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Ye et al.

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(54) **REFRIGERATOR**

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F25D 17/04 (2006.01)
F25D 17/06 (2006.01)
F25D 29/00 (2006.01)

(52) **U.S. Cl.**

CPC ***F25D 17/042*** (2013.01); ***F25D 17/062*** (2013.01); ***F25D 29/005*** (2013.01)

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CPC F25D 17/042; F25D 17/062; F25D 29/005; F25D 25/025; F25D 11/00; F25D 23/00; F25D 2317/0415

See application file for complete search history.

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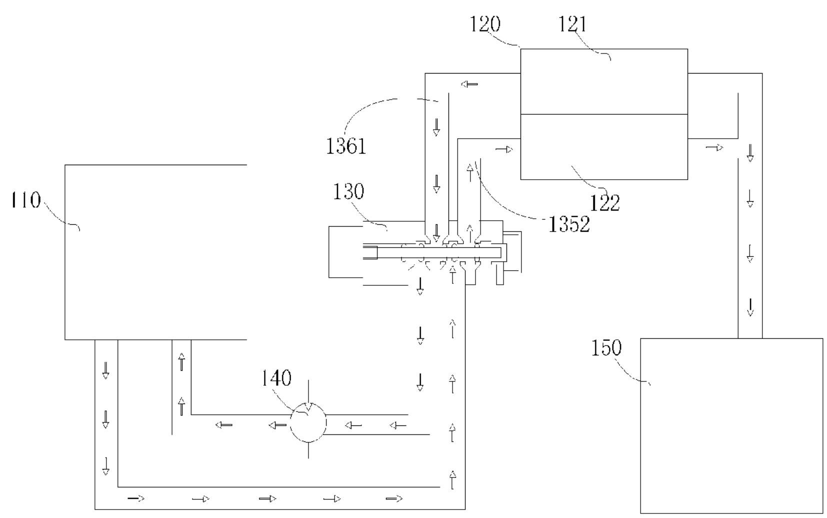
(57) **ABSTRACT**

A refrigerator is provided. The refrigerator includes a first fresh-preservation chamber, one or more adsorption towers, a valve, and an air pump. An air inlet of the air pump is in communication with the first fresh-preservation chamber, an air outlet of the air pump is in communication with an air inlet of each of the one or more adsorption towers through an air inlet channel of the valve, and the air inlet of each of the one or more adsorption towers is in communication with the first fresh-preservation chamber through an air outlet channel of the valve.

15 Claims, 7 Drawing Sheets



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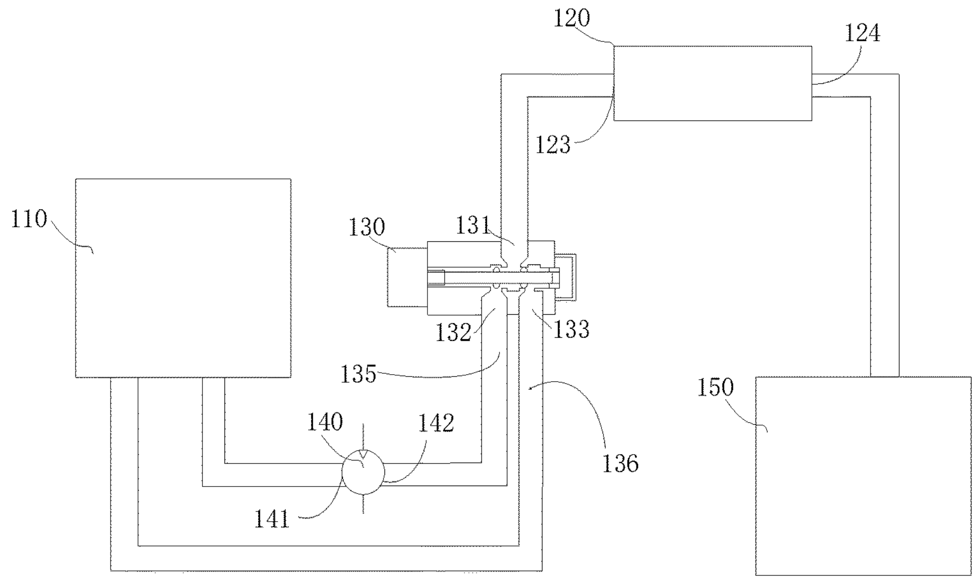
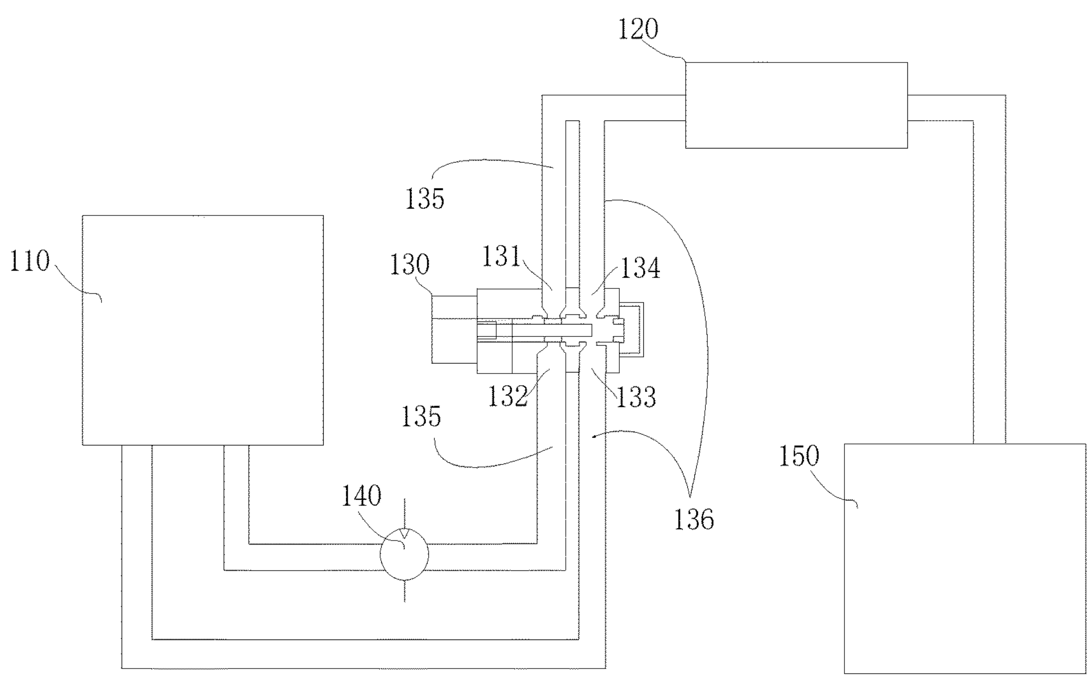

