ABSTRACT

In certain embodiments of the present disclosure, a refrigerator is described. The refrigerator includes a single temperature sensor associated with a freezer compartment that is separate from an ice compartment and electrically connected to an electronic control system.
REFRIGERATOR TEMPERATURE CONTROL METHOD AND APPARATUS

FIELD OF THE INVENTION

[0001] The present disclosure relates to a temperature control method and apparatus for a refrigerator.

BACKGROUND OF THE INVENTION

[0002] A known bottom freezer refrigerator includes a freezer storage compartment (freezer compartment) disposed below a fresh food storage compartment (fresh food compartment). In the known bottom freezer refrigerator, a temperature of an interior volume of the freezer compartment is generally maintained at or below a standard freezing point temperature of water (e.g., at or below 0 degrees Celsius), while a temperature of an interior volume of the fresh food compartment is generally maintained above the standard freezing point temperature of water (e.g., above 0 degrees Celsius).

[0003] Convenience necessitates that when a bottom freezer refrigerator includes an ice maker, the ice maker delivers ice through an opening in a door of the fresh food compartment, rather than an opening in a door of the freezer compartment. As such, the ice maker in a bottom freezer refrigerator in which ice is to be delivered through the door is typically located in an ice compartment in the fresh food compartment.

[0004] Such an arrangement suffers from certain disadvantages. In particular, an ice compartment temperature sensor is necessary to sense the ice compartment temperature while a separate freezer compartment temperature sensor to sense the freezer compartment temperature is also necessary.

[0005] Accordingly, a control system that eliminates the necessity for temperature sensors in both the ice compartment and freezer compartment would be beneficial. A refrigerator incorporating such a control system would be particularly useful.

BRIEF DESCRIPTION OF THE INVENTION

[0006] Aspects and advantages of the disclosure will be set forth in part in the following description, or may be obvious from the description, or may be learned through practice of the disclosure.

[0007] In certain embodiments of the present disclosure, a refrigerator is described. The refrigerator includes a refrigerator cabinet, a fresh food compartment disposed within the cabinet, a freezer compartment disposed within the cabinet, and an ice compartment disposed within the cabinet. The ice compartment is separate from the freezer compartment. The refrigerator further includes an electronic control system that can monitor and control temperature in the fresh food compartment, the freezer compartment, and the ice compartment. In addition, the refrigerator includes a fresh food compartment temperature sensor associated with the fresh food compartment and electrically connected to the electronic control system and a single temperature sensor associated with the freezer compartment and ice compartment and electrically connected to the electronic control system.

[0008] In yet other embodiments of the present disclosure, a method for adjusting the temperature of a refrigerator is described. The method includes adjusting the temperature of the refrigerator. The refrigerator includes a refrigerator cabinet, a fresh food compartment disposed within the cabinet, a freezer compartment disposed within the cabinet, and an ice compartment disposed within the cabinet. The ice compartment is separate from the freezer compartment. The refrigerator further includes an electronic control system that can monitor and control temperature in the fresh food compartment, the freezer compartment, and the ice compartment. In addition, the refrigerator includes a fresh food compartment temperature sensor associated with the fresh food compartment and electrically connected to the electronic control system and a single temperature sensor associated with the freezer compartment and ice compartment and electrically connected to the electronic control system.

DETAILED DESCRIPTION OF THE INVENTION

[0016] The present disclosure relates to refrigerator temperature control. The present disclosure describes a control system that eliminates the necessity for temperature sensors in both the ice compartment and freezer compartment. Reference now will be made in detail to embodiments of the invention, one or more examples of which are illustrated in the drawings. Each example is provided by way of explanation of the invention, not limitation of the invention. In fact, it will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the scope or spirit of the invention. For instance, features illustrated or described as part of one embodiment can be used with another embodiment to yield a still further embodiment. Thus, it is intended that the present invention covers such modifications and variations as come within the scope of the appended claims and their equivalents.

