Without the active venting capability, the amount of moisture being released from the bread has the ability of increasing the humidity in the cooking chamber 211 to a level detrimental to the process, resulting in too high of moisture content in the final baked bread (wet/soggy). With active venting, the %RH level can be precisely controlled to the desired level consistently one proof/bake recipe after another and independent of the bread load (1 tray vs. 10 trays). Proofing at lower %RH can dramatically reduce the moisture content in the bread, but this can lead to negative effects such as creating crust on the bread while the interior continues to proof resulting in cracks as the bread expands and a dull flat finish or "spotted" finish on the crust at the end of the bake cycle, both of which are aesthetically displeasing. It is also noted that proofing is usually conducted at a lower airflow (CFM and velocity) in a manner to maintain uniform temperature and humidity within the chamber without inducing too much impingement or force on the bread.

[0081] At the end of the proof cycle, the recipe includes a first active venting cycle for reducing the %RH within the chamber. This assists in reducing the moisture level within the bread. As moisture is vented from the chamber, moisture from the bread is more likely to escape to the gas in the chamber.

[0082] During the first temperature ramp step, proofing will continue until the yeast within the bread reaches a temperature at which it "dies." In the first ramp step, it is desirable to increase the chamber temperature and the corresponding bread temperature at a rate to promote uniform completion of proofing from the bread outer edges to the core as much as possible. This prevents the yeast from "dying" on the outer edges prematurely while the yeast in the core of the bread

continues to be active and outgassing. Additionally, to facilitate the uniform heating rate during the first ramp step, the convection blower can be run at a relatively slow speed, i.e., lower CFM/air impingement.

[0083] To manage the moisture being released from the bread in the final proofing process, which occurs during the first ramp step, it is beneficial to conduct the second active venting step after the first ramp step. The second active venting step evacuates water vapor within the cavity, and thus promotes additional moisture to transfer from the bread into the gas in the chamber. Accordingly, the second active venting step assists in reducing the remaining moisture level within the bread.

[0084] The second temperature ramp step is used to increase the temperature in the chamber to the desired final baking temperature. The second ramp step can have different characteristics than the first ramp step. For example, the second ramp step can be executed faster than the first ramp step because proofing has completed, and it is no longer necessary to promote uniform "dying" of the yeast in the skin and core of the bread. Once the yeast is no longer active, it is beneficial to ramp the temperature of the cavity and the bread surface at a rather rapid rate so that the skin/crust of the bread can be formed/set. During the second ramp step, higher power is used than in the first ramp step, to reach a desired bake set point temperature (e.g., about 325F or 350F). Additionally, it is preferred to run the convection blower at a higher speed resulting in higher CFM and velocity.

[0085] After the second temperature ramp step, the final bake step is executed at a lower power level to slow the browning and final baking. This assists in completing the internal baking of the bread and managing the moisture level along with more uniform browning. Achieving a complete proof and bake with the optimum balance of temperature, power

level/ramp rate or heat capacity, airflow, and humidity is key in achieving desired attributes including final bread cell structure, moisture level, bottom browning, minimal shrinking/collapse, and proper bread size (length/height/width).

[0086] Example

[0087] The following example recipe is provided by way of example without limitation.

Proof:

proofing temperature of between about 90-120F, more desirably about 100-110F, even more desirably about 105F;

about 50-90% RH, more desirably about 65-75% RH, even more desirably about 70%RH;

for about 20-70 minutes, more desirably about 25-45 minutes, more desirably about 30-40 minutes, even more desirably about 34 minutes and about 70% RH for about 34 minutes;

at a blower speed of about 10-575 CFM, more desirably about 400-575 CFM, and even more desirably about 490 CFM (a desired velocity at 490 CFM is about 1180 FPM).

First Active Venting:

positive pressure venting with blower at about 60 CFM;

for about 0.25-5 minutes, more desirably, about 0.5-3 minutes, even more desirably about 1 minute.

First Ramp (slow):

ramp up to maximum temperature between about 180-260F, more desirably about 200-240F, even more desirably about 220F;

at about 4000-6000W power, more desirably about 5000W power;

over about 10-25 minutes, more desirably about 15-20 minutes, even more desirably about 17 minutes;

at a blower speed of about 575-750 CFM, more desirably about 600-720 CFM, and even more desirably about 660 CFM (a desired velocity at 660 CFM is about 1600 FPM).

Second Active Venting:

positive pressure venting with blower at about 60 CFM;

for about 0.25-5 minutes, more desirably about 0.5-3 minutes, even more desirably about 1 minute.

Second Ramp (fast):

ramp up to maximum temperature between about 300-375F, more desirably about 315-360F, even more desirably about 325F or about 350F;

at about 6000-10000W power, more desirably about 7000-9000W power, even more desirably about 8000W power;

over about 2-10 minutes, more desirably about 4-8 minutes, even more desirably about 6 minutes;

at a blower speed of about 575-750 CFM, more desirably about 600-720 CFM, and even more desirably about 660 CFM (a desired velocity at 660 CFM is about 1600 FPM).

Final Bake:

baking temperature of between about 300-375F, more desirably about 315-360F, even more desirably about 325F or about 350F;

at about 6000-8000W power, more desirably about 7000W power;

over about 5-15 minutes, more desirably about 7-13 minutes, even more desirably about 10 minutes;

at a blower speed of about 575-750 CFM, more desirably about 600-720 CFM, and even more desirably about 660 CFM (a desired velocity at 660 CFM is about 1600 FPM).

[0088] The recipe outlined above has been found to be suitable for an oven including an internal volume (i.e., combined volume of cooking chamber and convection duct system) of about 17,000 cubic inches, and a cooking chamber volume of

about 14,000 cubic inches; and for a bread load of about 50 loaves (e.g., five levels of 10 loaves per level). It will be appreciated that the recipe above can be suitably modified for ovens having other internal volumes and for other bread loads. For example, in the ramp steps, the time to achieve desired temperature and power needed to achieve the temperature are a function of the internal volume, thermal mass of the oven, and bread load. The thermal mass of the oven is not usually directly proportional to the internal volume. Considering for example a half load of bread compared to a full load of bread, in a ramp step: shorter time could compensate for a smaller load and the oven's faster ramp to temperature at the same power; and lower power could compensate to make the ramp rate the same as the full load of bread in the same time. It is also likely that a difference in active vent time could optimize the bake results for substantial differences in bread load sizes because full loads release more moisture than smaller loads.

[0089] To execute an appropriate recipe for a desired bread load, it is possible to program the oven to adjust any of the recipe parameters based upon sensor feedback (e.g., sensed temperature and/or humidity) and elapsed time. The oven could be programmed to operate according to an algorithm to automatically adjust power level (temperature ramp rate), set-point temperature, active vent duration, and time of any recipe step, etc. Alternatively, the operator interface could include a "load size" selection option (e.g., "full load," "half load," etc.) to permit a user to enter the desired bread load size, according to which the oven could be programmed to select appropriate recipe parameters.

[0090] It will be understood the timing of the steps described above with respect to each other can be described in various ways. A step listed before another step can be said to begin before the later listed step. For example, an earlier listed temperature ramp step or active venting step can be said

to begin before a later listed temperature ramp step or active venting step. A step listed after another step can be said to begin after completion of the prior listed step. For example, a later listed temperature ramp step or active venting step can be said to begin after completion of an earlier listed temperature ramp step or active venting step. Moreover, other descriptions may be used, such as an active venting step beginning after a maximum temperature of a temperature ramping step is reached, a temperature ramping step begins after a time period following completion of an earlier temperature ramping step, or an active venting step begins after a time period following completion of an earlier active venting step. Other arrangements may be used without departing from the scope of the present invention.

[0091] The Title, Field of Invention, and Background are provided to help the reader quickly ascertain the nature of the technical disclosure. They are submitted with the understanding that they will not be used to interpret or limit the scope or meaning of the claims. They are provided to introduce a selection of concepts in simplified form that are further described in the Detailed Description. The Title, Field of Invention, and Background are not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used as an aid in determining the claimed subject matter.

[0092] For purposes of illustration, programs and other executable program components, such as the operating system, are illustrated herein as discrete blocks. It is recognized, however, that such programs and components reside at various times in different storage components of a computing device, and are executed by a data processor(s) of the device.

[0093] Although described in connection with an exemplary computing system environment, embodiments of the aspects of the invention are operational with numerous other general purpose or special purpose computing system environments or configurations.

The computing system environment is not intended to suggest any limitation as to the scope of use or functionality of any aspect of the invention. Moreover, the computing system environment should not be interpreted as having any dependency or requirement relating to any one or combination of components illustrated in the exemplary operating environment. Examples of well-known computing systems, environments, and/or configurations that may be suitable for use with aspects of the invention include, but are not limited to, personal computers, server computers, hand-held or laptop devices, multiprocessor systems, microprocessor-based systems, set top boxes, programmable consumer electronics, mobile telephones, network PCs, minicomputers, mainframe computers, distributed computing environments that include any of the above systems or devices, and the like.

[0094] Embodiments of the aspects of the invention may be described in the general context of data and/or processor-executable instructions, such as program modules, stored one or more tangible, non-transitory storage media and executed by one or more processors or other devices. Generally, program modules include, but are not limited to, routines, programs, objects, components, and data structures that perform particular tasks or implement particular abstract data types. Aspects of the invention may also be practiced in distributed computing environments where tasks are performed by remote processing devices that are linked through a communications network. In a distributed computing environment, program modules may be located in both local and remote storage media including memory storage devices.

[0095] In operation, processors, computers and/or servers may execute the processor-executable instructions (e.g., software, firmware, and/or hardware) such as those illustrated herein to implement aspects of the invention.

[0096] Embodiments of the aspects of the invention may be implemented with processor-executable instructions. The processor-executable instructions may be organized into one or more processor-executable components or modules on a tangible processor readable storage medium. Aspects of the invention may be implemented with any number and organization of such components or modules. For example, aspects of the invention are not limited to the specific processor-executable instructions or the specific components or modules illustrated in the figures and described herein. Other embodiments of the aspects of the invention may include different processor-executable instructions or components having more or less functionality than illustrated and described herein.

[0097] The order of execution or performance of the operations in embodiments of the aspects of the invention illustrated and described herein is not essential, unless otherwise specified. That is, the operations may be performed in any order, unless otherwise specified, and embodiments of the aspects of the invention may include additional or fewer operations than those disclosed herein. For example, it is contemplated that executing or performing a particular operation before, contemporaneously with, or after another operation is within the scope of aspects of the invention.

[0098] When introducing elements of aspects of the invention or the embodiments thereof, the articles "a," "an," "the," and "said" are intended to mean that there are one or more of the elements. The terms "comprising," "including," and "having" are intended to be inclusive and mean that there may be additional elements other than the listed elements.

[0099] In view of the above, it will be seen that several advantages of the aspects of the invention are achieved and other advantageous results attained.

[00100] Not all of the depicted components illustrated or described may be required. In addition, some implementations

and embodiments may include additional components. Variations in the arrangement and type of the components may be made without departing from the spirit or scope of the claims as set forth herein. Additional, different or fewer components may be provided and components may be combined. Alternatively or in addition, a component may be implemented by several components.

[00101] The above description illustrates the aspects of the invention by way of example and not by way of limitation. This description enables one skilled in the art to make and use the aspects of the invention, and describes several embodiments, adaptations, variations, alternatives and uses of the aspects of the invention, including what is presently believed to be the best mode of carrying out the aspects of the invention. Additionally, it is to be understood that the aspects of the invention is not limited in its application to the details of construction and the arrangement of components set forth in the description or illustrated in the drawings. The aspects of the invention are capable of other embodiments and of being practiced or carried out in various ways. Also, it will be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting.

[00102] Having described aspects of the invention in detail, it will be apparent that modifications and variations are possible without departing from the scope of aspects of the invention as defined in the appended claims. It is contemplated that various changes could be made in the above constructions, products, and methods without departing from the scope of aspects of the invention. In the preceding specification, various embodiments have been described with reference to the accompanying drawings. It will, however, be evident that various modifications and changes may be made thereto, and additional embodiments may be implemented, without departing from the broader scope of the aspects of the invention as set

forth in the claims that follow. The specification and drawings are accordingly to be regarded in an illustrative rather than restrictive sense.

WHAT IS CLAIMED IS:

1. A convection oven comprising:
 - an oven chamber for receiving food to be cooked therein,
 - at least one first outlet for delivering gas to the oven chamber,
 - at least one first exhaust for exhausting gas from the oven chamber,
 - re-circulation ducting defining a re-circulation gas flow path for flow of gas from the at least one first exhaust to the at least one first outlet for re-circulating gas from the oven chamber back to the oven chamber,
 - a blower for moving gas in the re-circulation ducting from the at least one first exhaust to the at least one first outlet,
 - a heater for heating the re-circulating gas,
 - a vent fan for delivering gas to the oven chamber for creating positive gas pressure in the oven chamber,
 - at least one second outlet downstream from the vent fan for delivering gas from the vent fan to the oven chamber, the at least one second outlet being connected to the oven chamber for gas flow from the at least one second outlet directly to the oven chamber, and
 - vent ducting defining a vent gas flow path from the vent fan to the at least one second outlet, the vent gas flow path being separate from the re-circulation gas flow path.
2. A convection oven as set forth in claim 1 wherein the vent ducting is separate from the re-circulation ducting.
3. A convection oven as set forth in claim 1 wherein the vent ducting includes a supply duct and an outlet plenum, the supply duct being positioned upstream from the outlet plenum, and wherein the at least one second outlet comprises a plurality of second outlets spaced from each other to deliver gas from the

vent fan to the oven chamber at different locations in the oven chamber, the plurality of second outlets being downstream from the outlet plenum.

4. A convection oven as set forth in claim 3 wherein the supply duct connects to the outlet plenum at a lower end of the outlet plenum for delivering gas from the fan to the lower end of the outlet plenum.

5. A convection oven as set forth in claim 1 wherein the at least one second outlet comprises a plurality of second outlets spaced from each other to deliver gas from the vent fan to the oven chamber at different locations in the oven chamber.

6. A convection oven as set forth in claim 5 further comprising supports in the oven chamber constructed for supporting pans in the oven chamber, the supports being positioned at different elevations in the oven chamber, the second outlets being positioned at different elevations in the oven chamber for delivering gas above respective supports.

7. A convection oven as set forth in claim 1 wherein the vent fan is positioned above the oven chamber and the vent ducting extends downward toward the at least one second outlet.

8. A convection oven as set forth in claim 1 further comprising a vent flue configured for venting gas from the oven chamber to ambient, wherein the vent flue has an inlet, and the inlet of the vent flue is connected to the re-circulation ducting for receiving gas from the oven chamber directly from the re-circulation ducting.

9. A convection oven as set forth in claim 8 wherein the blower includes a blower wheel, the re-circulation ducting

includes a duct housing the blower wheel, and the inlet of the vent flue is connected to said duct housing the blower wheel for receiving gas directly therefrom.

10. A convection oven as set forth in claim 9 wherein said duct housing the blower wheel is above the oven chamber.

11. A convection oven as set forth in claim 8 further comprising a flue valve having an open position permitting flow of gas and a closed position blocking flow of gas, the flue valve being in the open position when the vent fan is delivering gas to the oven chamber.

12. A method of operating a convection oven, the method comprising:

exhausting gas from an oven chamber holding food through at least one first exhaust,

heating the exhausted gas and operating a re-circulation blower to blow the exhausted gas along a re-circulation flow path in the oven from the at least one first exhaust to at least one first outlet for entering the cooking chamber,

operating a vent fan to blow gas into the oven chamber through at least one second outlet, the at least one second outlet being connected to the oven chamber for gas flow directly to the oven chamber from the at least one second outlet,

venting gas from the oven chamber through a vent flue by gas pressure created by the vent fan blowing the gas into the oven chamber through the at least one second outlet,

wherein blowing the gas into the oven chamber through the at least one second outlet comprises operating the vent fan to blow gas along a vent flow path extending from the vent fan to the at least one second opening separate from the re-circulation flow path.

13. A method as set forth in claim 12 wherein blowing gas into the oven chamber through the at least one second outlet comprises blowing gas through a plurality of second outlets spaced from each other to deliver gas from the vent fan to the oven chamber at different locations in the oven chamber.

14. A method as set forth in claim 13 wherein blowing gas into the oven chamber thorough the plurality of second outlets comprises blowing gas into the oven chamber through second outlets positioned above respective supports constructed for supporting pans positioned at different elevations in the oven chamber.

15. A method as set forth in claim 12 wherein the gas is blown through the at least one second outlet from the vent fan positioned above the oven chamber.

16. A method as set forth in claim 12 wherein gas from the re-circulation ducting flows into the vent flue directly from the re-circulation ducting.

17. A method as set forth in claim 12 wherein the gas from the re-circulation ducting flows into the vent flue directly from a duct of the re-circulation ducting that houses a blower wheel that blows gas along the re-circulation flow path.

18. A method as set forth in claim 12 wherein gas is blown along the re-circulation flow path at a time when gas is not blown into the oven chamber through the at least one second outlet.

19. A method as set forth in claim 12 wherein venting gas from the oven chamber through the vent flue comprises passing gas through an open flue valve.

20. A convection oven for proofing and baking dough, the oven comprising:

- a cooking chamber sized and shaped for receiving dough to be proofed and baked,

- a convection system including a blower and a heater for receiving gas from the cooking chamber and delivering heated gas to the cooking chamber,

- a vent system including a fan for actively venting moisture laden gas out of the cooking chamber,

- an oven controller for controlling operation of the convection system and the vent system to proof and bake dough in sequence in the cooking chamber, and

- a tangible storage medium having oven controller executable instructions stored thereon, said instructions, when executed by the oven controller, executing a proof and bake operation in the cooking chamber including:

- a proofing step during which the convection system maintains a proofing temperature in the cooking chamber for proofing the dough,

- a baking step after the proofing step during which the convection system maintains a baking temperature in the cooking chamber for baking the dough, and

- a transition phase between the proofing and baking steps including:

- a first active venting step during which the venting system actively vents moisture laden gas out of the cooking chamber for decreasing the humidity in the cooking chamber,

- a temperature ramping step during which the convection system increases the temperature in the cooking chamber to a maximum temperature greater than the proofing temperature, and

- a second active venting step during which the venting system actively vents moisture laden gas out

of the cooking chamber for decreasing the humidity in the cooking chamber.