120
124
123
110
130
131
132
133
135
136
140
142
141
150

FIG. 1


120
135
110
130
131
134
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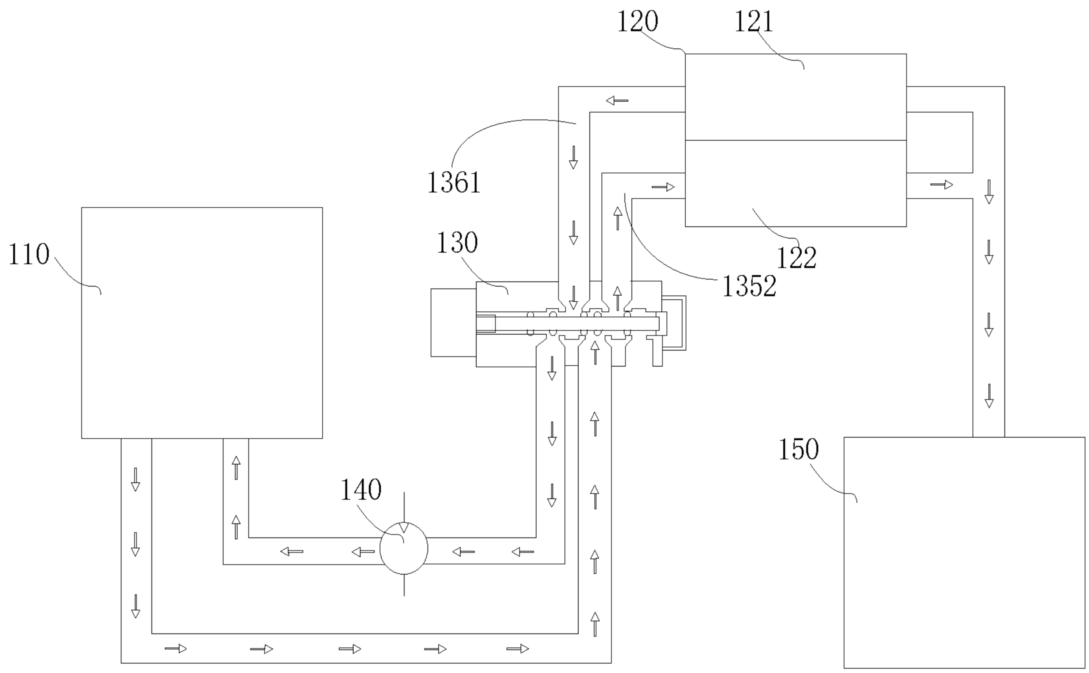
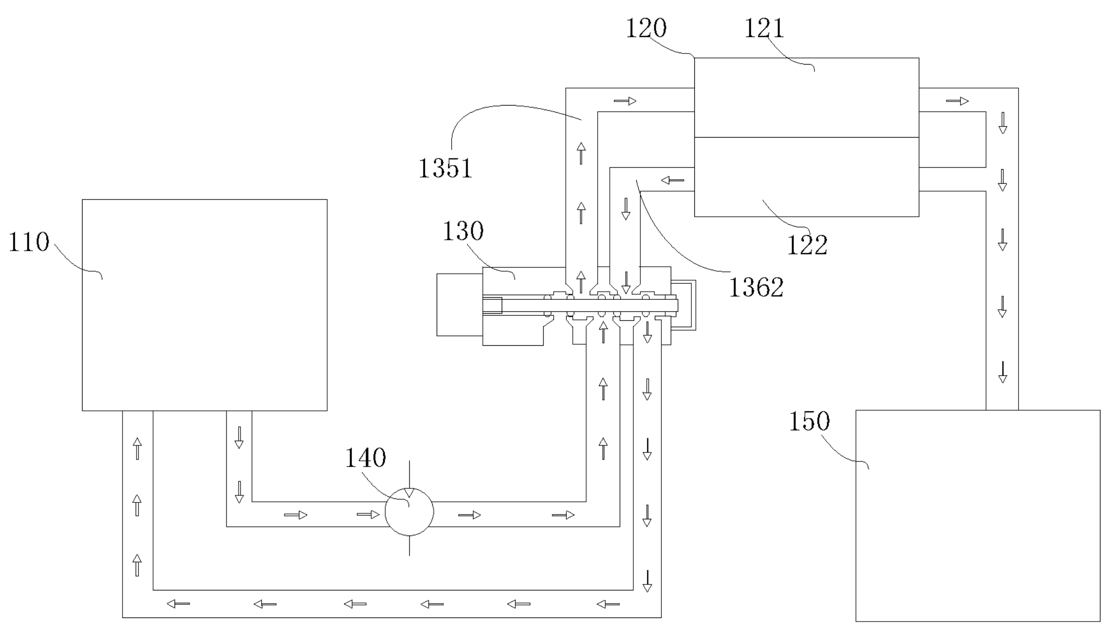
135
140
136
150