[0017] FIG. 1 is a front view of a refrigerator 100 including an ice-dispensing assembly 110 for dispensing water and/or ice. In the exemplary embodiment, ice-dispensing assembly
110 includes a dispenser 114 positioned on an exterior portion of refrigerator 100. Refrigerator 100 includes a housing 120 defining an upper refrigerator compartment 122 and a lower freezer compartment 124 arranged at the bottom of refrigerator 100. As such, refrigerator 100 is generally referred to as a bottom mount refrigerator. In the exemplary embodiment, housing 120 also defines a mechanical compartment (not shown). Mechanical compartment can receive a sealed cooling system (shown in FIG. 3). It is recognized, however, that the herein described principles and features may apply to other conventional refrigerators. Consequently, the description set forth herein is for illustrative purposes only and is not intended to limit the invention in any aspect. [0018] Refrigerator doors 128 are rotatably hinged to an edge of housing 120 for accessing refrigerator compartment 122. A freezer door 130 is arranged below refrigerator doors 128 for accessing freezer compartment 124. In the exemplary embodiment, freezer door 130 is coupled to a freezer drawer (not shown) slidably coupled within freezer compartment 124. [0019] In the exemplary embodiment, dispenser 114 includes a discharging outlet 132 for accessing ice and water. A single paddle 134 is mounted below discharging outlet 132 for operating dispenser 114. A control panel 136 is provided for controlling the mode of operation. For example, control panel 136 includes a water dispensing button (not labeled) and an ice-dispensing button (not labeled) for selecting a desired mode of operation. [0020] Discharging outlet 132 and paddle 134 are an external part of dispenser 114, and are mounted in a concave portion 138 defined in an outside surface of refrigerator door 128. Concave portion 138 is positioned at a predetermined elevation convenient for a user to access ice or water enabling the user to access ice without the need to bend-over, and without the need to access freezer compartment 124. In the exemplary embodiment, concave portion 138 is positioned at a level that approximates the chest level of a user. [0021] FIG. 2 is a perspective view of refrigerator 100 having doors 128 in an open position. As such, the various components of ice dispensing assembly 110 are illustrated. Ice-dispensing assembly 110 includes an insulated housing 142 mounted within refrigerator compartment 122 along an upper surface 144 of compartment 122 and along a sidewall 146 of compartment 122. Insulated housing 142 includes insulated walls 148 defining an insulated cavity (not shown). Due to the insulation which encloses cavity, the temperature within the cavity can be maintained at levels different from the ambient temperature in the surrounding refrigerator compartment 122. In the exemplary embodiment, insulated cavity is constructed and arranged to operate at a temperature to facilitate producing and storing ice. Alternatively, insulated housing 142 could be operated as a food storage compartment at higher or lower temperatures than that of the surrounding refrigerator compartment 122, to function for example as a quick chill or a quick thermo compartment. [0022] Ice-dispensing assembly 110 includes dispenser 114 coupled to refrigerator door 128. As illustrated in FIG. 2, dispenser 114 is arranged within refrigerator door 128, and particularly, is arranged along an inner edge 148 of refrigerator door 128. Additionally, dispenser 114 is positioned a distance from a top of refrigerator door 128. Distance is variable selected to orient dispenser 114 with respect to insulated housing 142 when refrigerator door 128 is in a closed position. Specifically, as will be described in more detail below, dispenser 114 is positioned proximate to and vertically below a portion of insulated housing 142 when door 128 is in the closed position such that ice is delivered from insulated housing 142 into dispenser 114 and to a user. Moreover, in the exemplary embodiment, a refrigerator control panel 153 is coupled to an interior of the refrigerator door 128 generally vertically above dispenser 114. Specifically, control panel 153 