21. A convection oven as set forth in claim 20 wherein the temperature ramping step is a first temperature ramping step, and the proof and bake operation includes a second temperature ramping step during which the convection system increases the temperature in the cooking chamber to a maximum temperature greater than the maximum temperature of the first temperature ramping step.

22. A convection oven as set forth in claim 21 wherein the second temperature ramping step begins after the second active venting step begins.

23. A convection oven as set forth in claim 21 wherein the second temperature ramping step has at least one different characteristic than the first temperature ramping step.

24. A convection oven as set forth in claim 21 wherein during the second temperature ramping step the convection system increases the temperature in the cooking chamber at a faster rate than during the first temperature ramping step.

25. A convection oven as set forth in claim 21 wherein during the second temperature ramping step the blower operates at a faster speed than during the first temperature ramping step.

26. A convection oven as set forth in claim 21 wherein the maximum temperature of the first temperature ramping step is between about 180-260 degrees Fahrenheit.

27. A convection oven as set forth in claim 21 wherein the maximum temperature of the first temperature ramping step is between about 200-240 degrees Fahrenheit.

28. A convection oven as set forth in claim 21 wherein the maximum temperature of the second temperature ramping step is the baking temperature.

29. A convection oven as set forth in claim 20 wherein the temperature ramping step begins after the first active venting step begins, and the second active venting step begins after the temperature ramping step begins.

30. A convection oven as set forth in claim 20 wherein the transition phase comprises at least one of:

- the temperature ramping step begins after the first active venting step begins;

- the second active venting step begins after the temperature ramping step begins;

- the temperature ramping step begins after completion of the first active venting step;

- the second active venting step begins after completion of the temperature ramping step;

- the second active venting step begins after the maximum temperature of the temperature ramping step is reached; and

- the second active venting step begins after a time period following completion of the first active venting step.

31. A method of proofing and baking dough in sequence in the same cooking chamber, the method comprising:

- executing a proofing step during which a proofing temperature is maintained in the cooking chamber for proofing the dough,

executing a baking step after the proofing step during which a baking temperature is maintained in the cooking chamber for baking the dough, and

executing a transition phase between the proofing and baking steps including:

executing a first active venting step during which moisture laden gas is actively vented out of the cooking chamber for decreasing the humidity in the cooking chamber,

executing a temperature ramping step during which the temperature in the cooking chamber is increased to a maximum temperature greater than the proofing temperature, and

executing a second active venting step during which moisture laden gas is actively vented out of the cooking chamber for decreasing the humidity in the cooking chamber.

32. A convection oven for proofing and baking dough, the oven comprising:

a cooking chamber sized and shaped for receiving dough to be proofed and baked,

a convection system including a blower and a heater arranged for receiving gas from the cooking chamber and delivering heated gas to the cooking chamber,

a vent system including a fan arranged for actively venting gas out of the cooking chamber,

an oven controller adapted for controlling operation of the convection system and the vent system to proof and bake dough in sequence in the cooking chamber, and

a tangible storage medium having oven controller executable instructions stored thereon, said instructions, when executed by the oven controller, executing a proof and bake operation in the cooking chamber including:

a proofing step during which the convection system maintains a proofing temperature in the cooking chamber for proofing the dough, and

a baking step after the proofing step during which the convection system maintains a baking temperature in the cooking chamber for baking the dough, and

a transition phase between the proofing and baking steps including:

a first temperature ramping step during which the convection system increases the temperature in the cooking chamber to a maximum temperature greater than the proofing temperature,

an active venting step during which the venting system actively vents moisture laden gas out of the cooking chamber for decreasing the humidity in the cooking chamber, and

a second temperature ramping step during which the convection system increases the temperature in the cooking chamber to a maximum temperature greater than the maximum temperature of the first temperature ramping step.

33. A convection oven as set forth in claim 32 wherein the second temperature ramping step begins after the second active venting step begins.

34. A convection oven as set forth in claim 32 wherein the second temperature ramping step has at least one different characteristic than the first temperature ramping step.

35. A convection oven as set forth in claim 32 wherein during the second temperature ramping step the convection system increases the temperature in the cooking chamber at a faster rate than during the first temperature ramping step.

36. A convection oven as set forth in claim 32 wherein during the second temperature ramping step the blower operates at a faster speed than during the first temperature ramping step.

37. A convection oven as set forth in claim 32 wherein the maximum temperature of the first temperature ramping step is between about 180-260 degrees Fahrenheit.

38. A convection oven as set forth in claim 32 wherein the maximum temperature of the first temperature ramping step is between about 200-240 degrees Fahrenheit.

39. A convection oven as set forth in claim 32 wherein the maximum temperature of the second temperature ramping step is the baking temperature.

40. A convection oven as set forth in claim 32 wherein the active venting step is a second active venting step, and the transition phase includes a first active venting step before the second active venting step during which the venting system actively vents moisture laden gas from the cooking chamber for decreasing the humidity in the cooking chamber.

41. A convection oven as set forth in claim 32 wherein the active venting step begins after the first temperature ramping step begins, and the second temperature ramping step begins after the active venting step begins.

42. A convection oven as set forth in claim 32 wherein the transition phase comprises at least one of:

the active venting step begins after the first temperature ramping step begins;

the second temperature ramping step begins after the active venting step begins;

the active venting step begins after completion of the first temperature ramping step;

the second temperature ramping step begins after completion of the active venting step;

the active venting step begins after the maximum temperature of the first temperature ramping step is reached; and

the second temperature ramping step begins after a time period following completion of the first temperature ramping step.

43. A method of proofing and baking dough in sequence in the same cooking chamber, the method comprising:

executing a proofing step during which a proofing temperature is maintained in the cooking chamber for proofing the dough,

executing a baking step after the proofing step during which a baking temperature is maintained in the cooking chamber for baking the dough, and

executing a transition phase between the proofing and baking steps including:

executing a first temperature ramping step during which the temperature in the cooking chamber is increased to a maximum temperature greater than the proofing temperature,

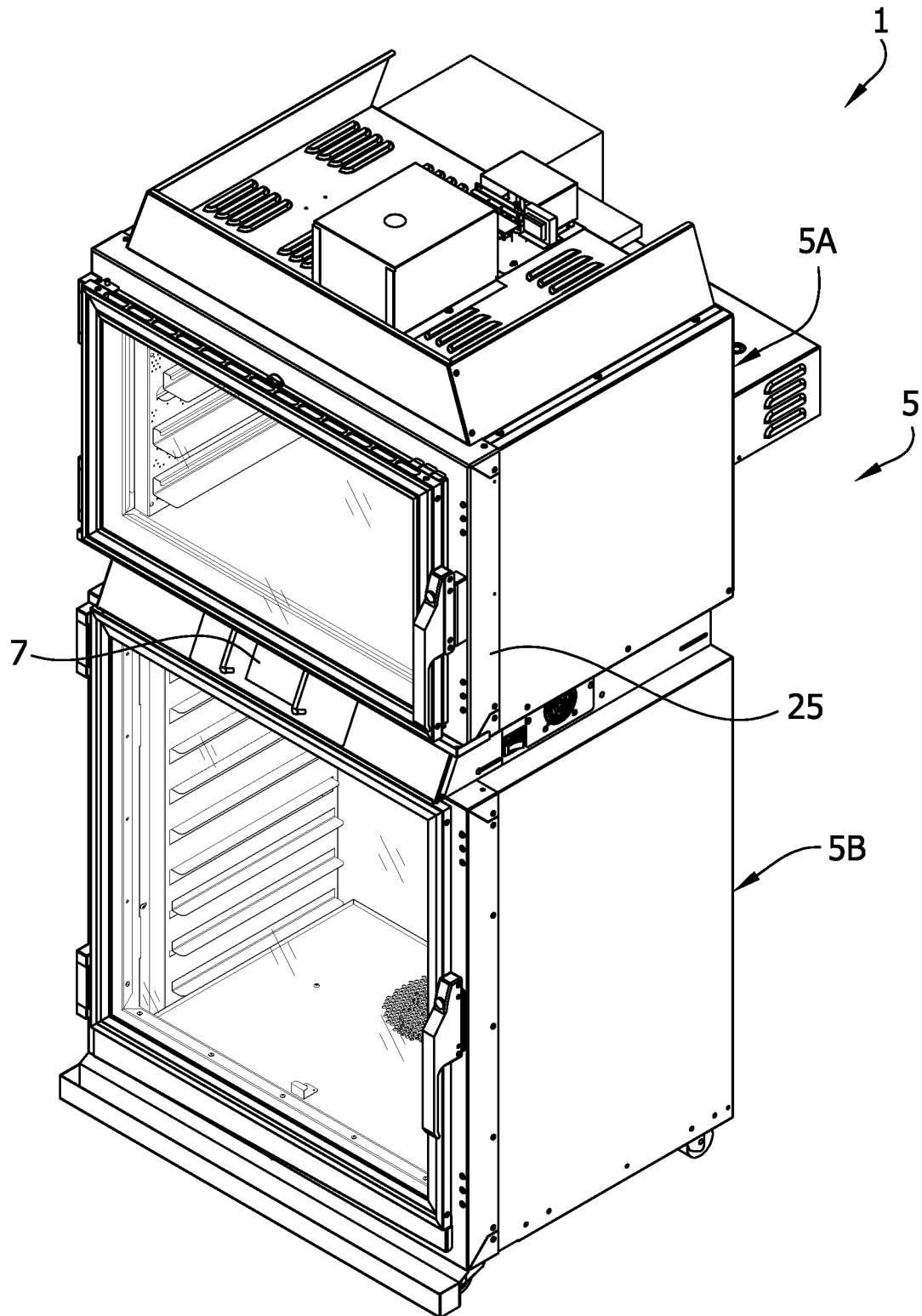
executing an active venting step during which moisture laden gas is actively vented out of the cooking chamber for decreasing the humidity in the cooking chamber, and

executing a second temperature ramping step during which the temperature in the cooking chamber is increased to a maximum temperature greater than the

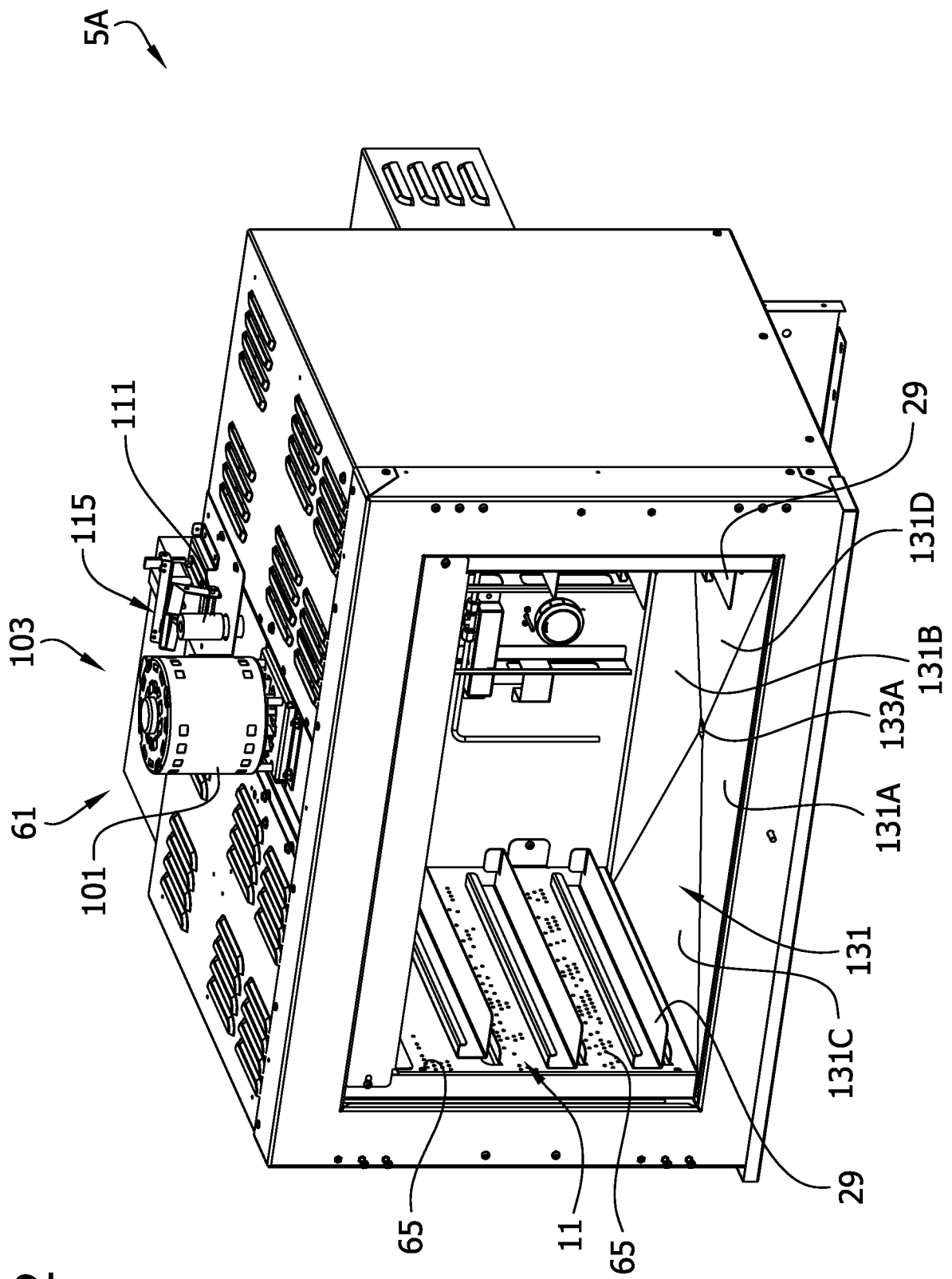
maximum temperature of the first temperature ramping step.

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FIG. 1



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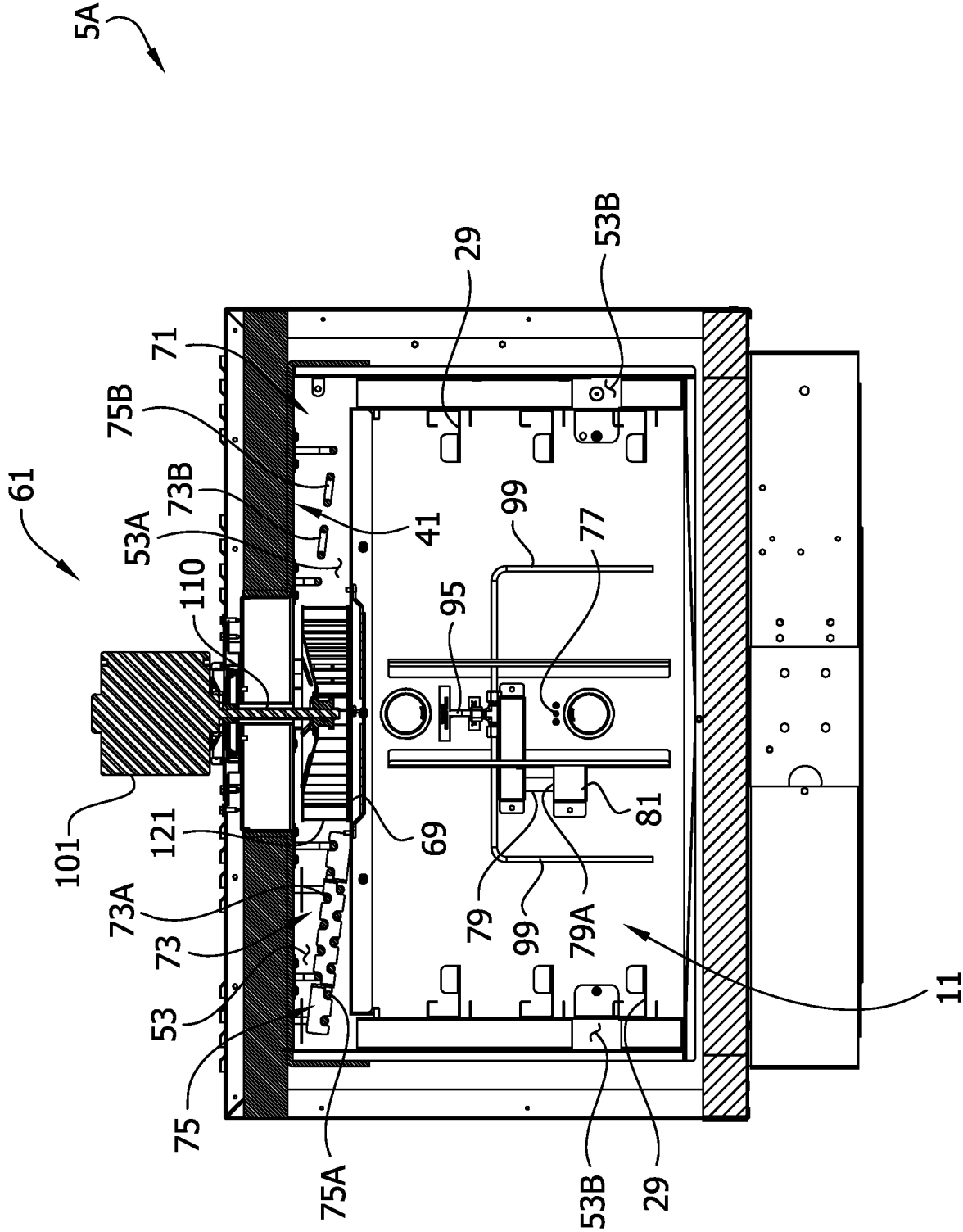