FIG. 2



120
121
1361
110
130
1352
122
140
150

FIG. 3



120
121
1351
110
130
122
1362
140
150

FIG. 4

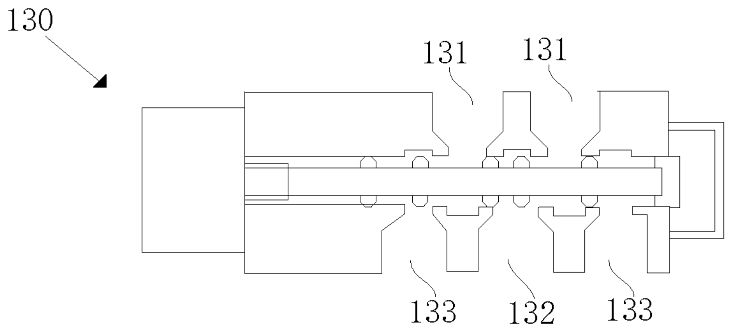


FIG. 5

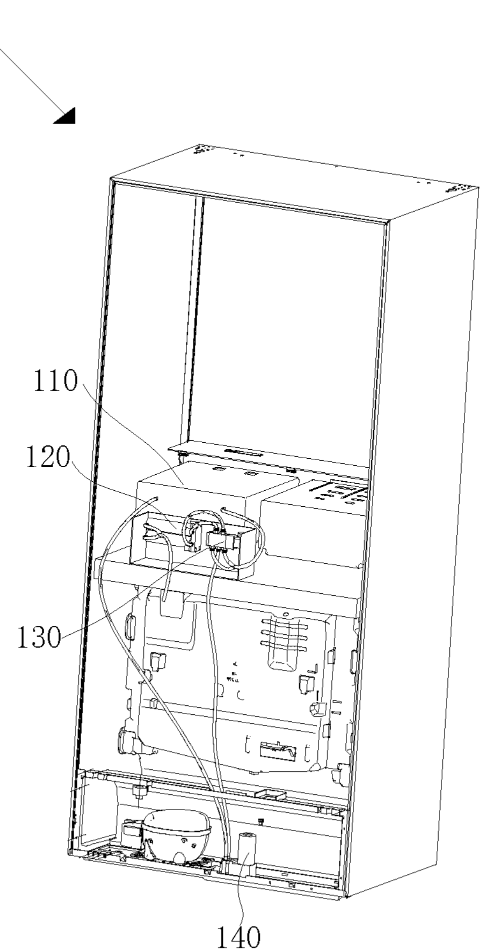


FIG. 6

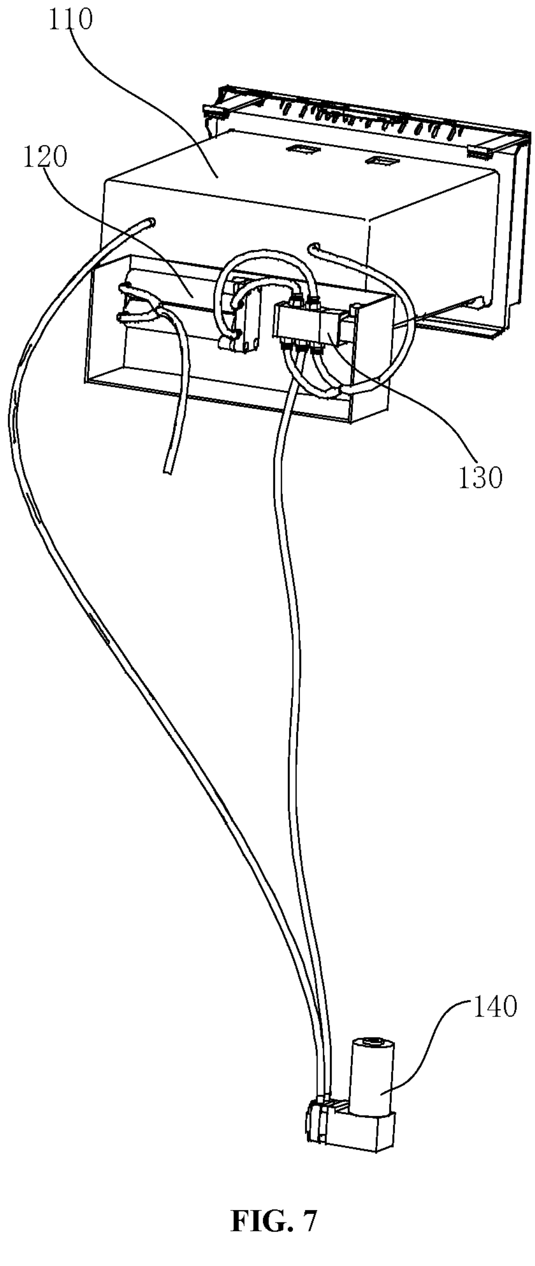


FIG. 7

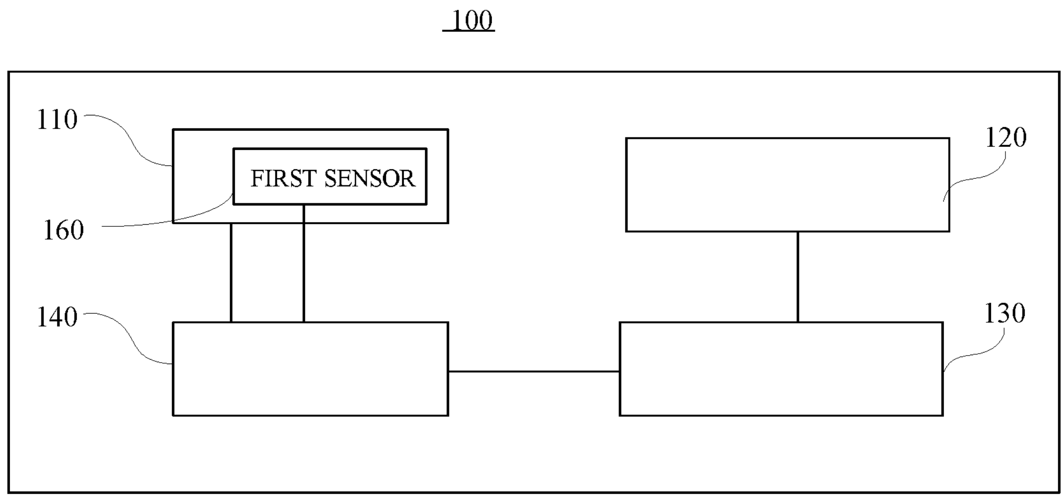

100
110
FIRST SENSOR
160
120
140
130

FIG. 8

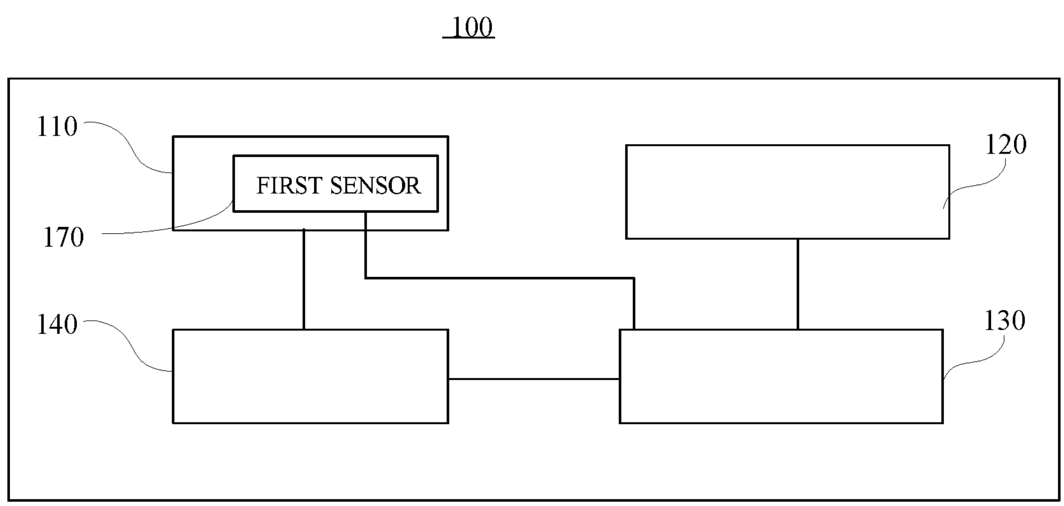

100
110
FIRST SENSOR
170
120
140
130

FIG. 9

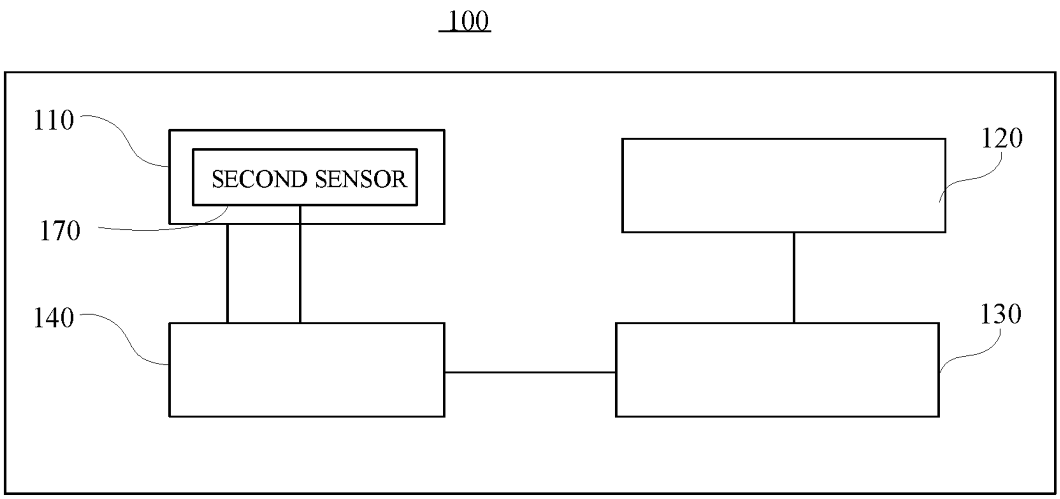

100
110
SECOND SENSOR
170
120
140
130

FIG. 10

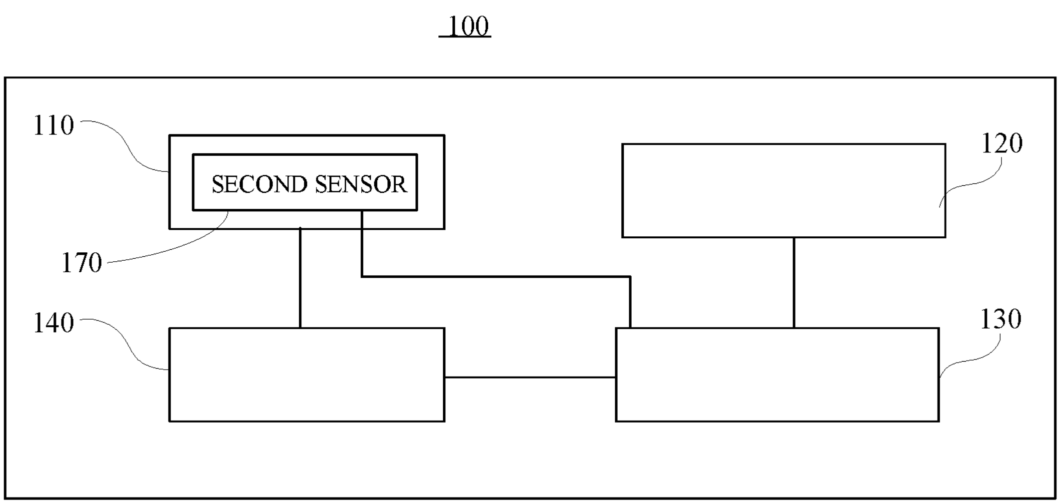

100
110
SECOND SENSOR
170
120
140
130

FIG. 11

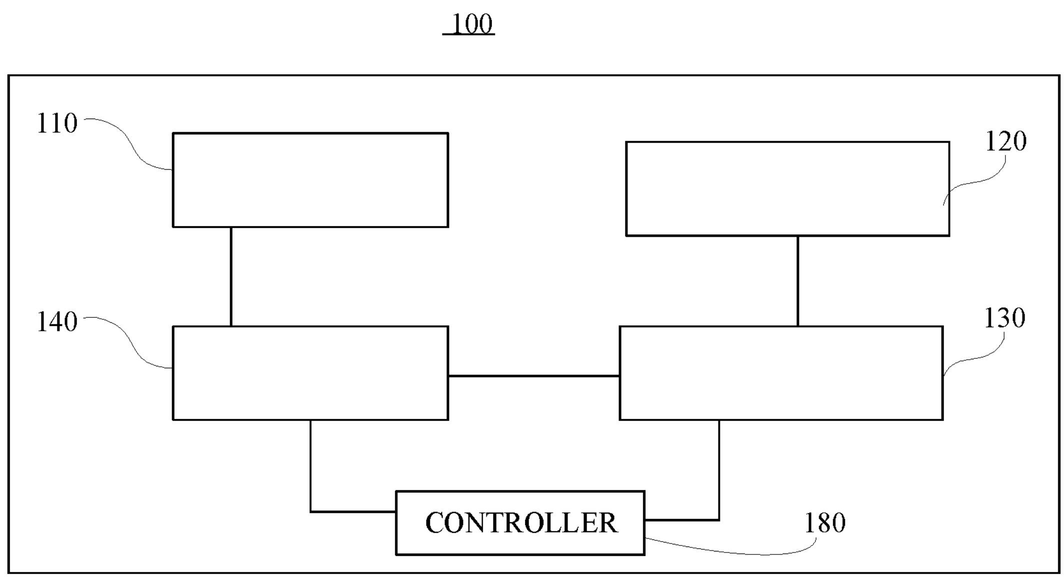


FIG. 12

REFRIGERATOR

CROSS REFERENCE

The application is a continuation of PCT International Patent Application No. PCT/CN2020/134690, filed on Dec. 8, 2020, entitled "Refrigerator," which claims priority to Chinese Patent Application No. 201911339640.4, filed on Dec. 23, 2019, the contents of which are herein incorporated by reference in their entireties.

TECHNICAL FIELD

The present disclosure relates to the field of home appliances, and in particular to a refrigerator.

BACKGROUND

During a long-distance transportation and storage, in order to keep fruits and vegetables fresh, a technology of reducing oxygen and filling with nitrogen for a fresh preservation has been widely used at home and abroad. However, in the field of home appliances, the technology has not been effectively used due to technical limitations, for example, an oxygen content is not significantly reduced.

SUMMARY

In some embodiments, a refrigerator in which an oxygen content is significantly reduced in a first fresh-preservation chamber of the refrigerator is provided.

According to an aspect of the present disclosure, a refrigerator is provided. The refrigerator includes a first fresh-preservation chamber, one or more adsorption towers, a valve, and an air pump. An air inlet of the air pump is in communication with the first fresh-preservation chamber, an air outlet of the air pump is in communication with an air inlet of each of the one or more adsorption towers through an air inlet channel of the valve, and the air inlet of each of the one or more adsorption towers is in communication with the first fresh-preservation chamber through an air outlet channel of the valve. In response to the air inlet channel of the valve being opened, the air pump is configured to pressurize air in the first fresh-preservation chamber, and transmit the air to each of the one or more adsorption towers, each of the one or more adsorption towers is configured to filter out oxygen in the air, the oxygen is discharged from an air outlet of each of the one or more adsorption towers, and residual gas is adsorbed by each of the one or more adsorption towers. In response to the air inlet channel of the valve being closed, the air pump is configured to stop pressurizing the air and transmitting the air to each of the one or more adsorption towers, the residual gas is released by each of the one or more adsorption towers, and discharged to the first fresh-preservation chamber through the air inlet of each of the one or more adsorption towers and the air outlet channel of the valve.

In some embodiments, the one or more adsorption towers include at least two adsorption towers, and the at least two adsorption towers include a first adsorption tower and a second adsorption tower. The valve defines a first air inlet channel and a first air outlet channel corresponding to each first adsorption tower, and defines a second air inlet channel and a second air outlet channel corresponding to each second adsorption tower. The valve is alternately switched between a state that the first air inlet channel is opened while the second air inlet channel of the valve is closed and a state that the first air inlet channel is closed while the second air inlet channel is opened.

In some embodiments, the one or more adsorption towers include two adsorption towers, and the valve is a two-position five-way solenoid valve.

In some embodiments, the at least two adsorption towers are arranged side by side, and all of the air inlets of the adsorption towers are arranged to face a same direction.

In some embodiments, each of the one or more adsorption towers is arranged with a zeolite molecular sieve particle, and a particle size of the zeolite molecular sieve particle is in a range from 0.4 mm to 0.8 mm. A pressure pressurized by the air pump on the air is in a range from 0.12 MPa to 0.2 MPa.