partially fills the space above dispenser 114, and as such, more space is available in refrigerator compartment 122. [0023] In the exemplary embodiment, dispenser 114 includes an inlet 154, an ice discharge conduit or chute 156, and a chute door 158 moveable between an open position and a closed position for passing ice therethrough. Chute 156 is in communication with inlet 154 and discharging outlet 132 outside refrigerator door 128 (shown in FIG. 1). In use, ice enters chute 156 through inlet 154 and is channeled through chute 156 to outlet 132 upon activation of paddle 134 (shown in FIG. 1). In the exemplary embodiment, chute door 158 is positioned at a bottom portion of chute 156, near first outlet 132 (shown in FIG. 1), and is opened upon activation of paddle 134. Ice entering chute 156 upon activation of paddle 134 is dispensed through chute door 158 and first outlet 132. [0024] In the exemplary embodiment, an ice-storage container 160 is movably received in insulated housing 142. A discharge opening 162 is defined through the bottom of ice-storage container 160. Discharge opening 162 is substantially aligned and in communication with inlet 154 of the door mounted portion of ice-dispensing assembly 110. In the exemplary embodiment, discharge opening 162 includes an access door 164 moveable between an open position and a closed position. When open, access door 164 provides access to ice-storage container 160 for discharging crushed or cubed ice from ice-storage container 160. As such, crushed or cubed ice produced and housed within insulated housing 142 is dispensed to an external portion of refrigerator 100 through discharge opening 162 and chute 156 of dispenser 114. [0025] In the exemplary embodiment, dispenser 114 includes a water tank (not shown) for storing a predetermined amount of water therein. Water tank is also in communication with discharging outlet 132 (shown in FIG. 1) such that water can be dispensed through refrigerator door 128. [0026] FIG. 3 is a schematic view of a sealed cooling system 310. A cooling duct 312 extends between insulated housing 142 and freezer compartment 124. Cooling air from freezer compartment 124 is channeled into insulated housing 142 via cooling duct 312, thus cooling insulated housing 142 to a predetermined temperature. A cooling duct fan 314 associated with the ice compartment is coupled to cooling duct 312 to channel air therethrough. Cooling duct fan 314 is optionally also be utilized to circulate air in the freezer compartment 124 and replace a dedicated circulation fan (not shown) for this purpose. Additionally, a secondary cooling duct (not shown) extends between freezer compartment 124 and refrigerator compartment 122 such that cold air from freezer compartment 124 is channeled into refrigerator compartment 122 for cooling refrigerator compartment 122. [0027] A return duct 500 filters air from insulated housing 142 back to freezer compartment 124. In accordance with the present disclosure, a temperature sensor 248 can be present adjacent to return duct 500 for determining the temperature of insulated housing 142 and freezer compartment 124 as described in further detail herein. [0028] FIG. 4 is a schematic view of a control system 320 applicable to refrigerator 100 (shown in FIG. 1). Control system 320 includes a controller 322, such as a microproces-
sor, for controlling the operation of refrigerator 100 by directing energy to the various electrical components of refrigerator 100. Controller 322 receives signals from inputs such as, for example, control panel 136, water sensor 240, a door switch sensor 324 for determining when a door such as refrigerator door 128 is open, and temperature sensor 248, for determining the temperature in insulated housing (shown in FIG. 2) and freezer compartment as well as fresh food temperature sensor (not shown) positioned within the refrigerator compartments of refrigerator 100. Controller 322 could also receive signals from other inputs associated with refrigerator 100 including ambient temperature, ambient humidity, or the like. Moreover, controller 322 is operatively coupled to the cooling system 210 and ice-dispensing assembly 110, whereby, certain functions are performed in response to signals received from these inputs.