FIG. 3A

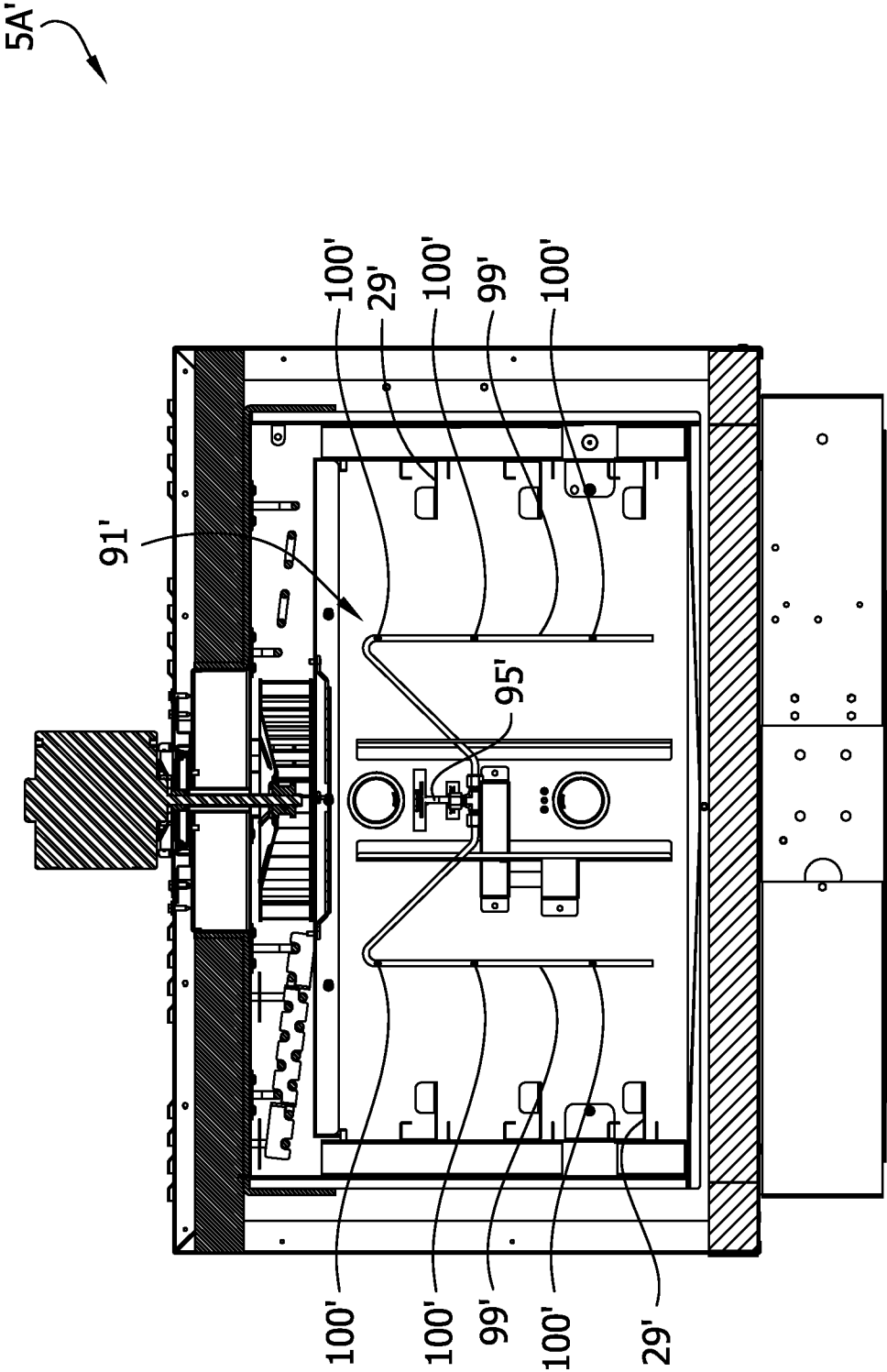


FIG. 4

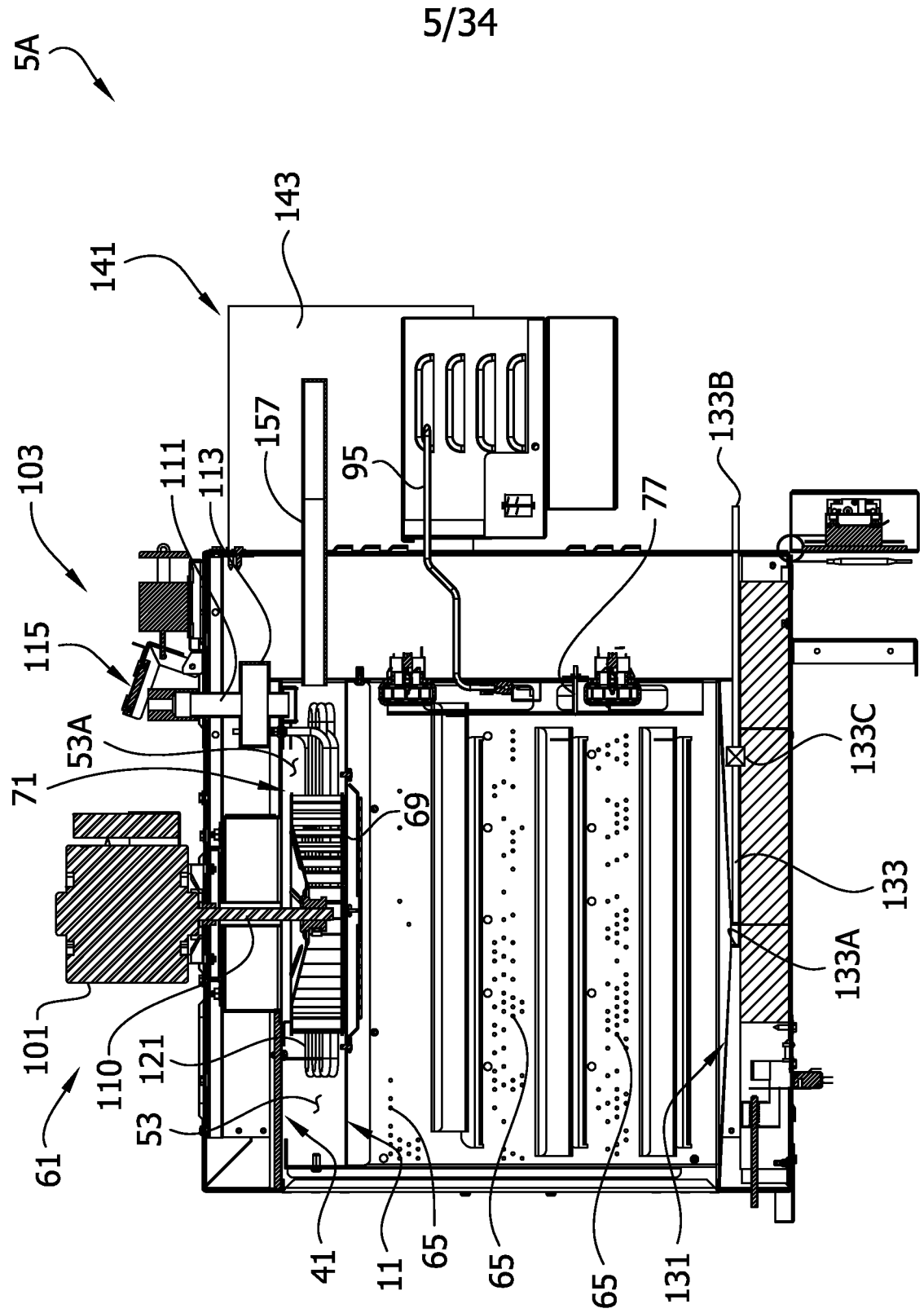
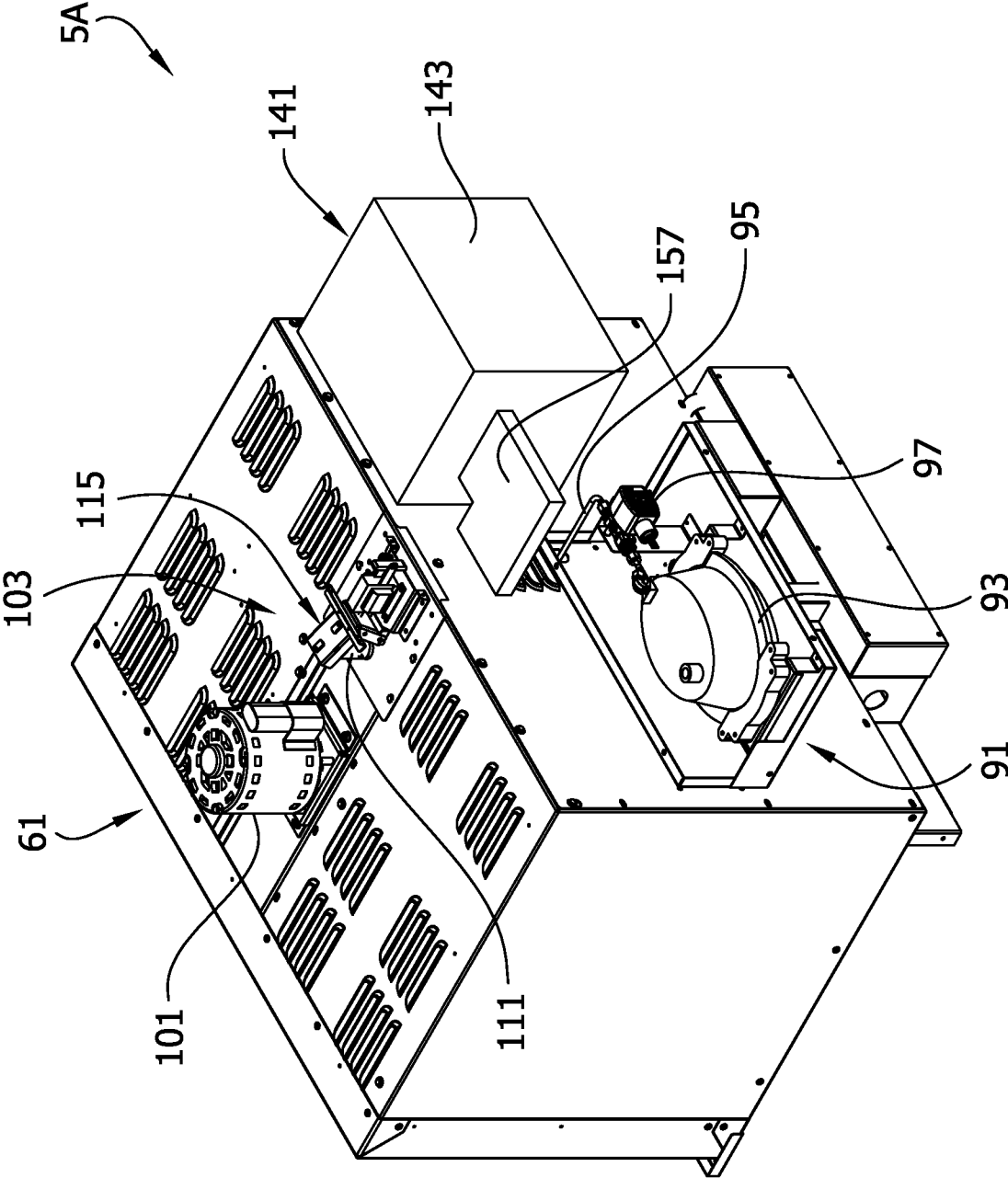
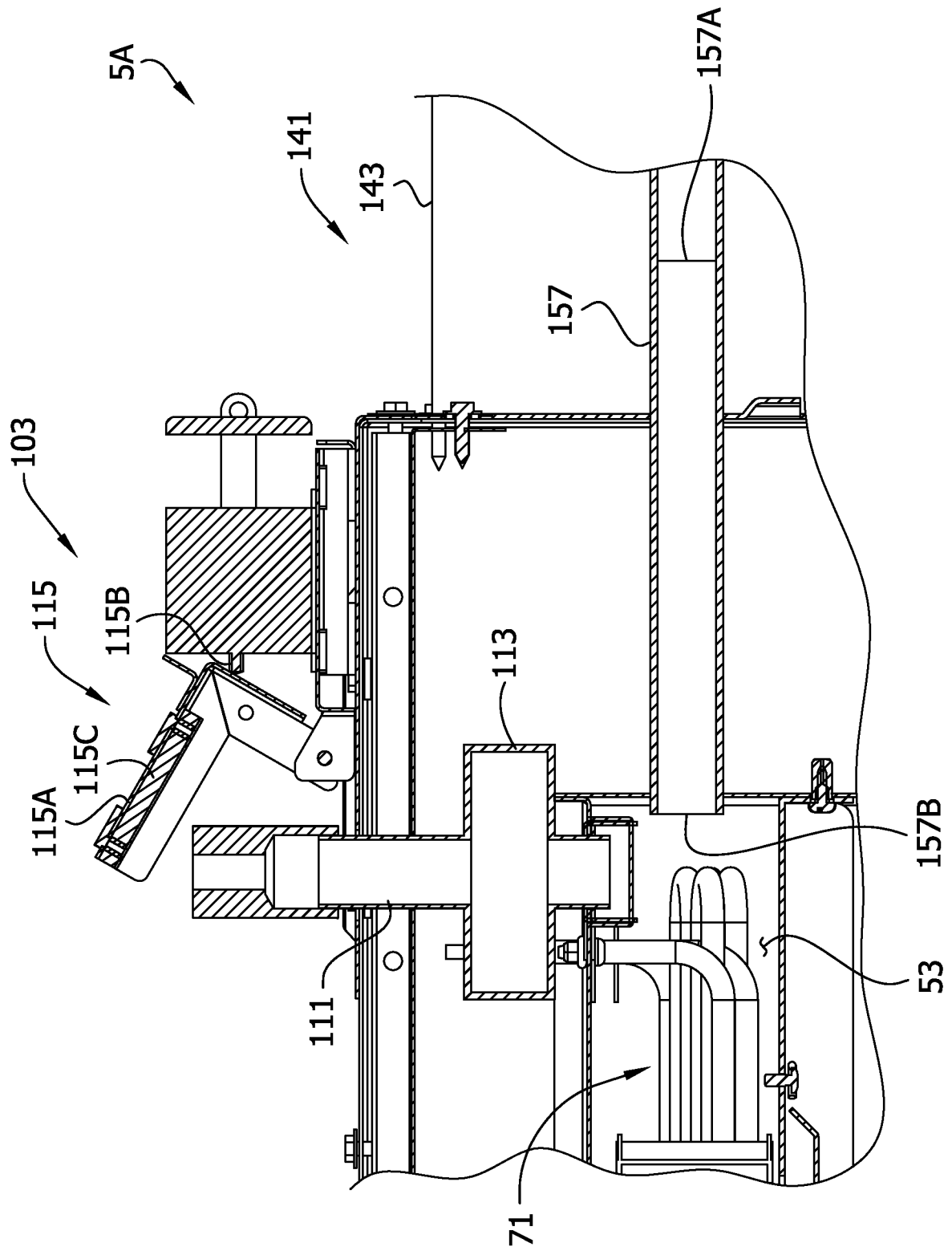
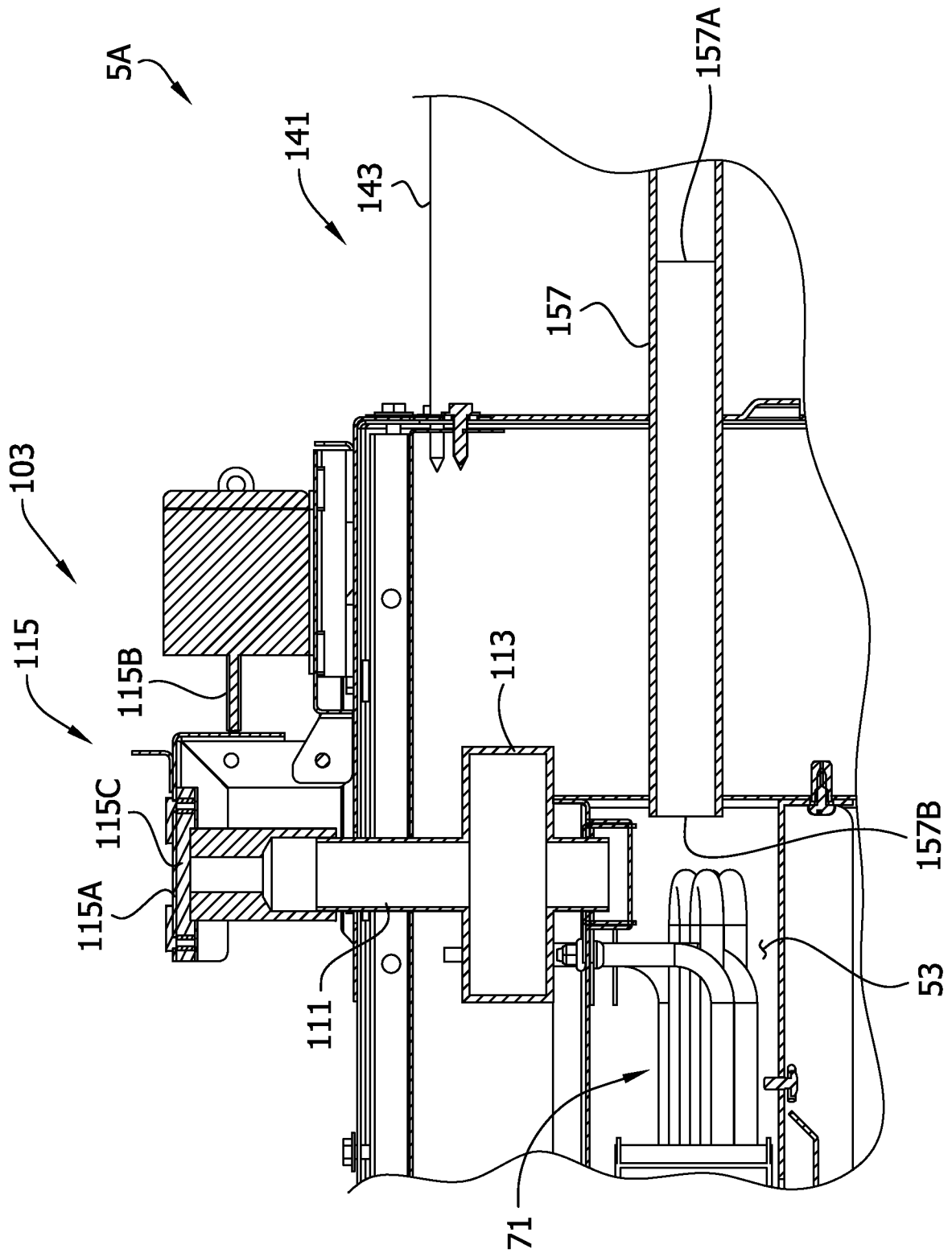