In some embodiments, a ratio of a transmission flow of the air pump per second to a volume of each of the one or more adsorption towers is in a range from 1.2 to 2.2.

In some embodiments, a shape of each of the one or more adsorption towers is substantially cylindrical, a diameter of each of the one or more adsorption towers is in a range from 20 mm to 30 mm, and a height of each of the one or more adsorption towers is in a range from 150 mm to 300 mm. a transmission flow of the air pump is in a range from 5 L/min to 15 L/min.

In some embodiments, the refrigerator further includes a second fresh-preservation chamber. The air outlet of each of the one or more adsorption towers is in communication with the second fresh-preservation chamber.

In some embodiments, the first fresh-preservation chamber is arranged with a first sensor, and the first sensor is configured to detect the oxygen content of the first fresh-preservation chamber and is connected to the air pump.

In some embodiments, the first fresh-preservation chamber is arranged with a second sensor, and the second sensor is configured to detect whether the first fresh-preservation chamber is opened and is connected to the air pump.

In some embodiments of the present disclosure, an adsorption state or desorption state of the adsorption tower may be controlled by an operation of the valve and the air pump. When the adsorption tower is in the adsorption state, the adsorption tower may be configured to filter out the oxygen in the air, the oxygen may be discharged from the air outlet of the adsorption tower, and the residual gas may be adsorbed by the adsorption tower. When the adsorption tower is in the desorption state, the residual gas may be released by the adsorption tower, and discharged into the first fresh-preservation chamber through the air inlet of the adsorption tower and the air outlet channel of the valve. The air in the first fresh-preservation chamber may be extracted and filtered out, and the residual gas from which the oxygen is removed may be returned, thereby reducing the oxygen content of the first fresh-preservation chamber. In other words, the oxygen content of the first fresh-preservation chamber may be effectively reduced by the air pump, the valve, and the adsorption tower, such that the fresh preservation is achieved by means of controlling the oxygen, thereby improving a fresh-preservation effect. Further, a total air content of the first fresh-preservation chamber may also be reduced, such that the air in the first fresh-preservation chamber may be in a negative pressure state, thereby achieving the fresh preservation by means of the negative pressure. Thus, double fresh-preservation effect may be achieved by means of controlling the oxygen and the negative pressure.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to more clearly describe the technical solutions in the embodiments of the present disclosure or the related art, the drawings that need to be used in the description of the embodiments or the related art will be briefly described in the following. Apparently, the drawings in the following description are only some embodiments of the present disclosure. For those skilled in the art, other drawings can be obtained based on these drawings without creative work.

FIG. **1** is a schematic structural view of a refrigerator according to some embodiments of the present disclosure.

FIG. **2** is a schematic structural view of the refrigerator according to other embodiments of the present disclosure.

FIG. **3** is a schematic structural view of a working state of the refrigerator according to still other embodiments of the present disclosure.

FIG. **4** is a schematic structural view of another working state of the refrigerator according to still other embodiments of the present disclosure.

FIG. **5** is a schematic structural view of a valve of the refrigerator according to other embodiments of the present disclosure.

FIG. **6** is a perspective schematic view of the refrigerator according to yet other embodiments of the present disclosure.

FIG. **7** is a partial structural schematic view of the refrigerator shown in FIG. **6**.

FIG. **8** is a schematic structural view of a refrigerator according to other embodiments of the present disclosure.