In the exemplary embodiment, controller 322 operates cooling system 210 based on inputs from control panel 136. Specifically, control panel 136 includes a user operable interface and display 326 for receiving inputs from and displaying data to a user. For example, a user selects an operating temperature or related setting for freezer compartment 122, refrigerator compartment 124 and/or insulated housing 142. Such setting is displayed on control panel 136. Additionally, such input is transmitted to controller 322 and controller 322 operates cooling system 210 to achieve the selected temperature within the various compartments 124, 122 and/or insulated housing 142.

In this regard, controller 322 can receive a signal from temperature sensor 248 indicating the freezer compartment 124 temperature. Advantageously, controller 322 can initiate cooling duct fan 314 associated with ice compartment (depicted in FIG. 3) which results in air flow via return duct 500 from insulated housing 142 to freezer compartment 124. Controller 322 can receive a signal from temperature sensor 248 while fan 314 is running indicating insulated housing 142 temperature. In accordance with the present disclosure, only temperature sensor 248 is needed to determine the temperature of both freezer compartment 124 and insulated housing 142.

Moreover, controller 322 can operate cooling system 210 and/or ice-dispensing assembly 110 based on inputs from door switch sensor 324. Specifically, when door switch sensor 324 determines that a door, such as refrigerator door 128, is in the open position, controller 322 changes the mode of operation of cooling system 210. For example, cooling system 210 ceases operation in response to refrigerator door 128 being in the open position. Alternatively, cooling system 210 operates in a power save mode when refrigerator door 128 is open. In the exemplary embodiment, controller 322 changes the mode of operation of ice-dispensing assembly 110 when door switch sensor 324 determines that refrigerator door 128 is in the open position. Additionally, ice making and/or ice dispensing from ice-dispensing assembly 110 cease when refrigerator door 128 is open.

In this regard, controller 322 can cease operating the icebox fan 314 if a freezer compartment temperature reading is required. Alternatively, controller 322 can initiate the icebox fan 314 if an insulated housing temperature reading is required. Typically, controller 322 can regularly cycle between readings for freezer compartment and insulated housing.

In the exemplary embodiment, controller 322 operates cooling system 210 and/or ice-dispensing assembly 110 based on inputs from temperature sensor 248. When temperature sensor 248 determines that a temperature in insulated housing 142 is above a preset temperature, controller 322 changes the mode of operation of cooling system 210. For example, controller 322 activates cooling system when the temperature is above a preset temperature. Additionally, when temperature sensor (not shown) determines that a temperature in refrigerator compartment 122 is below a preset temperature, such as, for example, a temperature at approximately a freezing temperature, controller 322 changes the mode of operation of cooling system.

Referring to FIG. 5, four signals in a test refrigerator built with certain aspects of the present disclosure are illustrated. The signals indicate ice compartment actual temperature, freezer compartment actual temperature, the single temperature sensor associated with the freezer compartment and ice compartment, and the fan associated with the ice compartment. When the fan associated with the ice compartment 314 is off, the temperature reading of the single temperature sensor associated with the freezer compartment and ice compartment tracks the reading of the freezer compartment actual temperature. When the fan associated with the ice compartment 314 is on, the temperature reading of the single temperature sensor associated with the freezer compartment and ice compartment tracks the reading of the ice compartment actual temperature. If the controller 322 needs to determine the temperature of the freezer compartment when the fan associated with the ice compartment is on, the controller 322 will turn off the fan associated with the ice compartment for a short period of time. After the controller 322 receives the temperature of the freezer compartment, the controller 322 will control the fan associated with the ice compartment according to the control logic. If the controller 322 needs to determine the temperature of the ice compartment when the fan associated with the ice compartment is off, the controller 322 will turn on the fan associated with the ice compartment for a short period of time. After the controller 322 receives the temperature of the ice compartment, the controller 322 will control the fan associated with the ice compartment according to the control logic. Therefore, controller 322 uses a dual sampling speed to determine the temperature of freezer compartment and the temperature of the ice compartment using this single temperature sensor associated with the freezer compartment and ice compartment.

In alternative embodiments of the present disclosure, air diverted from a main freezer evaporator fan can be utilized to chill the ice box versus a separate ice box fan. A damper system as would be understood by one of ordinary skill in the art can be located on the supply duct and can be opened to cool the ice box and closed when the ice box reaches a desired temperature. The damper would be closed to determine the freezer temperature and opened to read the ice box temperature utilizing a single temperature sensor in connection with a control algorithm as described herein.

This written description uses examples to disclose the invention, including the best mode, and also to enable any person skilled in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they include
structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal languages of the claims.

What is claimed is:

1. A refrigerator, comprising:
a refrigerator cabinet;
a fresh food compartment disposed within the cabinet;
a freezer compartment disposed within the cabinet;
an ice compartment disposed within the cabinet, the ice compartment being separate from the freezer compartment;
an electronic control system associated with the refrigerator and adapted to monitor and control temperature in the fresh food compartment, the freezer compartment, and the ice compartment;
a fresh food compartment temperature sensor associated with the fresh food compartment and electrically connected to the electronic control system; and
a single temperature sensor associated with the freezer compartment and ice compartment and electrically connected to the electronic control system.