FIG. 5

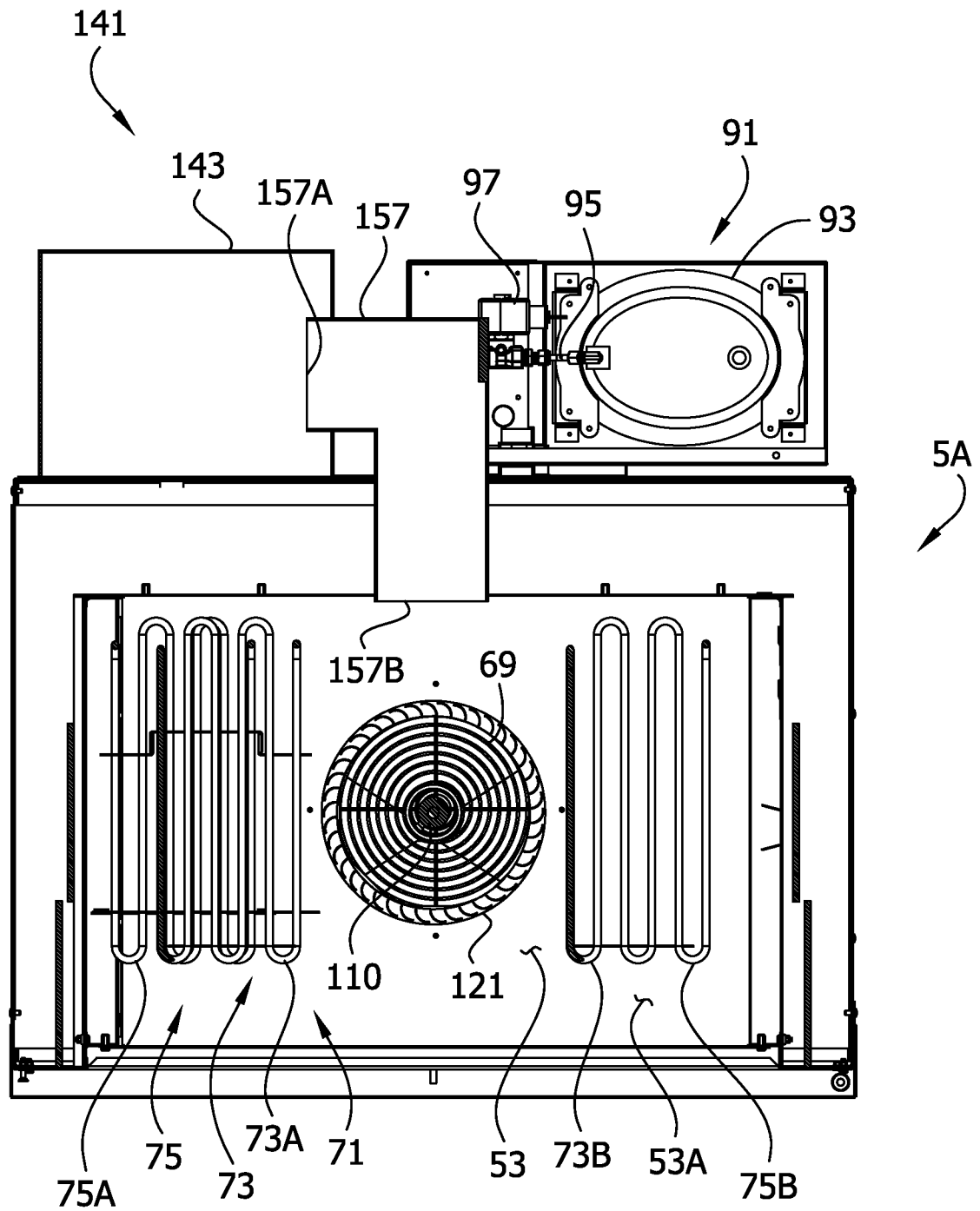






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FIG. 8



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FIG. 9

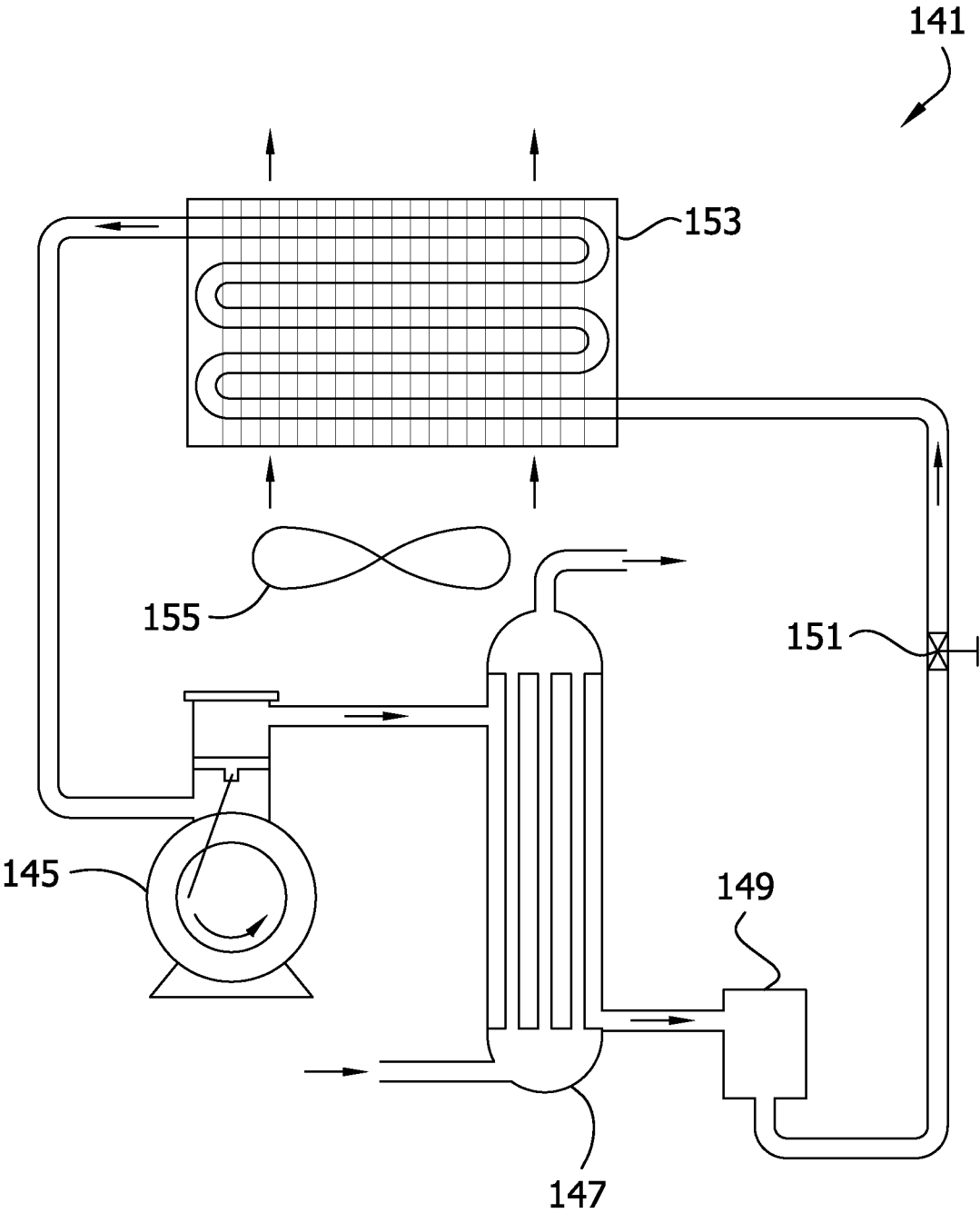
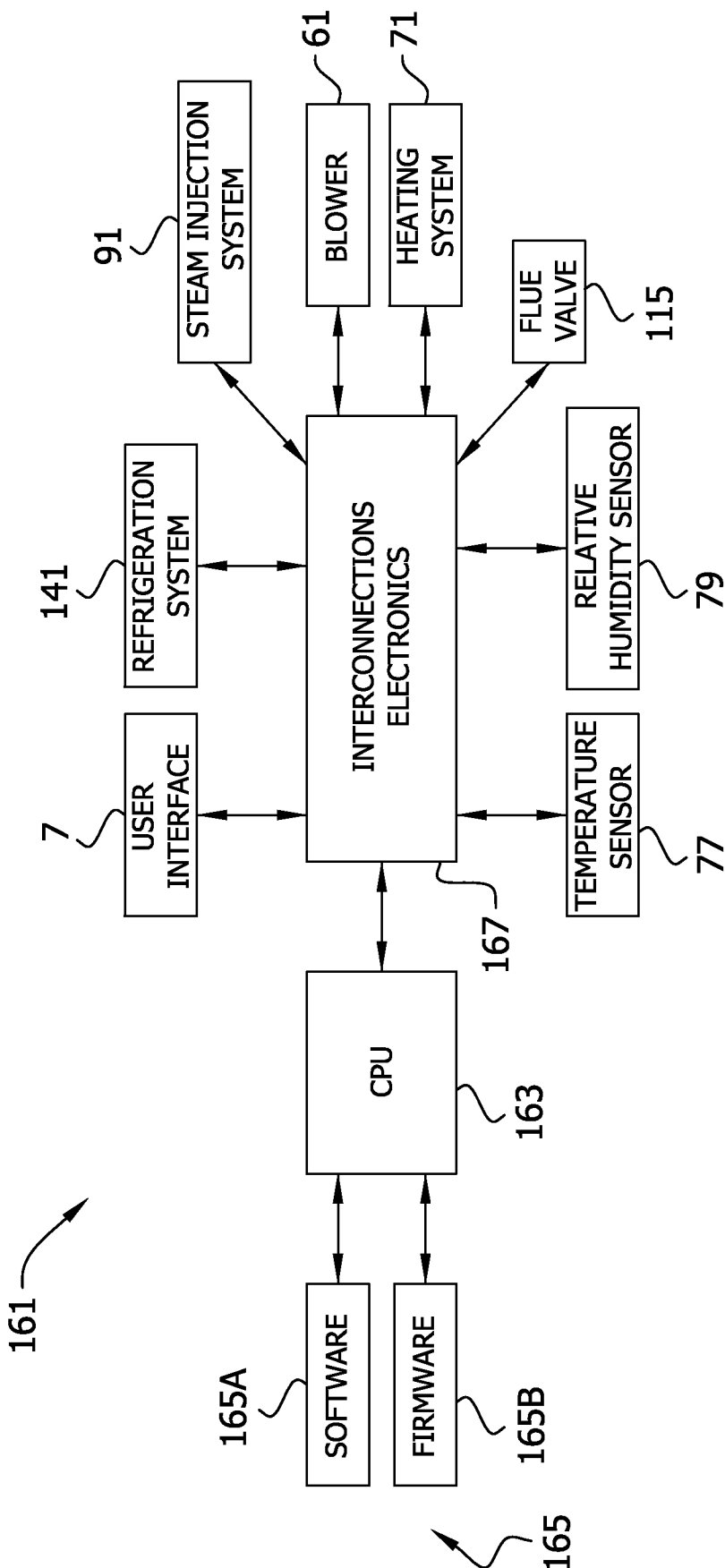