FIG. **9** is a schematic structural view of a refrigerator according to other embodiments of the present disclosure.

FIG. **10** is a schematic structural view of a refrigerator according to other embodiments of the present disclosure.

FIG. **11** is a schematic structural view of a refrigerator according to other embodiments of the present disclosure.

FIG. **12** is a schematic structural view of a refrigerator according to other embodiments of the present disclosure.

DETAILED DESCRIPTION

The technical solutions in the embodiments of the present disclosure will be clearly and completely described below in conjunction with the accompanying drawings in the embodiments of the present disclosure. It is clear that the embodiments described are only a part of the embodiments of the present disclosure, and not all of them. Based on the embodiments in the present disclosure, other embodiments obtained by those skilled in the art without creative work fall within the scope of the present disclosure.

As shown in FIG. **1**, a refrigerator **100** includes a first fresh-preservation chamber **110**, an adsorption tower **120**, a valve **130**, and an air pump **140**. An air inlet **141** of the air pump **140** is in communication with the first fresh-preservation chamber **110**, an air outlet **142** of the air pump **140** is in communication with an air inlet **123** of the adsorption tower **120** through an air inlet channel **135** of the valve **130**, and the air inlet **123** of the adsorption tower **120** is in communication with the first fresh-preservation chamber **110** through an air outlet channel **136** of the valve **130**. When the air inlet channel **135** of the valve **130** is opened, the air pump **140** is configured to pressurize air in the first fresh-preservation chamber **110**, and further transmit the air to the adsorption tower **120**. In this case, the adsorption tower **120** may be configured to filter out oxygen in the air, the oxygen is discharged from an air outlet **124** of the adsorption tower **120**, and residual gas is adsorbed by the adsorption tower **120**. When the air inlet channel **135** of the valve **130** is closed, the air pump **140** is configured to stop pressurizing the air and transmitting the air to the adsorption tower **120**. In this case, the residual gas is released by the adsorption tower **120**, and residual gas discharged into the first fresh-preservation chamber **110** through the air inlet **123** of the adsorption tower **120** and the air outlet channel **136** of the valve **130**.

In a fresh-preservation process of the refrigerator **100** according to some embodiments of the present disclosure, the air in the first fresh-preservation chamber **110** is extracted and the oxygen is filtered out, and the residual gas from which the oxygen is removed is returned to the first fresh-preservation chamber **110**. In this way, an oxygen content of the first fresh-preservation chamber **110** may be reduced, such that a fresh preservation may be achieved by means of controlling the oxygen. Furthermore, a total air content of the first fresh-preservation chamber **110** may also be reduced, such that the air in the first fresh-preservation chamber **110** may be in a negative pressure state, thereby achieving the fresh preservation by means of the negative pressure. Thus, double fresh-preservation effect may be achieved by means of controlling the oxygen and the negative pressure.

In some embodiments, the valve **130** includes the air inlet channel **135** and the air outlet channel **136**, and the air inlet channel **135** and the air outlet channel **136** are arranged separately, thus the valve **130** includes at least three ports. As shown in FIG. **1**, the at least three ports include a first port **131**, a second port **132**, and a third port **133**. The first port **131** of the valve **130** is in communication with the air inlet **123** of the adsorption tower **120**. The second port **132** of the valve **130** is in communication with the air outlet **142** of the air pump **140**. The air inlet channel **135** is defined between the first port **131** and the second port **132** of the valve **130**, such that the air outlet **142** of the air pump **140** is in communication with the air inlet **123** of the adsorption tower **120** through the air inlet channel **135** of the valve **130**. In addition, the third port **133** of the valve **130** is in communication with the first fresh-preservation chamber **110**. The air outlet channel **136** is defined between the third port **133** of the valve **130** and the first port **131** of the valve **130**, such that the air inlet **123** of the adsorption tower **120** is in communication with the first fresh-preservation chamber **110** through the air outlet channel **136** of the valve **130**. In this case, an air flow direction may be switched via the valve **130**.

In another embodiment, as shown in FIG. **2**, the valve **130** may include four ports, and the four ports may be the first port **131**, the second port **132**, the third port **133**, and a fourth port **134**. The air inlet **123** of the adsorption tower **120** is in communication with the first port **131** and the fourth port **134**. The second port **132** of the valve **130** is in communication with the air outlet **142** of the air pump **140**. The air inlet channel **135** is defined between the first port **131** of the valve **130** and the second port **132** of the valve **130**. The third port **133** of the valve **130** is in communication with the first fresh-preservation chamber **110**. The air outlet channel **136** is defined between the fourth port **134** of the valve **130** and the third port **133** of the valve **130**. In this way, the air flow direction may be switched only by switching open/close states of the air inlet channel **135** and the air outlet channel **136** of the valve **130**, thereby controlling an inflow and outflow of the air in the first fresh-preservation chamber **110**.

The number of the adsorption towers **120** is at least two. Oxygen in the air in the first fresh-preservation chamber **110** may be continuously discharged by at least two adsorption towers **120**, and the residual gas adsorbed by the adsorption tower **120** may be continuously desorbed to the first fresh-preservation chamber **110**, thus, the oxygen content of the first fresh-preservation chamber **110** may be controlled at a high efficiency and low time-consumption. In some embodiments, the at least two adsorption towers **120** may include a first adsorption tower **121** and a second adsorption tower **122**.

Accordingly, the valve **130** defines a first air inlet channel **1351** and a first air outlet channel **1361** corresponding to each first adsorption tower **121**. The valve **130** further defines a second air inlet channel **1352** and a second air outlet channel **1362** corresponding to each second adsorption tower **121**. By alternately controlling the first air inlet channel **1351** to be opened while the second air inlet channel **1352** of the valve **130** to be closed, or the first air inlet channel **1351** to be closed while the second air inlet channel **1352** to be opened, when one of the first adsorption tower **121** and the second adsorption tower **122** is adsorbing, the residual gas desorbed from the other of the first adsorption tower **121** and the second adsorption tower **122** flows into the first fresh-preservation chamber **110** through the air outlet channel **136**, thus the oxygen content of the first fresh-preservation chamber **110** may be controlled at the high efficiency and low time-consumption.

At least two first ports **131** of the valve **130** and at least two third ports **133** of the valve **130** may also be provided. The number of the first ports **131** of the valve **130** and the number of the third ports **133** of the valve **130** may be substantially equal to that of the adsorption towers **120**. The air inlet **123** of each adsorption tower **120** may be connected to one of the third ports **133**. The air outlet channel **136** is defined between each first port **131** and a corresponding one of the third ports **133**. All of the third ports **133** are in communication with the first fresh-preservation chamber **110**. In addition, the number of the second ports **132** of the valve **130** may be one, and the air inlet channel **135** may be defined between each first port **131** and the second port **132**.

In another embodiment, as shown in FIG. **3** and FIG. **4**, the number of the adsorption towers **120** may be two. The valve **130** may be a two-position five-way solenoid valve. In this way, it is easy to switch opened/closed states of the first air outlet channel **1361**, the second air outlet channel **1362**, the first air inlet channel **1351**, and the second air inlet channel **1362** of the valve **30** by the two-position five-way solenoid valve, such that working states of the two adsorption towers **120** may be switched. In this case, when the one of the first adsorption tower **121** and the second adsorption tower **122** is adsorbing, the residual gas desorbed from the another of the first adsorption tower **121** and the second adsorption tower **122** flows into the first fresh-preservation chamber **110** through the air outlet channel **136**. Thus the oxygen in the air in the first fresh-preservation chamber **110** may be continuously discharged by means of controlling an operation of the valve **130** and the air pump **140**. The residual gas adsorbed by the adsorption tower **120** may be continuously desorbed and transmitted to the first fresh-preservation chamber **110**, thereby controlling the oxygen content of the first fresh-preservation chamber **110** at the high efficiency and low time-consumption.