2. A refrigerator as in claim 1, further comprising a fan associated with the ice compartment, wherein the temperature sensor associated with the freezer compartment and ice compartment is adapted for sensing the freezer compartment temperature when the fan associated with the ice compartment is on.

3. A refrigerator as in claim 1, further comprising a fan associated with the ice compartment, wherein the temperature sensor associated with the freezer compartment and ice compartment is adapted for sensing the freezer compartment temperature when the fan associated with the ice compartment is off.

4. A refrigerator as in claim 1, further comprising a fan associated with the ice compartment, wherein the electronic control system is adapted to actuate the fan associated with the ice compartment on when the control system needs to determine the ice compartment temperature when the fan associated with the ice compartment is off.

5. A refrigerator as in claim 1, further comprising a fan associated with the ice compartment, wherein the electronic control system is adapted to actuate the fan associated with the ice compartment off when the control system needs to determine the freezer compartment temperature when the fan associated with the ice compartment is on.

6. A refrigerator as in claim 1, wherein the temperature sensor associated with the freezer compartment and ice compartment is located in the freezer compartment.

7. A refrigerator as in claim 6, further comprising a return duct in communication between the ice compartment and the freezer compartment, wherein the temperature sensor is positioned adjacent to the return duct.

8. A refrigerator as in claim 1, wherein the temperature sensor associated with the freezer compartment and ice compartment is located in the return duct between the ice compartment and the freezer compartment.

9. A refrigerator as in claim 8, wherein the temperature sensor is positioned adjacent to the freezer compartment.

10. A refrigerator as in claim 1, wherein the electronic control system utilizes dual sampling speeds to track both ice compartment temperature and freezer compartment temperature.

11. A method for adjusting the temperature of a refrigerator, comprising:
adjusting the temperature of the refrigerator, the refrigerator comprising:
a refrigerator cabinet;
a fresh food compartment disposed within the cabinet;
a freezer compartment disposed within the cabinet;
an ice compartment disposed within the cabinet, the ice compartment being separate from the freezer compartment;
an electronic control system associated with the refrigerator and adapted to monitor and control temperature in the fresh food compartment, the freezer compartment, and the ice compartment;
a fresh food compartment temperature sensor associated with the fresh food compartment and electrically connected to the electronic control system; and
a single temperature sensor associated with the freezer compartment and ice compartment and electrically connected to the electronic control system.

12. A method as in claim 11, further comprising a fan associated with the ice compartment, wherein the temperature sensor associated with the freezer compartment and ice compartment is adapted for sensing the ice compartment temperature when the fan associated with the ice compartment is on.

13. A method as in claim 11, further comprising a fan associated with the ice compartment, wherein the temperature sensor associated with the freezer compartment and ice compartment is adapted for sensing the freezer compartment temperature when the fan associated with the ice compartment is off.

14. A method as in claim 11, further comprising a fan associated with the ice compartment, wherein the electronic control system is adapted to actuate the fan associated with the ice compartment on when the control system needs to determine the ice compartment temperature when the fan associated with the ice compartment is off.

15. A method as in claim 11, further comprising a fan associated with the ice compartment, wherein the electronic control system is adapted to actuate the fan associated with the ice compartment off when the control system needs to determine the freezer compartment temperature when the fan associated with the ice compartment is on.

16. A method as in claim 11, wherein the temperature sensor associated with the freezer compartment and ice compartment is located in the freezer compartment.

17. A method as in claim 16, further comprising a return duct in communication between the ice compartment and the freezer compartment, wherein the temperature sensor is positioned adjacent to the return duct.

18. A method as in claim 11, wherein the temperature sensor associated with the freezer compartment and ice compartment is located in the return duct between the ice compartment and the freezer compartment.

19. A method as in claim 18, wherein the temperature sensor is positioned adjacent to the freezer compartment.

20. A method as in claim 11, wherein the electronic control system utilizes dual sampling speeds to track both ice compartment temperature and freezer compartment temperature.