FIG. 10



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FIG. 11



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FIG. 12



FIG. 13

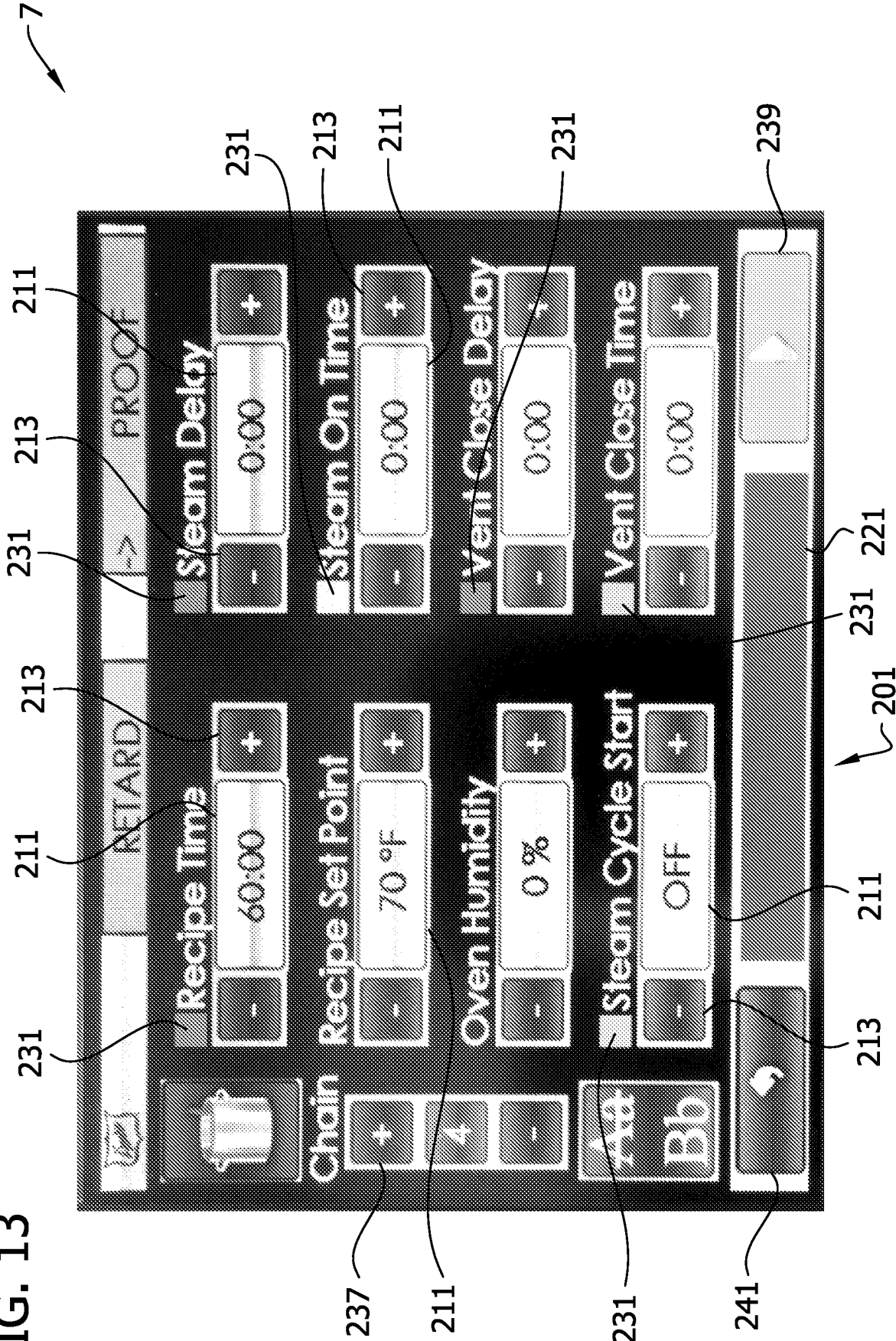


FIG. 14

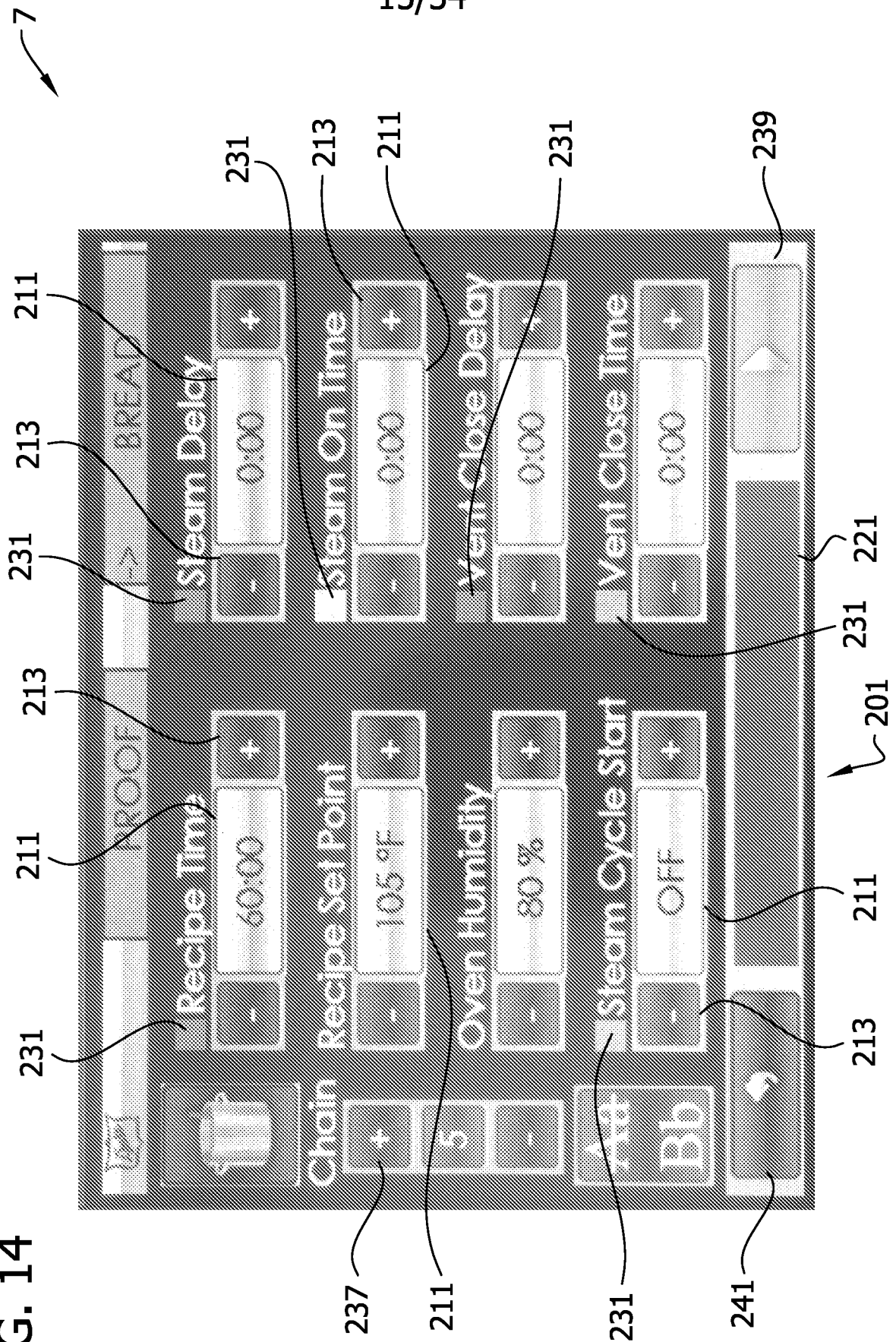
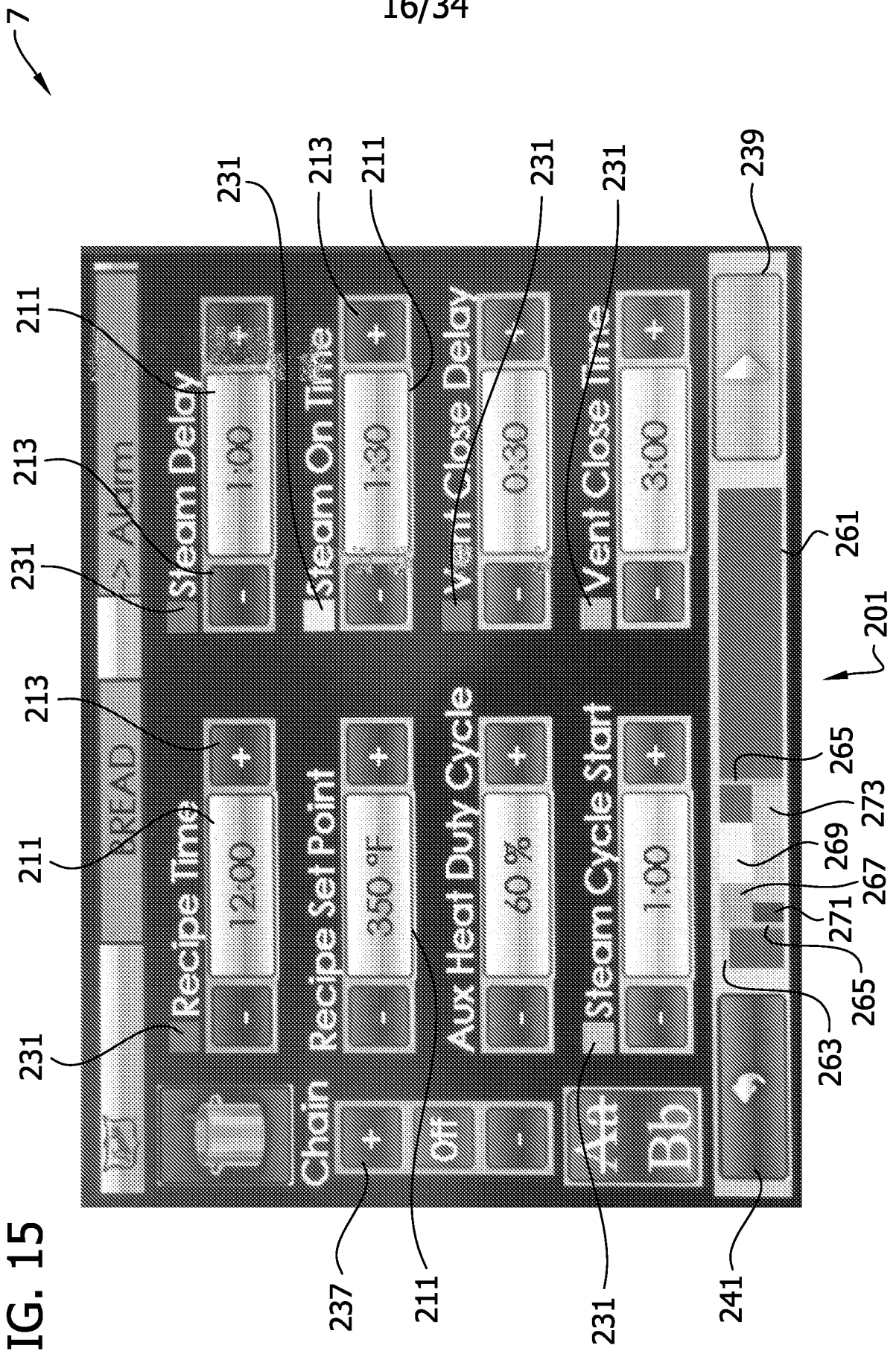


FIG. 15



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FIG. 16

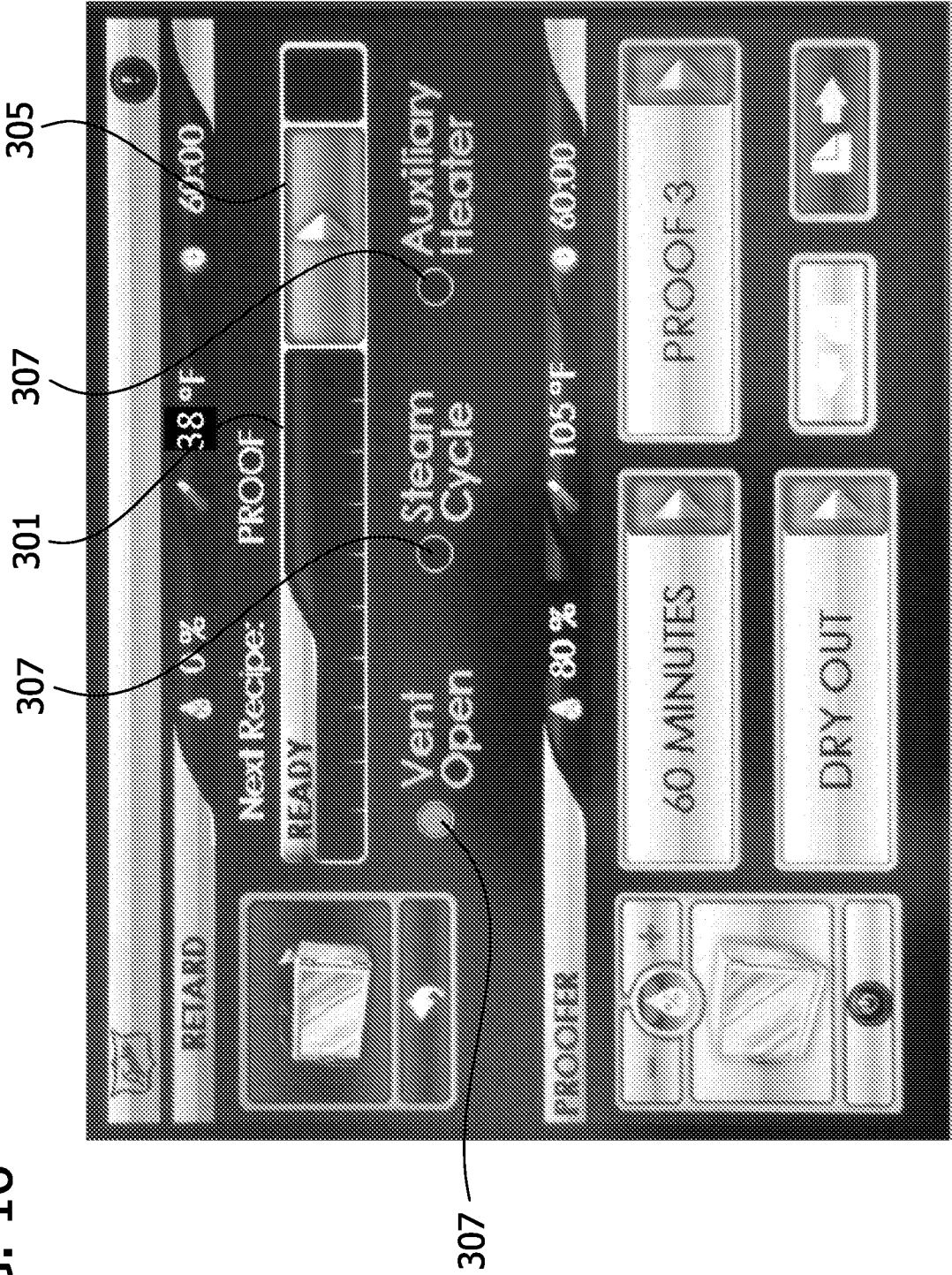
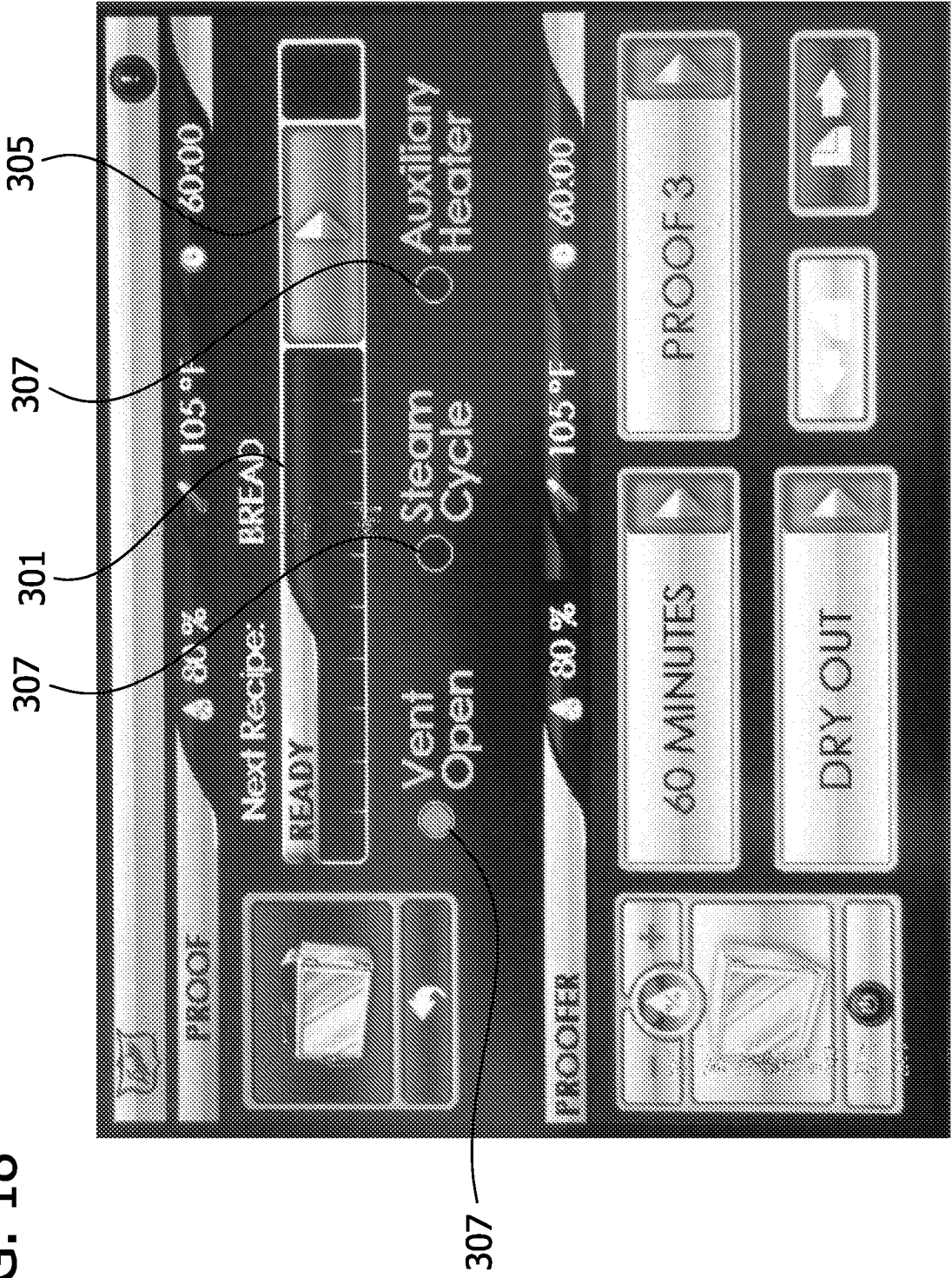