As shown in FIG. **5**, the two-position five-way solenoid valve may include two first ports **131**, one second port **132**, and two third ports **133**. One of the two first ports **131** is in communication with an air inlet of the first adsorption tower **121**, and the other of the two first ports **131** is in communication with an air inlet of the second adsorption tower **122**. The first air outlet channel **1361** is defined between the first port **131** connected to the air inlet of the first adsorption tower **121** and the corresponding third port **133** which is corresponding to the first port **131** connected to the air inlet of the first adsorption tower **121**. The second air outlet channel **1362** is defined between the first port **131** connected to the air inlet of the second adsorption tower **122** and the corresponding third port **133** which is corresponding to the first port **131** connected to the air inlet of the second adsorption tower **122**. All of the third ports **133** are in communication with the first fresh-preservation chamber **110**. The first air inlet channel **1351** is defined between the first port **131** connected to the air inlet of the first adsorption tower **121** and the second port **132**. The second air inlet channel **1352** is defined between the first port **131** connected to the air inlet of the second adsorption tower **122** and the second port **132**.

In the embodiment, the adsorption tower **120** may be arranged with an adsorbing substance. When the adsorbing substance arranged in the adsorption tower **120** is in an adsorption state, the adsorbing substance has an adsorption capacity in adsorbing nitrogen greater than that of the oxygen. The adsorbing substance arranged in the adsorption tower **120** may be a zeolite molecular sieve particle. A polarity of the nitrogen in the air is greater than that of the oxygen. The zeolite molecular sieve has different adsorption capacities for the oxygen and nitrogen components in the air, such that the nitrogen may be preferentially adsorbed from the air by the zeolite molecular sieve, and the oxygen in the air may be filtered out. Therefore, the air entering from the air inlet **123** of the adsorption tower **120**, adsorbed by the zeolite molecular sieve and further flowing out of the adsorption tower **120** may have the oxygen content greater than an oxygen content of the air before entering into the adsorption tower **120**, while the gas desorbed from the zeolite molecular sieve has the oxygen content obviously less than the oxygen content of the air before entering into the adsorption tower **120**. In other words, the gas desorbed from the zeolite molecular sieve is gas having a low oxygen content. The air desorbed from the zeolite molecular sieve may be further transmitted to the first fresh-preservation chamber **110**, thereby reducing the oxygen content of the first fresh-preservation chamber **110**, thus the fresh-preservation effect may be achieved. A particle size of the zeolite molecular sieve may be in a range from 0.4 mm to 0.8 mm, such as 0.5 mm, 0.6 mm, or 0.7 mm. Of course, in other embodiments, the adsorbing substance arranged in the adsorption tower **120** may be a phosphate aluminum molecular sieve.

In some embodiments of the present disclosure, the oxygen content of the first fresh-preservation chamber **110** may be controlled by means of an adsorption and desorption of the adsorption tower **120**. Since the adsorbing substance has a characteristic that the adsorption capacity increases as a partial pressure of the adsorbed component increases, the adsorption and desorption may be achieved by means of a pressure change, thereby separating the air, that is, the adsorption tower **120** may be in the adsorption state or the desorption state by changing the pressure. In some embodiments, the pressure of the air is increased by the air pump **140**, such that the air becomes compressed air, and the compressed air is in turn transmitted into the adsorption tower **120**, thereby increasing the pressure in the adsorption tower **120** in a disguised manner. Therefore, the adsorption tower **120** may be in an adsorption stage, that is, at least a part of the oxygen in the compressed air is filtered out by the adsorption tower **120**. When the compressed air is no longer transmitted to the adsorption tower **120** by the air pump **140**, the pressure in the adsorption tower **120** decreases, and the adsorption capacity of the adsorption tower **120** in adsorbing the nitrogen and other substances is reduced, thus the substance adsorbed by the adsorption tower **120** is desorbed from the adsorption tower **120**, and flows into the first fresh-preservation chamber **110** through the air inlet **123** of the adsorption tower **120** and the air outlet channel **136** of the valve **130**, that is, the residual gas desorbed from the adsorption tower **120** flows into the first fresh-preservation chamber **110**, such that the oxygen content of the first fresh-preservation chamber **110** is reduced, thereby achieving the fresh preservation by means of controlling the oxygen. Furthermore, the total air content of the first fresh-preservation chamber **110** may also be reduced, such that the air in the first fresh-preservation chamber **110** may be in the negative pressure state, thereby achieving the fresh preservation by means of the negative pressure. In this way, the double fresh-preservation effect may be achieved by means of controlling the oxygen and the negative pressure. In the embodiment, a pressure pressurized by the air pump on the air is in a range from 0.12 MPa to 0.2 MPa, according to the particle size of the zeolite molecular sieve.

The air pump **140** may be miniaturized according to a corresponding relationship between the particle size of the zeolite molecular sieve and pressurization on the air by the air pump **140**, such that a power consumption of the refrigerator **100** and a noise are reduced. If the particle size of the zeolite molecular sieve is too small, a transmission resistance of the air flow is too large. In this case, to increase the pressure appropriately, the particle size of the zeolite molecular sieve filled in the adsorption tower **120** may be uniform and moderate. For example, the particle size of the zeolite molecular sieve is set in a range from 0.4 mm to 0.8 mm, such that the air pump **140** is not required to increase excessive pressure on the air, thus the air pump **140** may be miniaturized, thereby reducing the power consumption of the refrigerator **100** and the noise.

In the embodiment, a shape of the adsorption tower **120** may be substantially cylindrical. Of course, the adsorption tower **120** may also be in other regular shapes, such as cube, cuboid. The adsorption tower **120** may also be in irregular shape.

The adsorption capacity of the adsorption tower **120** may be controlled by means of controlling a size of the adsorption tower **120**. The size of the adsorption tower **120** may be controlled in an appropriate range, thus the adsorption capacity of the adsorption tower **120** may not only be ensured, but also a volume of the adsorption tower **120** may be small. In some embodiments, a diameter of the adsorption tower **120** may be in a range from 20 mm to 30 mm. A height of the adsorption tower **120** may be in a range from 150 mm to 300 mm. Optionally, the diameter of the adsorption tower **120** may be 20 mm, 22 mm, 24 mm, 25 mm, or 27 mm. The height of the adsorption tower **120** may be 160 mm, 186 mm, 200 mm, 230 mm, or 250 mm.

A transmission flow of the air pump **140** is designed correspondingly to a small size design of the adsorption tower **120**. A contact duration between molecules in the compressed air and the adsorbing substances in the adsorption tower **120** may be changed by changing the transmission flow of the air pump **140**, thereby changing an adsorption efficiency of the adsorption tower **120** for the compressed air. If a transmission speed is too fast, the contact duration between the molecules in the compressed air and the adsorbing substance will be too short, which is not conducive to the adsorption of the air, and the adsorption efficiency is reduced. If the transmission speed is too low, the volume of the adsorption tower **120** will increase. Therefore, the transmission flow should be controlled in an appropriate range. In this embodiment, the transmission flow of the air pump **140** is in a range from 5 L/min to 15 L/min, such as 7 L/min, 9 L/min, or 11 L/min. Of course, in order to ensure the adsorption efficiency of the adsorption tower **120**, a ratio of the transmission flow of the air pump **140** per second to the volume of the adsorption tower **120** is in a range from 1.2 to 2.2.

The first fresh-preservation chamber **110** may be a sealed space, such that the air in the first fresh-preservation chamber **110** is not in communication with atmosphere. At least a part of the oxygen in the air in the first fresh-preservation chamber **110** may be removed, and the air from which the oxygen is removed is returned to the first fresh-preservation chamber **110** again. In this way, the oxygen content of the first fresh-preservation chamber **110** is reduced, thereby achieving the fresh preservation by means of controlling the oxygen. Furthermore, the total air content of the first fresh-preservation chamber **110** may also be reduced, such that the air in the first fresh-preservation chamber **110** may be in the negative pressure state, thereby achieving the fresh preservation by means of the negative pressure. Thus, the double fresh-preservation effect may be achieved by means of controlling the oxygen and the negative pressure.