FIG. 17





FIG. 18



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FIG. 19

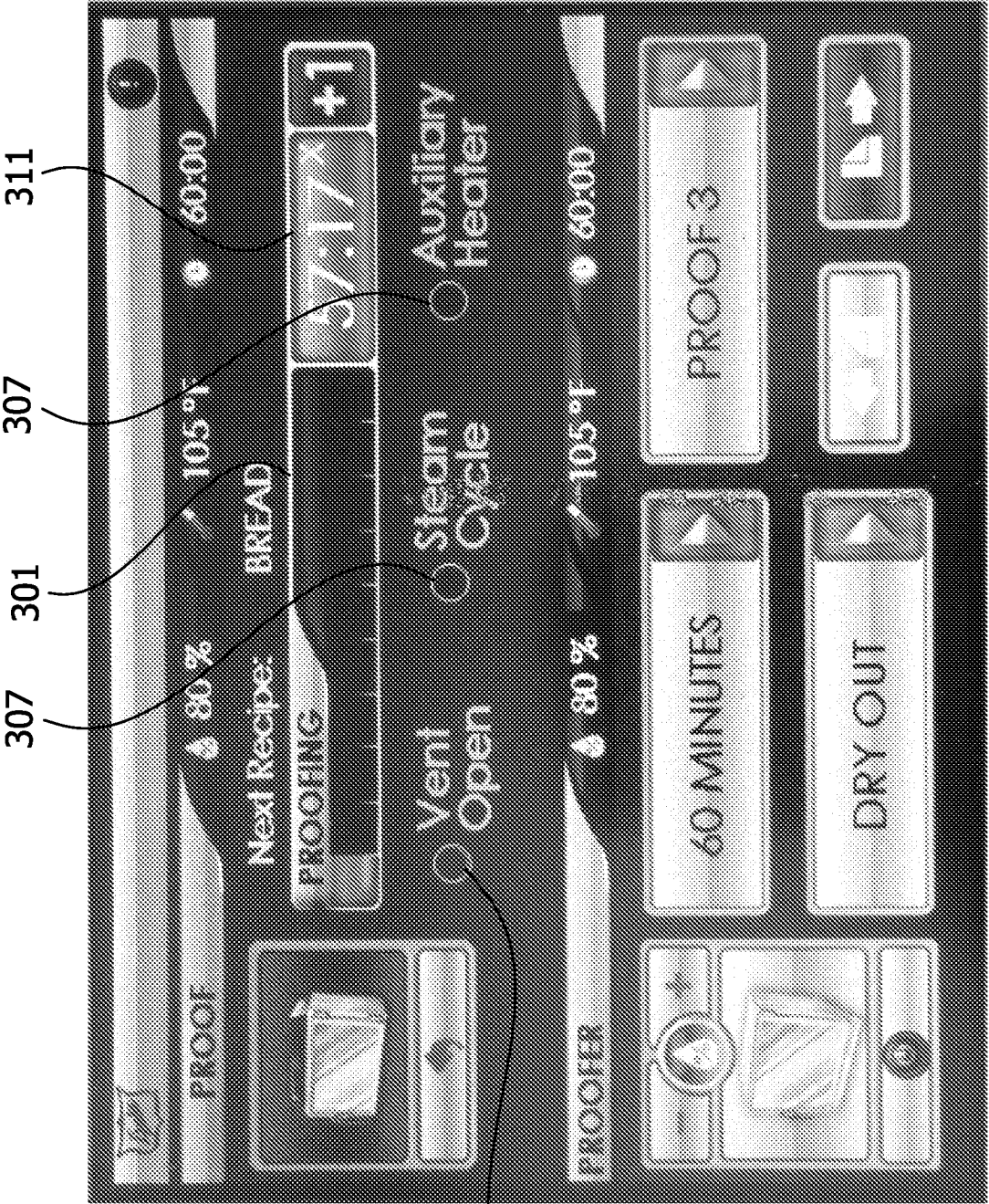


FIG. 20

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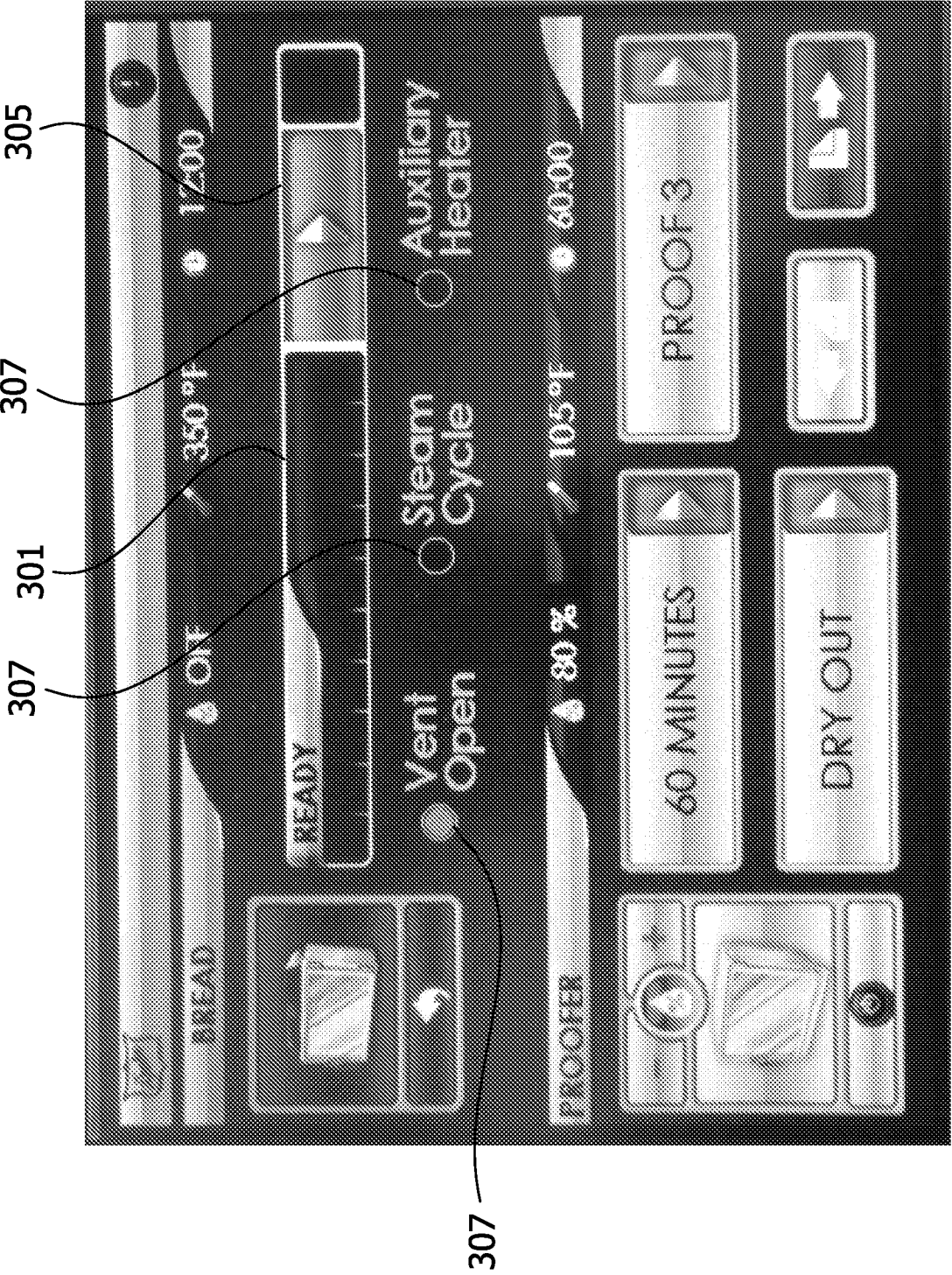
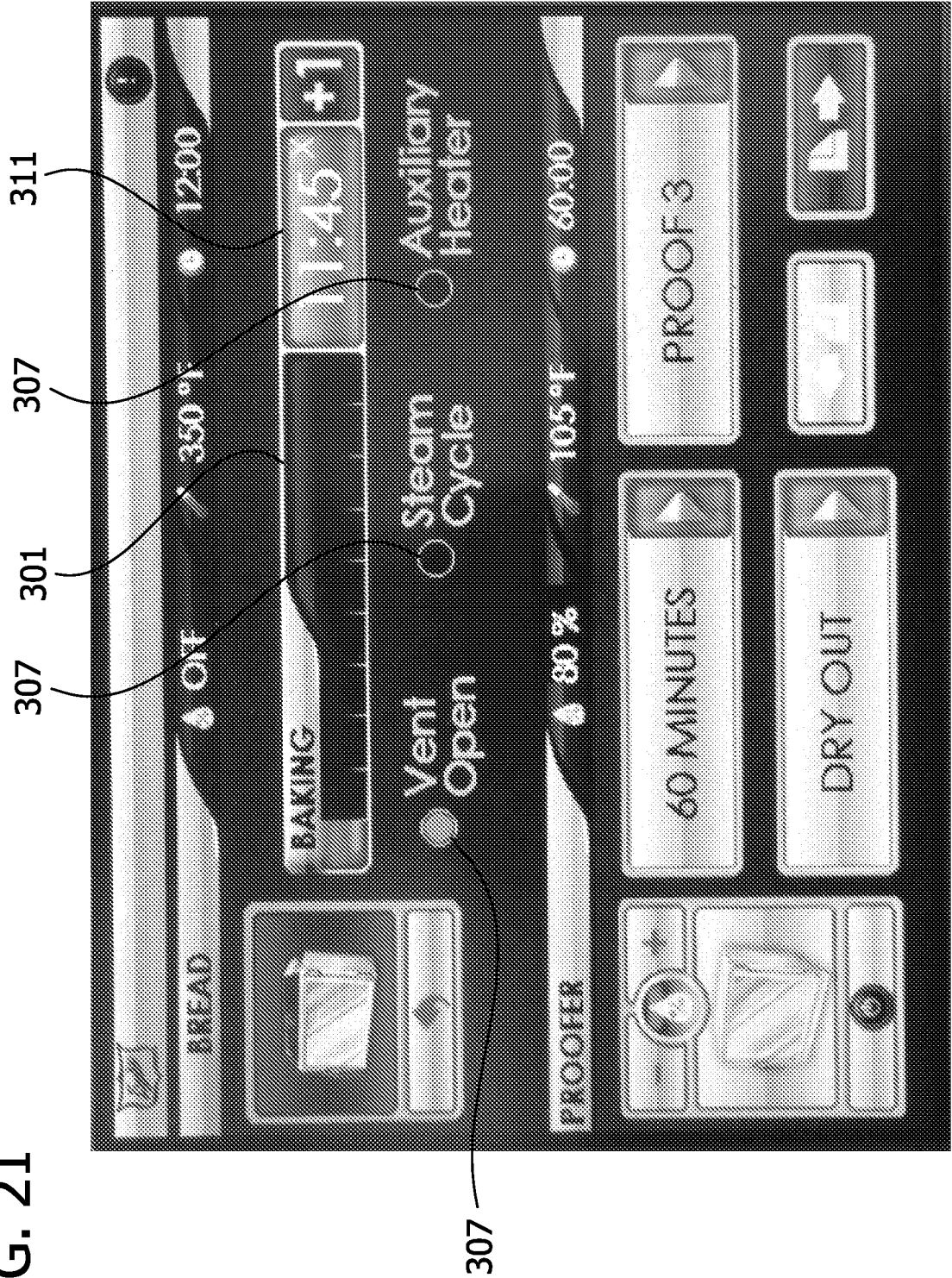


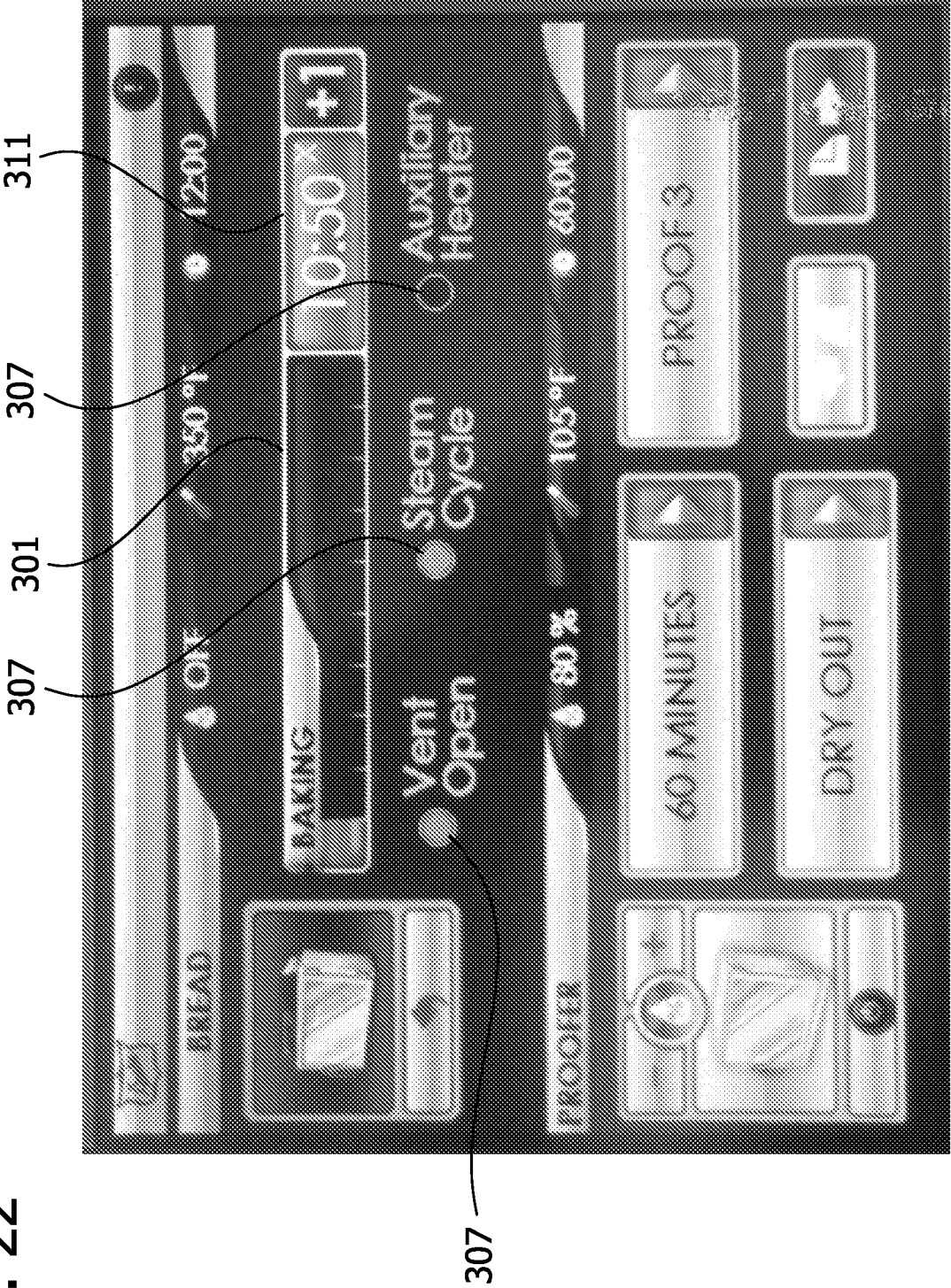


FIG. 21



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FIG. 22



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FIG. 23

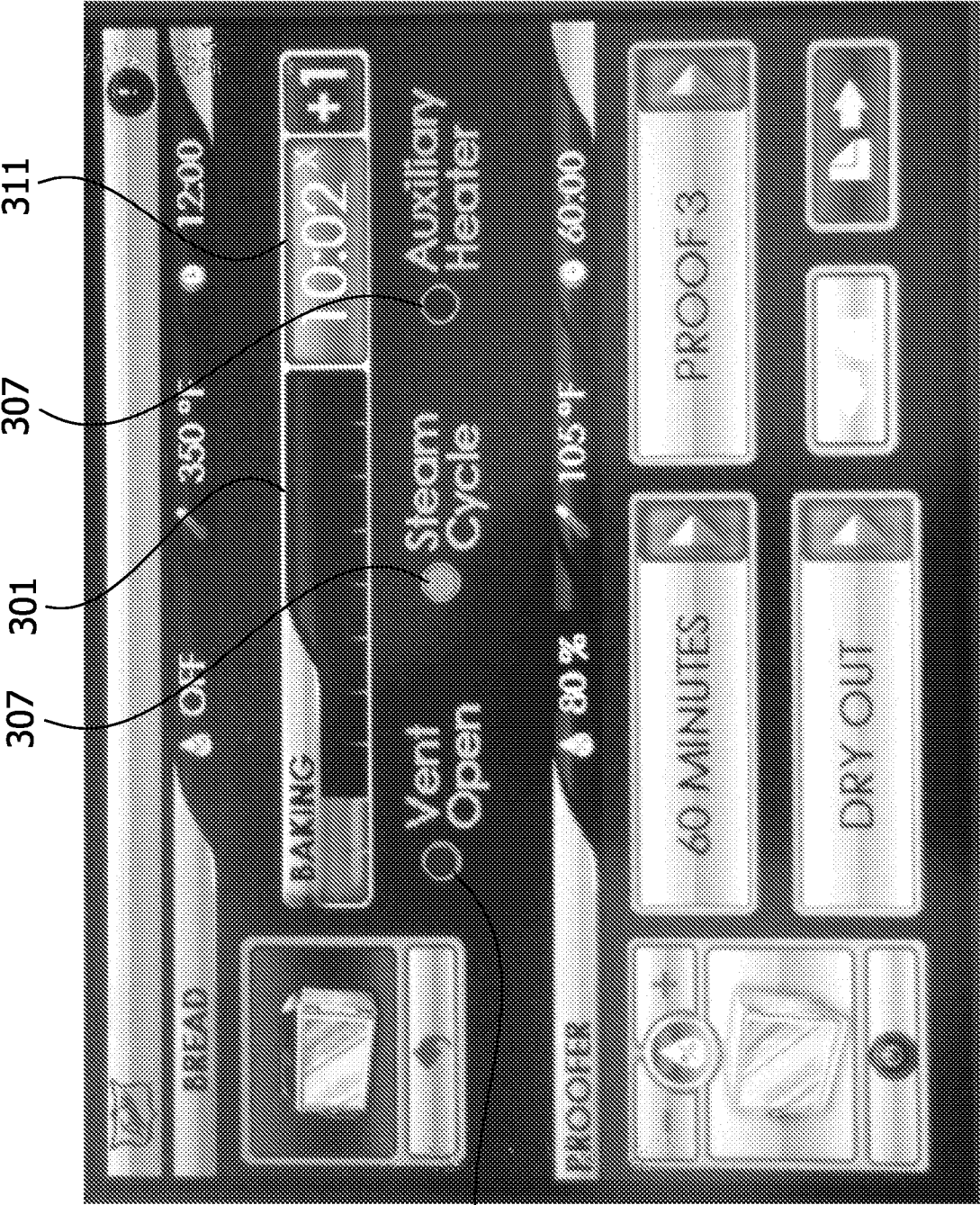
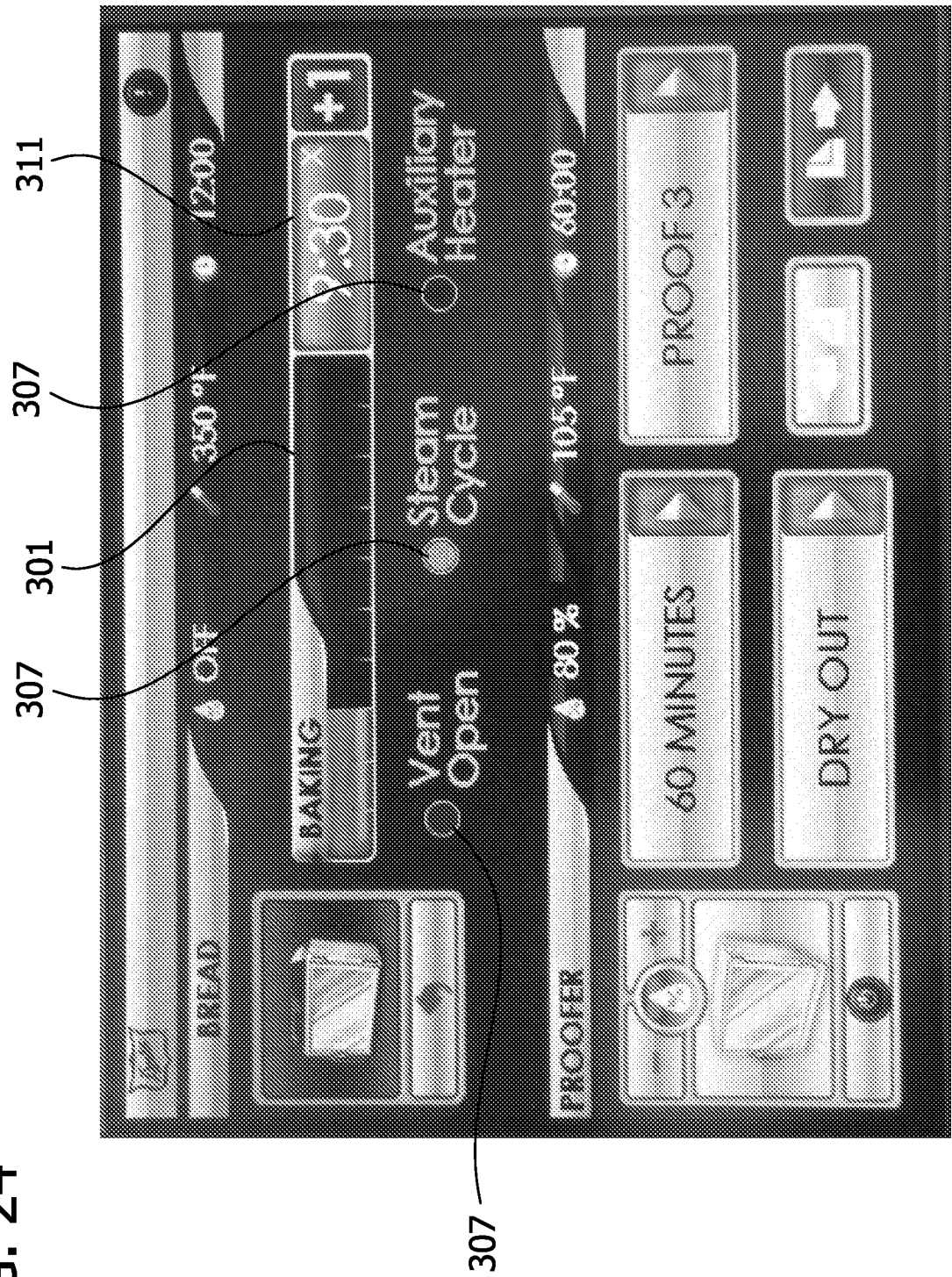


FIG. 24



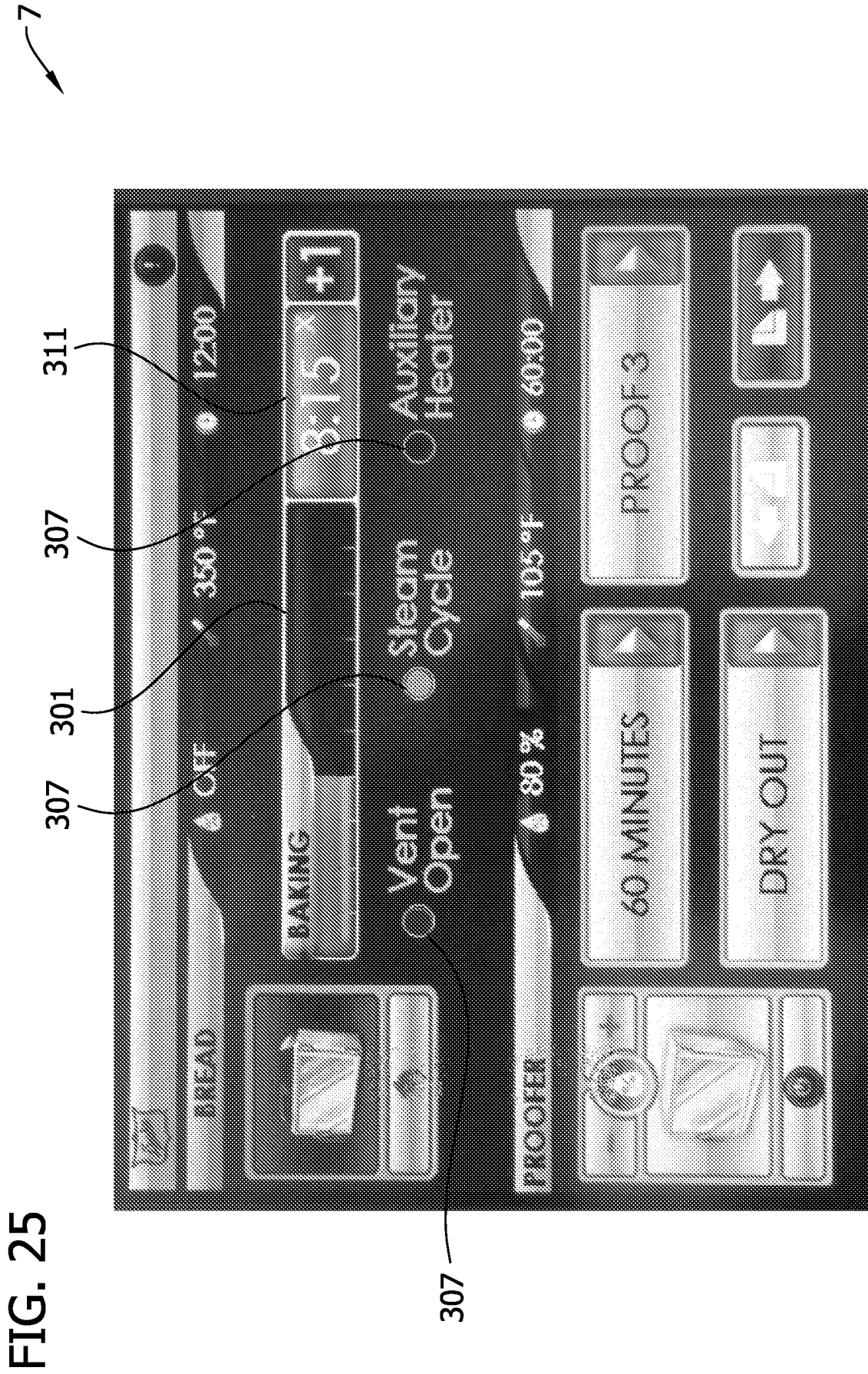




FIG. 26

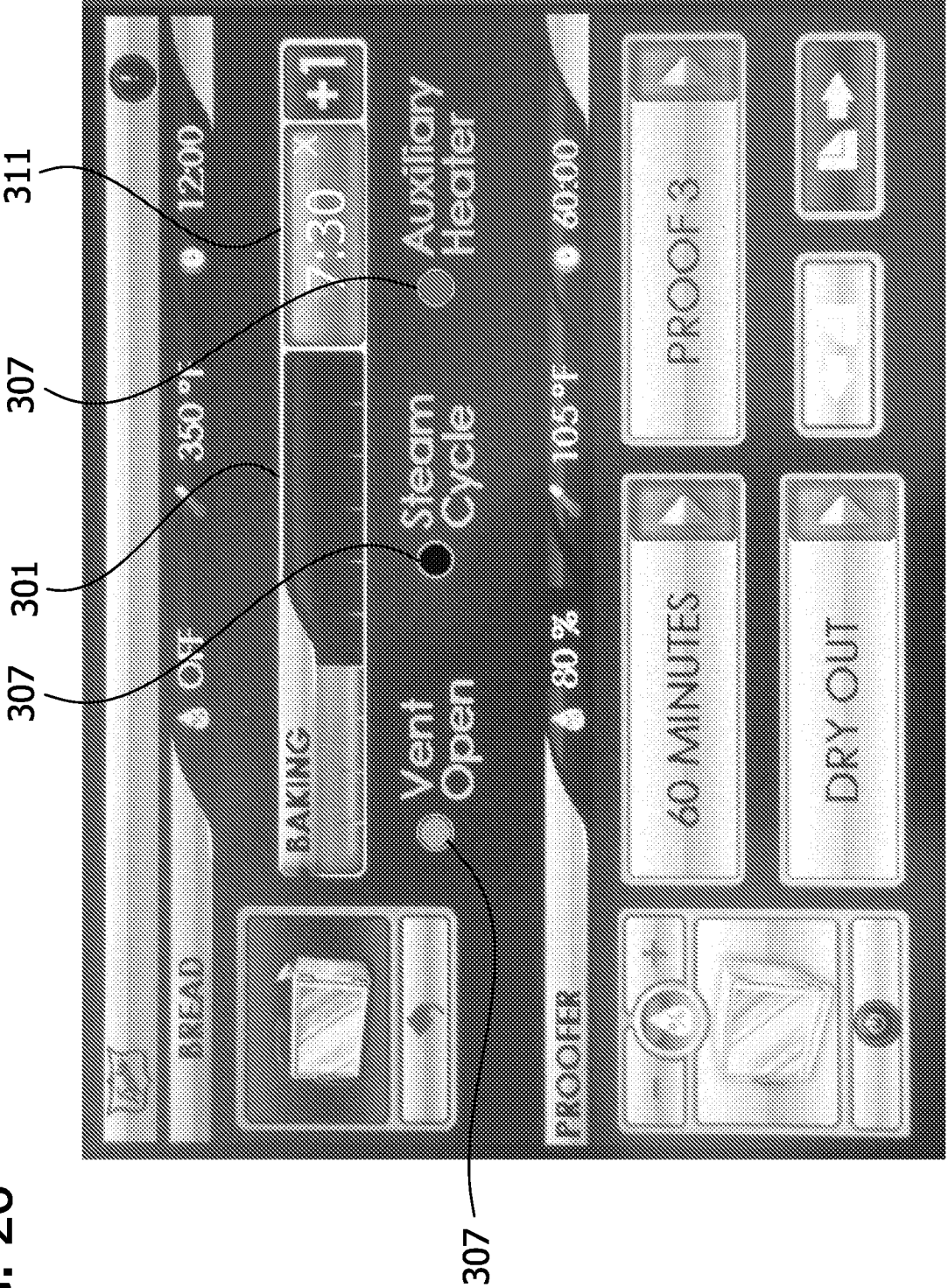


FIG. 27

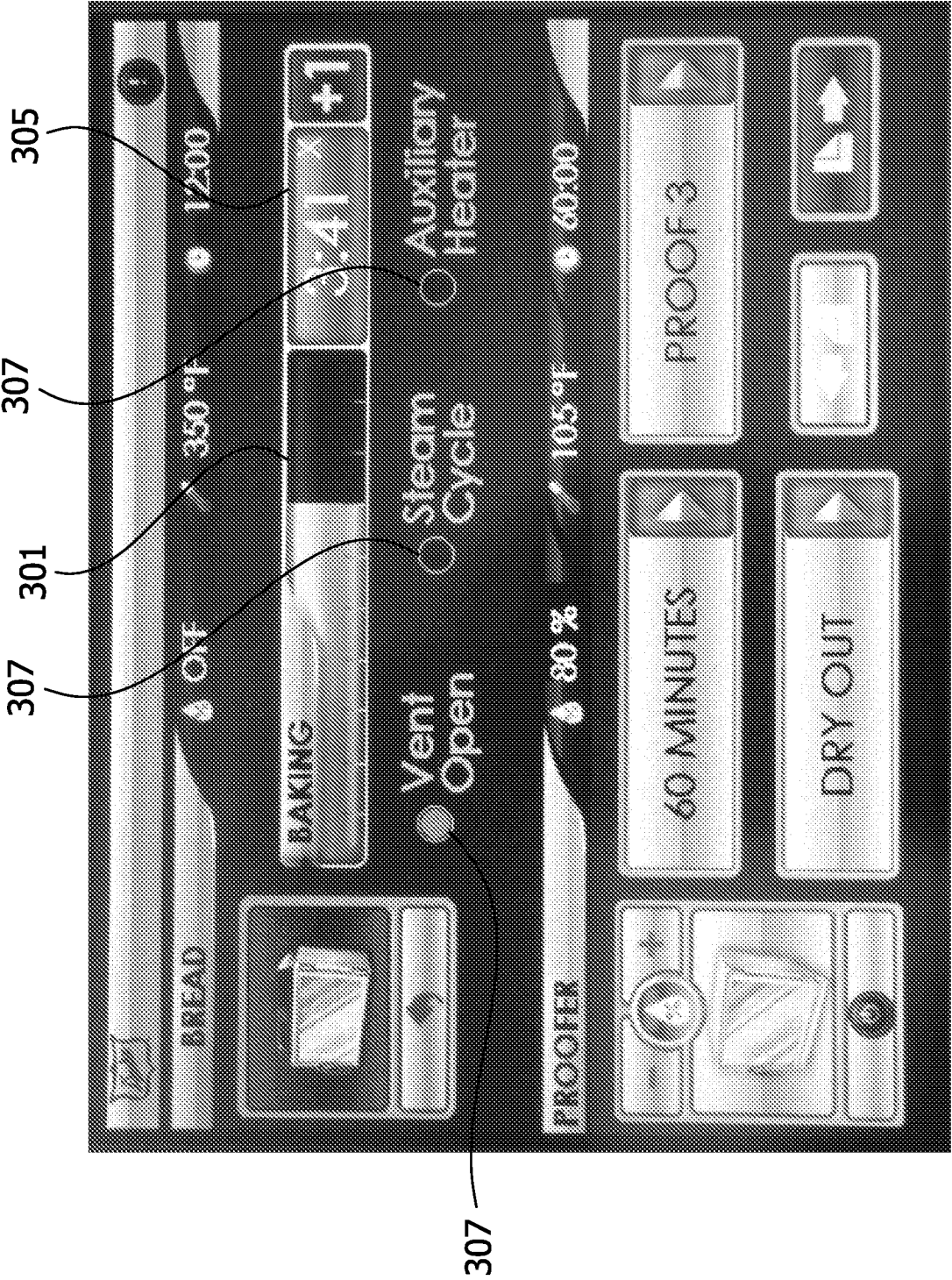


FIG. 28

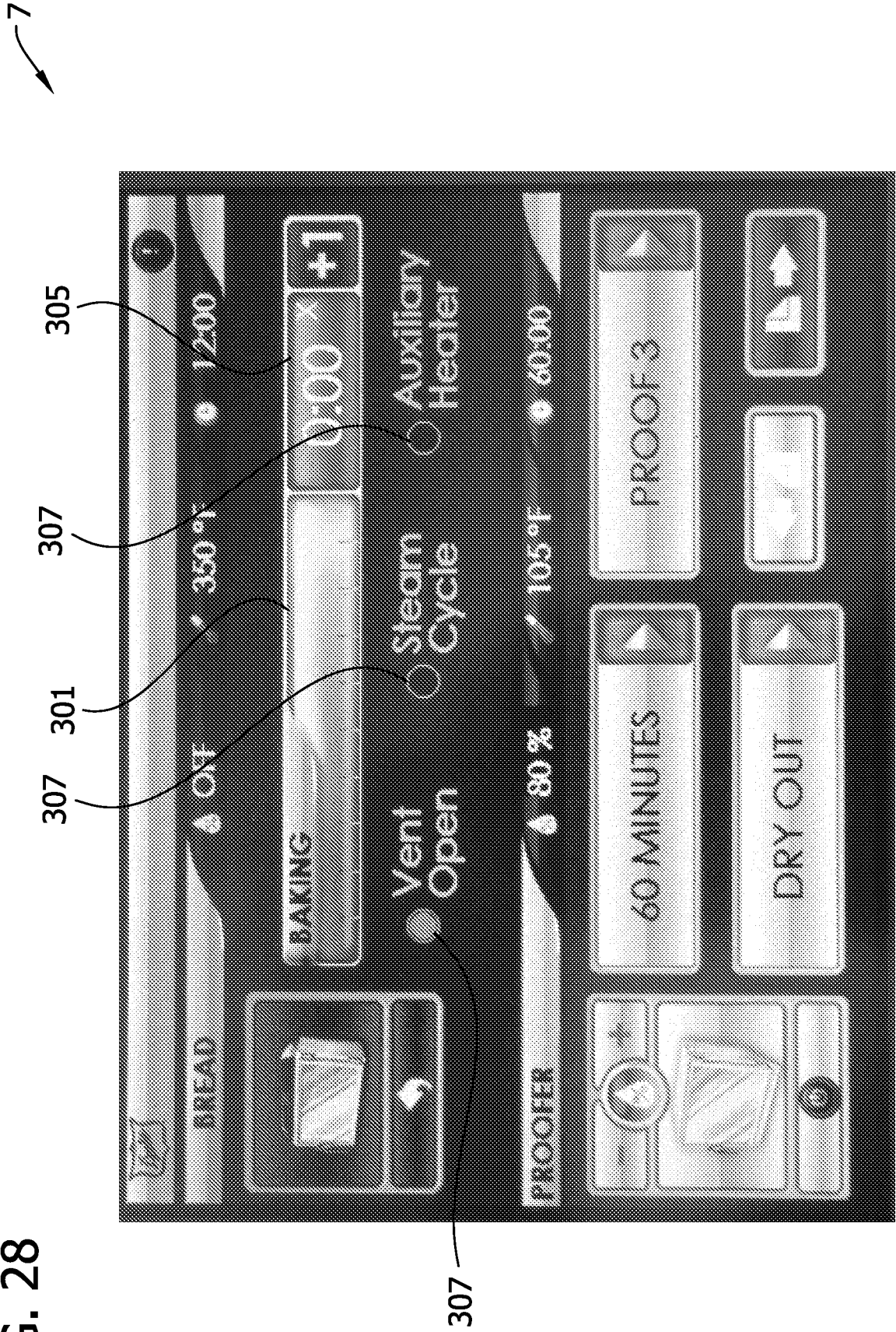
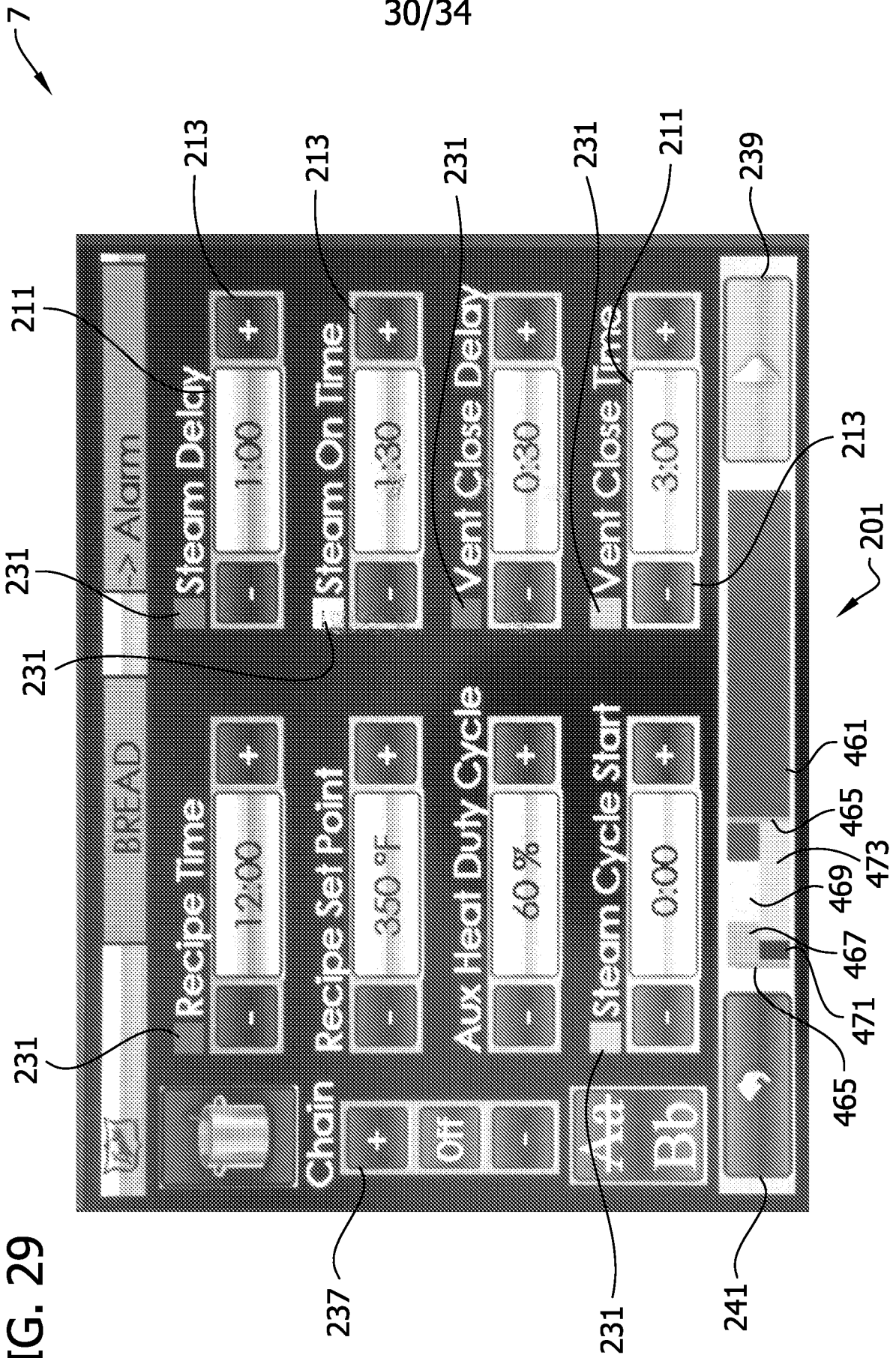
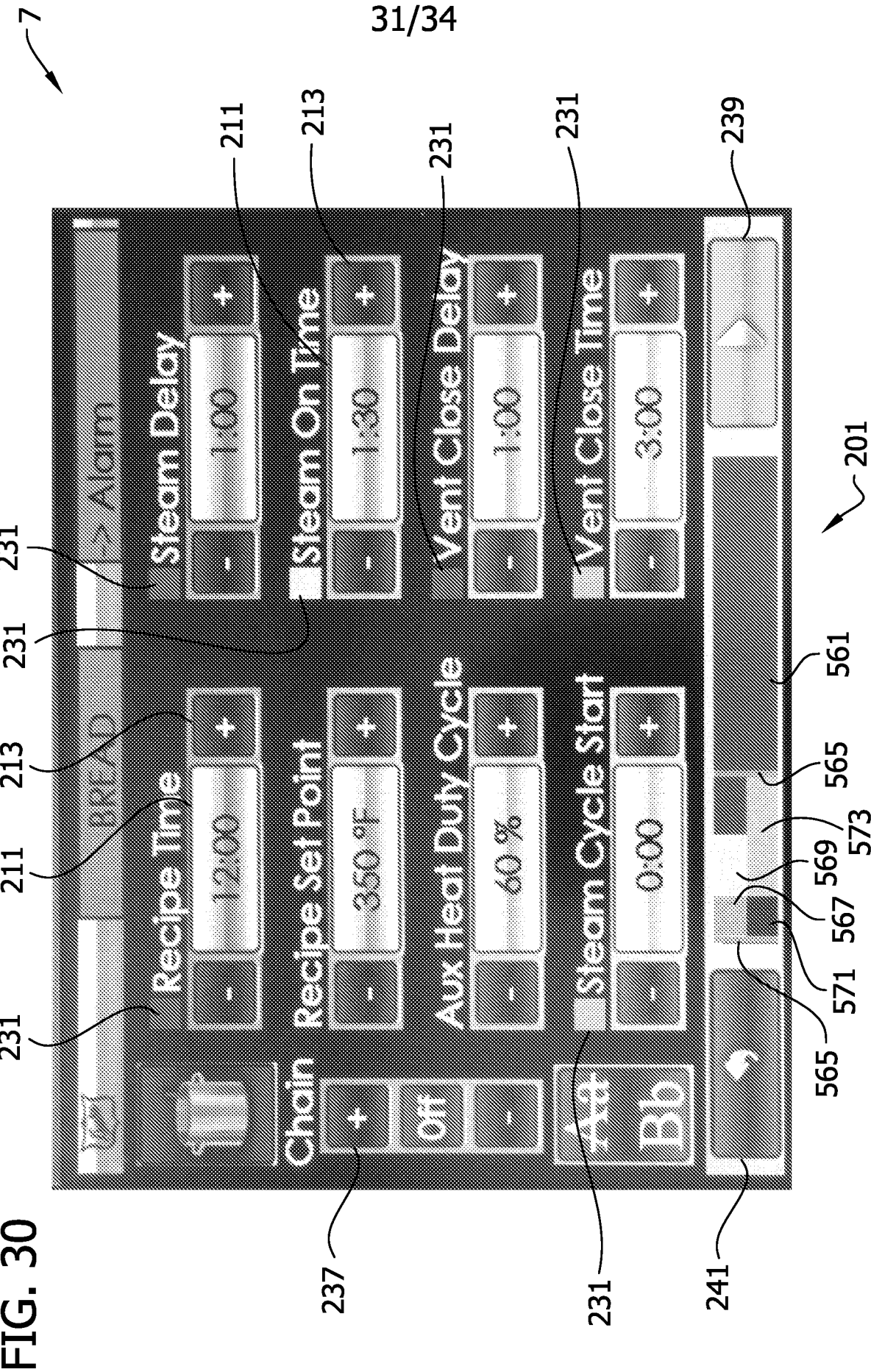