The number of the first fresh-preservation chamber **110** may be one or more. The first fresh-preservation chamber **110** may be a fresh-preservation chamber configured to store food, such as vegetables, fruits, etc. The oxygen content of the first fresh-preservation chamber **110** may be controlled to a low level, such that a respiration rate of food stored in the first fresh-preservation chamber **110** may be reduced, and a metabolism of the food may be inhibited, thereby achieving the fresh-preservation effect, and thus deterioration of the food and reproduction of bacteria are inhibited.

As shown in FIG. **8** and FIG. **9**, FIG. **8** is a schematic structural view of a refrigerator according to another embodiment of the present disclosure, and FIG. **9** is a schematic structural view of a refrigerator according to another embodiment of the present disclosure. The first fresh-preservation chamber **110** may be arranged with a first sensor **160**. The first sensor **160** may be configured to detect the oxygen content of the first fresh-preservation chamber **110**. When the oxygen content of the first fresh-preservation chamber **110** detected by the first sensor **160** is greater than a first threshold, the air pump **140** and the valve **130** may be controlled, and the oxygen content of the first fresh-preservation room **110** may be cooperatively controlled by the air pump **140**, the valve **130**, and the adsorption tower **120**, so as to reduce the oxygen content of the first fresh-preservation room **110**. When the oxygen content of the first fresh-preservation chamber **110** detected by the first sensor **160** is less than a second threshold, the air pump **140** may be controlled to stop operating, that is, the oxygen content of the first fresh-preservation room **110** is no longer cooperatively controlled by the air pump **140**, the valve **130**, and the adsorption tower **120**. The first sensor **160** is connected to the air pump **140**. The first sensor **160** may be further connected to the valve **130**.

As shown in FIG. **10** and FIG. **11**, FIG. **10** is a schematic structural view of a refrigerator according to another embodiment of the present disclosure, and FIG. **11** is a schematic structural view of a refrigerator according to another embodiment of the present disclosure. The first fresh-preservation chamber **110** may be further arranged with a second sensor **170**. The second sensor **170** is configured to detect whether the first fresh-preservation chamber **110** is opened. When the second sensor **170** detects that the first fresh chamber **110** is opened, the air pump **140** and the valve **130** may be controlled, and the oxygen content of the first fresh-preservation room **110** may be cooperatively controlled by the air pump **140**, the valve **130**, and the adsorption tower **120**, so as to reduce the oxygen content of the first fresh-preservation room **110**. The second sensor **170** is connected to the air pump **140**. The second sensor **170** may be further connected to the valve **130**.

As shown in FIG. **12**, FIG. **12** is a schematic structural view of a refrigerator according to another embodiment of the present disclosure. In the embodiment, the first fresh-preservation chamber **110** further includes a controller **180**. The controller **180** may be connected to the air pump **140** and the valve **130**. The controller **180** may be configured to control the operation of the air pump **140**. Further, the controller **180** may be configured to control the opened/closed state of the air inlet channel **135** and the air outlet channel **136** of the valve **130**.

Furthermore, the controller **180** may also be connected to the first sensor **160**, and configured to receive data detected by the first sensor **160**. Of course, according to the detected data, the controller **180** may also be configured to analyze whether to control the oxygen content of the first fresh-preservation room **110** by the air pump **140**, the valve **130**, and the adsorption tower **120**. Further, according to an analysis result, the controller **180** may also be configured to control the operations of the air pump **140** and the valve **130**.

Furthermore, the controller **180** may also be connected to the second sensor **170**, and configured to receive data detected by the second sensor **170**. Of course, according to the data detected by the second sensor **170**, the controller **180** may be configured to analyze whether to control the oxygen content of the first fresh-preservation room **110** by the air pump **140**, the valve **130**, and the adsorption tower **120**. Further, according to an analysis result, the controller **180** may also be configured to control the operations of the air pump **140** and the valve **130**.

In the embodiment, an air outlet switch may also be arranged at the air outlet **124** of the adsorption tower **120**. When the adsorption tower **120** is in the adsorption state, the air outlet switch is switched on, such that gas which is not adsorbed by the adsorbing substance in the adsorption tower **120** may be discharged from the air outlet **124** of the adsorption tower **120**. When the adsorption tower **120** is in the desorption state, the air outlet switch is switched off, such that air desorbed from the adsorption tower **120** can only flow into the first fresh-preservation chamber **110** through the air inlet **123** of the adsorption tower **120** and the air inlet channel **135** of the valve **130**. Besides, it is possible to prevent outside air from entering into the adsorption tower **120** through the air outlet **124** of the adsorption tower **120**, such that it is possible to prevent the outside air from flowing into the first fresh-preservation chamber **110** together with the air desorbed from the adsorption tower **120**, thereby ensuring an efficiency of reducing the oxygen content of the first fresh-preservation chamber **110**.

In the embodiment, the refrigerator **100** further includes a second fresh-preservation chamber **150**. The air outlet **124** of the adsorption tower **120** is in communication with the second fresh-preservation chamber **150**. In other words, the second fresh-preservation chamber **150** may be configured to receive oxygen-enriched air which is discharged from the adsorption tower **120**, such that an oxygen content of the second fresh-preservation chamber **150** is increased. The second fresh-preservation chamber **150** may be configured to store meats. A fresh-preservation color of meats stored in the second fresh-preservation room **150** may be ensured to be bright by means of increasing the oxygen content of the second fresh-preservation room **150**.

As shown in FIG. **6** and FIG. **7**, specifically, the first fresh-preservation chamber **110** is disposed in the refrigerator **100** in a manner of a drawer. The adsorption tower **120** and the valve **130** are disposed at a back of the first fresh-preservation chamber **110**, that is, the adsorption tower **120** and the valve **130** are disposed at a side of the first fresh-preservation chamber **110** away from the refrigerator **100**. In this way, when the first fresh-preservation chamber **110** is opened, an impact on a position of the valve **130** and the adsorption tower **120** may be reduced, and an impact on a connection relationship among the valve **130**, the adsorption tower **120**, and the air pump **140** may also be reduced. The air pump **140** is disposed at a bottom of the refrigerator **100**. The first fresh-preservation chamber **110** is connected to the air inlet **141** of the air pump **140** by an air tube, the air outlet **142** of the air pump **140** is connected to the valve **130** by another air tube, and the adsorption tower **120** is connected to the valve **130** by an additional air tube. In this way, when the first fresh-preservation chamber **110** is opened, connections among the air inlets and the air outlets are not affected. The air tube may be a soft air tube or a rigid air tube.

Furthermore, when the number of the adsorption towers **120** is two, the two adsorption towers **120** are arranged side by side, and all of the air inlets of the adsorption towers **120** are arranged to face the same direction, such that a structure and a layout of the entire refrigerator **100** are compact.

In short, in the fresh-preservation process of the refrigerator, the air in the first fresh-preservation chamber **110** is extracted and the oxygen is filtered out, and the residual gas from which the oxygen is removed is returned to the first fresh-preservation chamber **110**. In this way, the oxygen content of the first fresh-preservation chamber **110** may be reduced, such that the fresh preservation may be achieved by means of controlling the oxygen. Furthermore, the total air content of the first fresh-preservation chamber **110** may also be reduced, such that the air in the first fresh-preservation chamber **110** may be in the negative pressure state, thereby achieving the fresh preservation by means of the negative pressure, thus double fresh-preservation effect may be achieved by means of controlling the oxygen and the negative pressure.

According to an aspect of the present disclosure, a refrigerator is provided. The refrigerator includes a first fresh-preservation chamber, one or more adsorption towers, a valve, and an air pump. An air inlet of the air pump is in communication with the first fresh-preservation chamber, an air outlet of the air pump is in communication with an air inlet of each of the one or more adsorption towers through an air inlet channel of the valve, and the air inlet of each of the one or more adsorption towers is in communication with the first fresh-preservation chamber through an air outlet channel of the valve. In response to the air inlet channel of the valve being opened, the air pump is configured to pressurize air in the first fresh-preservation chamber, and transmit the air to each of the one or more adsorption towers, each of the one or more adsorption towers is configured to filter out oxygen in the air, the oxygen is discharged from an air outlet of each of the one or more adsorption towers, and residual gas is adsorbed by each of the one or more adsorption towers. In response to the air inlet channel of the valve being closed, the air pump is configured to stop pressurizing the air and transmitting the air to each of the one or more adsorption towers, the residual gas is released by each of the one or more adsorption towers, and discharged to the first fresh-preservation chamber through the air inlet of each of the one or more adsorption towers and the air outlet channel of the valve.

In some embodiments, the one or more adsorption towers include at least two adsorption towers, and the at least two adsorption towers include a first adsorption tower and a second adsorption tower. the valve defines a first air inlet channel and a first air outlet channel corresponding to each first adsorption tower, and defines a second air inlet channel and a second air outlet channel corresponding to each second adsorption tower. The valve is alternately switched between a state that the first air inlet channel is opened while the first air inlet channel of the valve is closed and a state that the first air inlet channel is closed while the second air inlet channel is opened.

In some embodiments, the one or more adsorption towers include two adsorption towers, and the valve is a two-position five-way solenoid valve.

In some embodiments, the at least two adsorption towers are arranged side by side, and all of the air inlets of the adsorption towers are arranged to face a same direction.

In some embodiments, each of the one or more adsorption towers is arranged with a zeolite molecular sieve particle, and a particle size of the zeolite molecular sieve particle is in a range from 0.4 mm to 0.8 mm. A pressure pressurized by the air pump on the air is in a range from 0.12 MPa to 0.2 MPa.

In some embodiments, a ratio of a transmission flow of the air pump per second to a volume of each of the one or more adsorption towers is in a range from 1.2 to 2.2.

In some embodiments, a shape of each of the one or more adsorption towers is substantially cylindrical, a diameter of each of the one or more adsorption towers is in a range from 20 mm to 30 mm, and a height of each of the one or more adsorption towers is in a range from 150 mm to 300 mm. A transmission flow of the air pump is in a range from 5 L/min to 15 L/min.

In some embodiments, the refrigerator further includes a second fresh-preservation chamber. The air outlet of the air outlet of each of the one or more adsorption towers is in communication with the second fresh-preservation chamber.

In some embodiments, the first fresh-preservation chamber is arranged with a first sensor, and the first sensor is configured to detect the oxygen content of the first fresh-preservation chamber and is connected to the air pump.

In some embodiments, the first fresh-preservation chamber is arranged with a second sensor, and the second sensor is configured to detect whether the first fresh-preservation chamber is opened and is connected to the air pump.

In some embodiments, the refrigerator further includes a controller connected to the air pump and the valve.

In some embodiments, the valve includes a plurality of ports.

In some embodiments, the plurality of ports include a first port, a second port, and a third port, the air inlet channel is defined between the first port and the second port, and the air outlet channel is defined between the third port and the first port.

In some embodiments, the plurality of ports include a first port, a second port, a third port, and a fourth port, the air inlet channel is defined between the first port and the second port, and the air outlet channel is defined between the third port and the fourth port.

In some embodiments, each of the one or more adsorption towers is arranged with a phosphate aluminum molecular sieve.

In some embodiments, each of the one or more adsorption towers and the valve are disposed at a side of the first fresh-preservation chamber away from the refrigerator, and the air pump is disposed at a bottom of the refrigerator.

The above are only embodiments of the present disclosure and are not intended to limit the scope of the present disclosure. Any equivalent structural changes made under the concept of the present disclosure, using the contents of the specification of the present disclosure and the accompanying drawings, or applied directly/indirectly in other related fields of technology are included in the scope of protection of the present disclosure.

What is claimed is:

1. A refrigerator, comprising:

a first fresh-preservation chamber, one or more adsorption towers, a valve, and an air pump;

wherein an air inlet of the air pump is in communication with the first fresh-preservation chamber, an air outlet of the air pump is in communication with an air inlet of each of the one or more adsorption towers through an air inlet channel of the valve, and the air inlet of each of the one or more adsorption towers is in communication with the first fresh-preservation chamber through an air outlet channel of the valve;

in response to the air inlet channel of the valve being opened, the air pump is configured to pressurize air in the first fresh-preservation chamber, and transmit the air to each of the one or more adsorption towers, each of the one or more adsorption towers is configured to filter out oxygen in the air, the oxygen is discharged from an air outlet of each of the one or more adsorption towers, and residual gas is adsorbed by each of the one or more adsorption towers; and

in response to the air inlet channel of the valve being closed, the air pump is configured to stop pressurizing the air and transmitting the air to each of the one or more adsorption towers, the residual gas is released by each of the one or more adsorption towers, and discharged to the first fresh-preservation chamber through the air inlet of each of the one or more adsorption towers and the air outlet channel of the valve, wherein the one or more adsorption towers comprise at least two adsorption towers, and the at least two adsorption towers comprise a first adsorption tower and a second adsorption tower;

the valve defines a first air inlet channel and a first air outlet channel corresponding to each first adsorption tower, and defines a second air inlet channel and a second air outlet channel corresponding to each second adsorption tower; and

the valve is alternately switched between a state that the first air inlet channel is opened while the second air inlet channel of the valve is closed and a state that the first air inlet channel is closed while the second air inlet channel is opened.

2. The refrigerator as claimed in claim **1**, wherein the one or more adsorption towers comprise two adsorption towers, and the valve is a two-position five-way solenoid valve.

3. The refrigerator as claimed in claim **1**, wherein the at least two adsorption towers are arranged side by side, and all of the air inlets of the adsorption towers are arranged to face a same direction.

4. The refrigerator as claimed in claim **1**, wherein each of the one or more adsorption towers is arranged with a zeolite molecular sieve particle, and a particle size of the zeolite molecular sieve particle is in a range from 0.4 mm to 0.8 mm; and a pressure pressurized by the air pump on the air is in a range from 0.12 I\SPa to 0.2 MPa.

5. The refrigerator as claimed in claim **4**, wherein a ratio of a transmission flow of the air pump per second to a volume of each of the one or more adsorption towers is in a range from 1.2 to 2.2.

6. The refrigerator as claimed in claim **5**, wherein a shape of each of the one or more adsorption towers is cylindrical, a diameter of each of the one or more adsorption towers is in a range from 20 mm to 30 mm, and a height of each of the one or more adsorption towers is in a range from 150 mm to 300 mm; and

a transmission flow of the air pump is in a range from 5 L/min to 15 L/min.

7. The refrigerator as claimed in claim **1**, further comprising: a second fresh-preservation chamber;

wherein the air outlet of each of the one or more adsorption towers is in communication with the second fresh-preservation chamber.

8. The refrigerator as claimed in claim **1**, wherein the first fresh-preservation chamber is arranged with a first sensor, and the first sensor is configured to detect the oxygen content of the first fresh-preservation chamber and is connected to the air pump.

9. The refrigerator as claimed in claim **1**, wherein the first fresh-preservation chamber is arranged with a second sensor, and the second sensor is configured to detect whether the first fresh-preservation chamber is opened and is connected to the air pump.

10. The refrigerator as claimed in claim **1**, further comprising:

a controller connected to the air pump and the valve.

11. The refrigerator as claimed in claim **1**, wherein the valve comprises a plurality of ports.

12. The refrigerator as claimed in claim **11**, wherein the plurality of ports comprise a first port, a second port, and a third port, the air inlet channel is defined between the first port and the second port, and the air outlet channel is defined between the third port and the first port.

13. The refrigerator as claimed in claim **11**, wherein the plurality of ports comprise a first port, a second port, a third port, and a fourth port, the air inlet channel is defined between the first port and the second port, and the air outlet channel is defined between the third port and the fourth port.

14. The refrigerator as claimed in claim **1**, wherein each of the one or more adsorption towers is arranged with a phosphate aluminum molecular sieve.

15. The refrigerator as claimed in claim **1**, wherein each of the one or more adsorption towers and the valve are disposed at a side of the first fresh-preservation chamber away from the refrigerator, and the air pump is disposed at a bottom of the refrigerator.

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