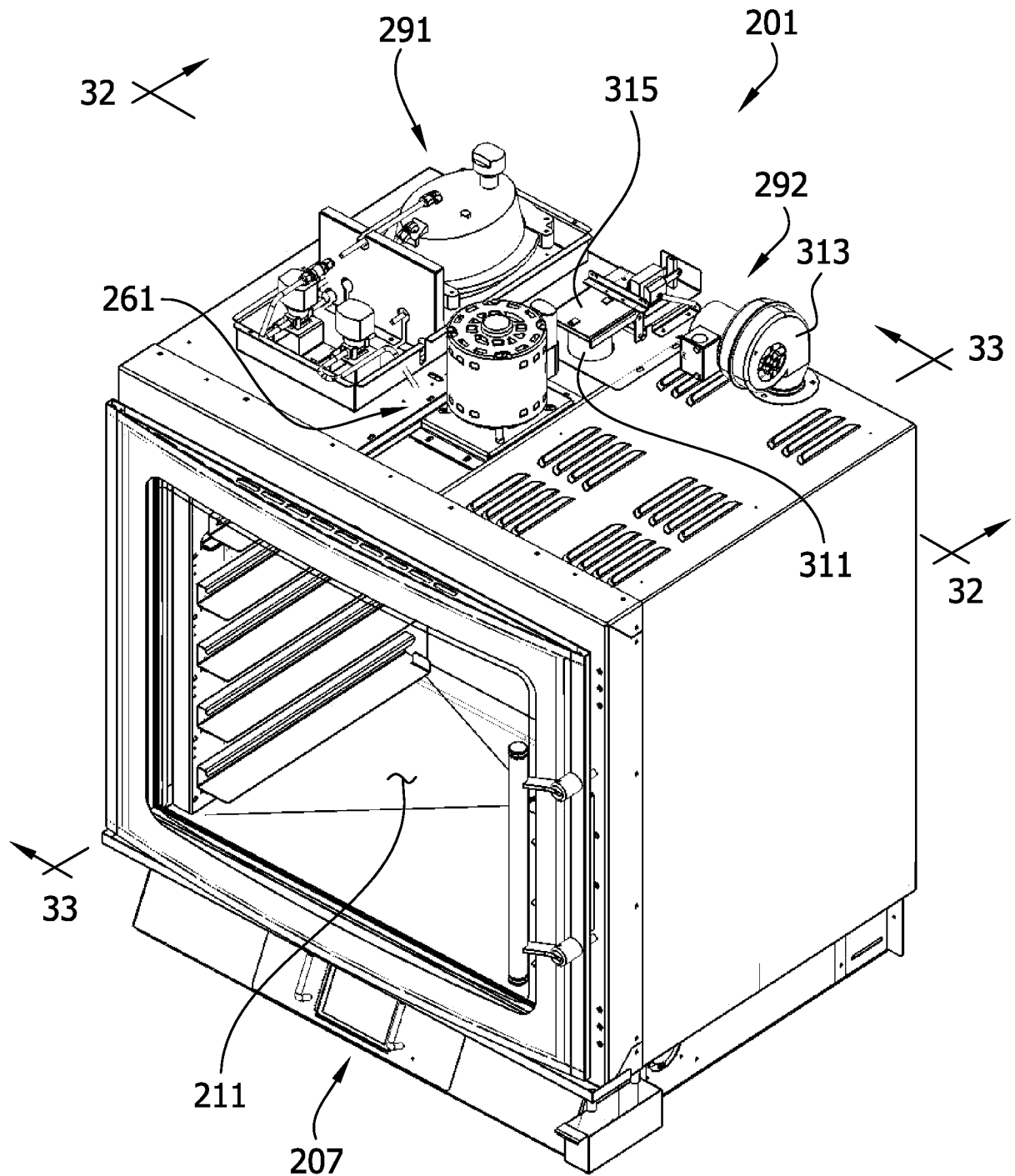
FIG. 29





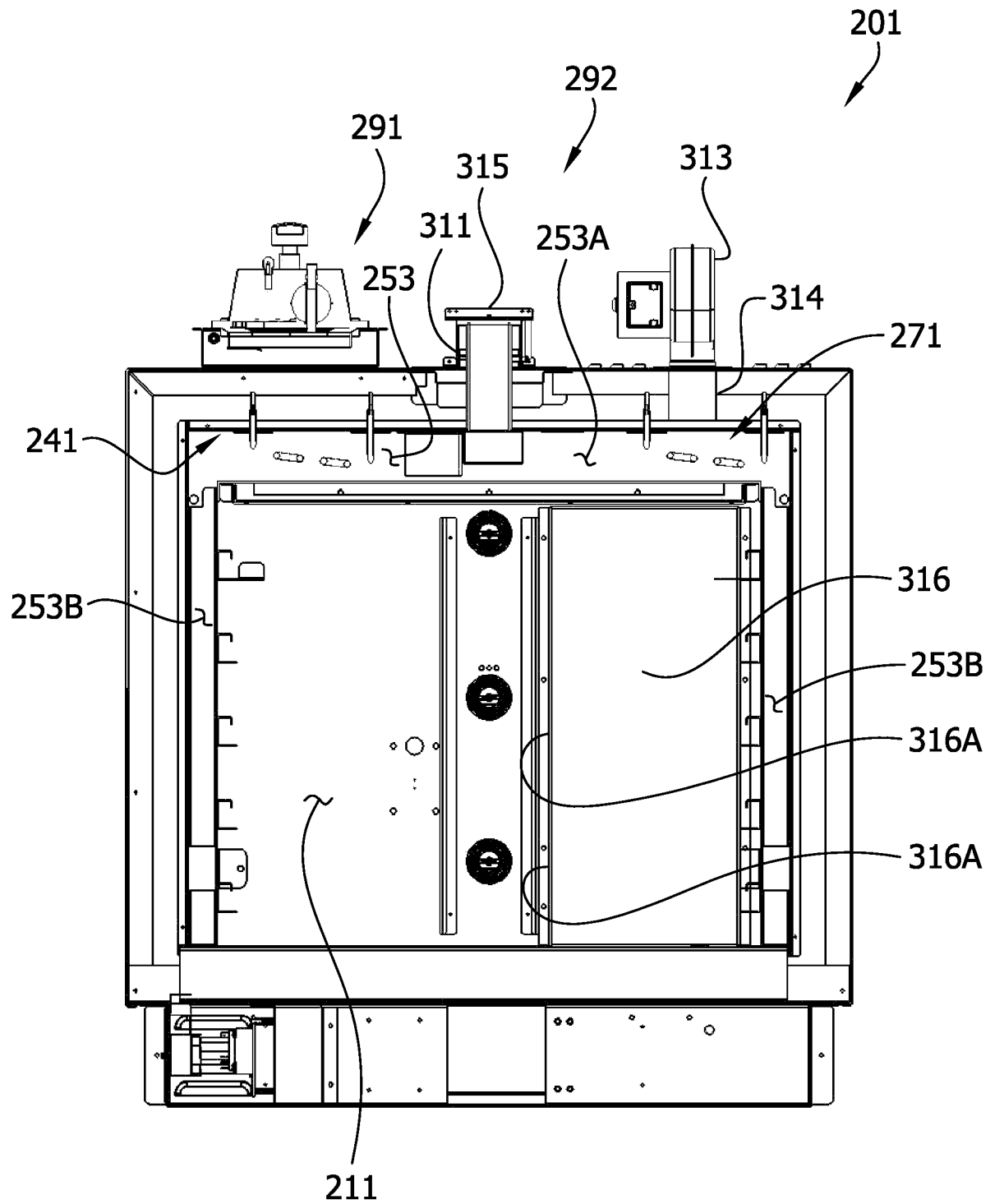
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FIG. 31



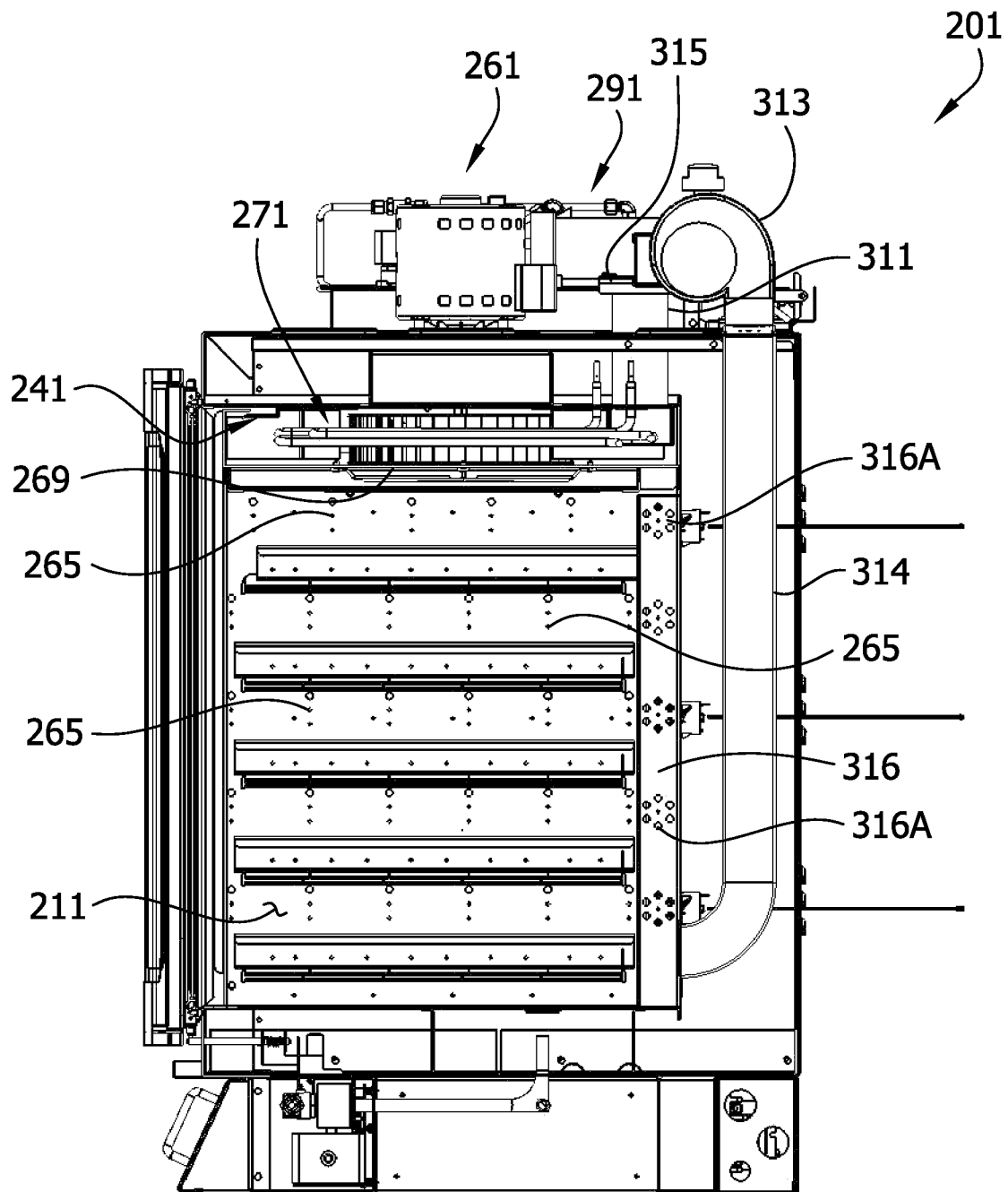
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FIG. 32



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FIG. 33



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US15/27815

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - A21B 1/26; A21D 8/06 (2015.01)

CPC - A21B 1/26; F24C 15/322

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) Classification(s): A21B 1/26; A21D 8/06 (2015.01)

CPC Classification(s): A21B 1/26; F24C 15/322

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PatSeer (US, EP, WO, JP, DE, GB, CN, FR, KR, ES, AU, IN, CA, INPADOC Data); ProQuest; Google; Google Scholar
Convection, oven, circulate, recirculate, positive, increase, add, apply, pressure, fan, blower, chamber, vent

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2014/0083309 A1 (DUKE MANUFACTURING CO) 27 March 2014; paragraphs [0121], [0135]	1, 2, 7 --- 1, 3-6, 8-19
Y	US 2013/0243923 A1 (DUKE MANUFACTURING CO) 19 September 2013; figure 5; paragraph [0054]	1, 3-6, 8-19
A	US 4,813,398 A (SAVAGE, JA) 21 March 1989; entire document	1-19

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

03 September 2015 (03.09.2015)

Date of mailing of the international search report

30 SEP 2015

Name and mailing address of the ISA/

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450

Facsimile No. 571-273-8300

Authorized officer

Shane Thomas

PCT Helpdesk: 571-272-4300
PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US15/27815

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

-Please See Supplemental Page-

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-19

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

-Continued from Box No. III: Observations where unity of invention is lacking-

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I: claims 1-19 are directed toward a convection oven comprising re-circulation ducting defining a re-circulation gas flow path.

Group II: claims 20-43 are directed toward a convection oven for proofing and baking dough comprising an oven controller for controlling operation of the convection system and the vent system.

The inventions listed as Groups I-II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons.

The special technical features of Group I include re-circulation ducting defining a re-circulation gas flow path for flow of gas from the at least one first exhaust to the at least one first outlet for re-circulating gas from the oven chamber back to the oven chamber, a blower for moving gas in the re-circulation ducting from the at least one first exhaust to the at least one first outlet, a heater for heating the re-circulating gas, a vent fan for delivering gas to the oven chamber for creating positive gas pressure in the oven chamber, at least one second outlet downstream from the vent fan for delivering gas from the vent fan to the oven chamber, the at least one second outlet being connected to the oven chamber for gas flow from the at least one second outlet directly to the oven chamber, and vent ducting defining a vent gas flow path from the vent fan to the at least one second outlet, the vent gas flow path being separate from the re-circulation gas flow path; venting gas from the oven chamber through a vent flue by gas pressure created by the vent fan blowing the gas into the oven chamber through the at least one second outlet, wherein blowing the gas into the oven chamber through the at least one second outlet comprises operating the vent fan to blow gas along a vent flow path extending from the vent fan to the at least one second opening separate from the re-circulation flow path (which is not present in Group II).

The special technical features of Group II include a convection oven for proofing and baking dough, the oven comprising: a cooking chamber sized and shaped for receiving dough to be proofed and baked, an oven controller for controlling operation of the convection system and the vent system to proof and bake dough in sequence in the cooking chamber, and a tangible storage medium having oven controller executable instructions stored thereon, said instructions, when executed by the oven controller, executing a proof and bake operation in the cooking chamber including: a proofing step during which the convection system maintains a proofing temperature in the cooking chamber for proofing the dough, a baking step after the proofing step during which the convection system maintains a baking temperature in the cooking chamber for baking the dough, and a transition phase between the proofing and baking steps including: a first active venting step during which the venting system actively vents moisture laden gas out of the cooking chamber for decreasing the humidity in the cooking chamber, a temperature ramping step during which the convection system increases the temperature in the cooking chamber to a maximum temperature greater than the proofing temperature, and a second active venting step during which the venting system actively vents moisture laden gas out of the cooking chamber for decreasing the humidity in the cooking chamber; and a second temperature ramping step during which the convection system increases the temperature in the cooking chamber to a maximum temperature greater than the maximum temperature of the first temperature ramping step (which is not present in Group I).

The common technical features of Groups I-II include a convection oven comprising: an oven chamber for receiving food to be cooked therein, at least one first outlet for delivering gas to the oven chamber, at least one first exhaust for exhausting gas from the oven chamber, a blower for moving gas, a heater for heating the gas, a vent fan venting gas from the oven chamber.

These common technical features are disclosed by US 2013/0243923 A1 (DUKE): a convection oven comprising: an oven chamber (11) for receiving food to be cooked therein, at least one first outlet (65; figure 4) for delivering gas to the oven chamber, at least one first exhaust (69; figure 3) for exhausting gas from the oven chamber, a blower (61) for moving gas, a heater (71) for heating the gas, a vent fan (431; figure 1) venting gas from the oven chamber.

Because the common technical features are disclosed by DUKE, the inventions are not so linked as to form a single general inventive concept. Therefore, Groups I-II lack unity.