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(54) **Refrigerator**

(57) A refrigerator is provided. The refrigerator includes a storage space (2), capable of maintaining a low-pressure state; a vacuum pump (3); an air evacuation path (4), connected between the storage space (2) and the vacuum pump (3); a bypass (5), connected to the air evacuation path (4), where when the vacuum pump (3) is in work, the bypass (5) is closed, while when the vacuum pump (3) finishes work, the bypass (5) is opened to transport external air to the air evacuation path (4); and an electromagnetic valve (7), for opening or closing the bypass (5). According to the suggestion, after the vacuum pump (3) finishes work, the electromagnetic valve (7) is powered on and opens the bypass (5); and after a preset time, the electromagnetic valve (7) is powered off, so that the bypass (5) is closed and remains closed until next time the vacuum pump (3) finishes work.

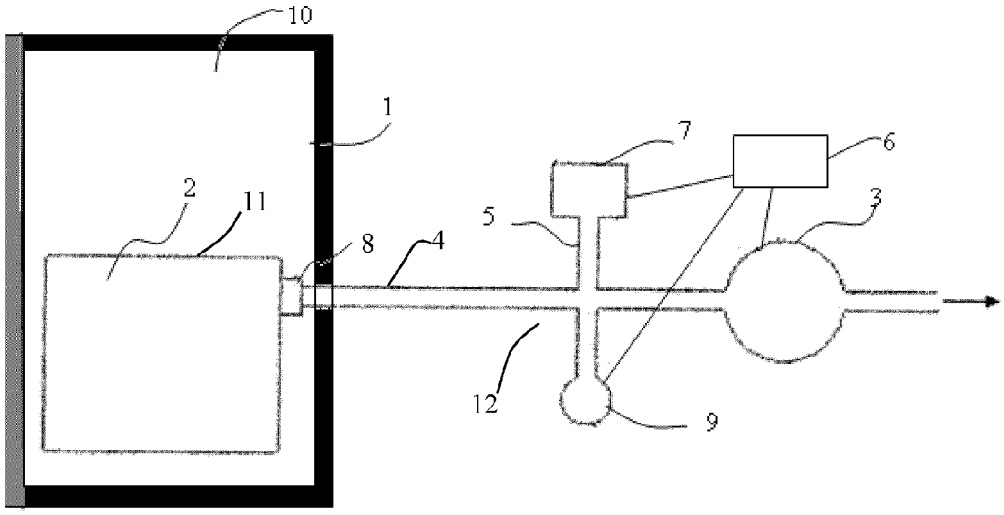


FIG. 1

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## Description

### BACKGROUND

#### Technical Field

**[0001]** The present invention relates to a refrigerator and a working method thereof, and more particularly to a refrigerator with a storage space capable of maintaining a low-pressure state and a working method thereof.

#### Related Art

**[0002]** A refrigerator capable of preserving food in a low-pressure environment is known in the prior art. Such a refrigerator generally has an evacuatable storage chamber (commonly known as a "vacuum chamber" in the industry). By extracting at least one part of air out of the storage chamber, the air content in the storage chamber is lowered, so as to weaken the oxidization process of food, thus extending the preservation time and quality of food.

**[0003]** The Chinese Invention Patent CN 101331970 B discloses a vacuum preservation system and a control method thereof. The vacuum preservation system includes a low-pressure chamber/vacuum chamber, a vacuum pump, and an air evacuation path connected between the vacuum pump and the low-pressure chamber. When the vacuum pump is in work, air in the low-pressure chamber may be extracted out through the air evacuation path. The air evacuation path has a bypass connected to external air (external atmospheric pressure), and an electromagnetic valve for controlling the opening and closing of the bypass is disposed in the bypass. When an evacuation procedure is started, first, a control circuit board issues an instruction to switch the electromagnetic valve to a closed position, then, the vacuum pump is started, and after the low-pressure chamber reaches a preset vacuum degree, the vacuum pump stops work. Next, the control circuit board issues an instruction to switch the electromagnetic valve from the closed position to an open position, so as to import external air into the air evacuation path at a certain flow rate, thereby closing a mechanical valve disposed on the low-pressure chamber with such a pressure difference.

**[0004]** In a method of powering off a normally open valve to close a bypass, a closure component of the valve moves under the action of a mechanical force, which is a very slow process, possibly causing insufficient external air to flow into the air evacuation path and failure of the mechanical valve to close instantly, thus leading to an air-return phenomenon, that is, external air enters the low-pressure chamber. Besides, after the evacuation procedure ends, pressure maintenance relies entirely on the mechanical valve of the low-pressure chamber. If the mechanical valve fails, external air will soon enter the low-pressure chamber.

### SUMMARY

**[0005]** An objective of the present invention is to resolve at least one of the foregoing technical problems, so as to provide a refrigerator with a more reliable low-pressure storage system.

**[0006]** Accordingly, in one aspect, the present invention provides a refrigerator, which includes: a storage space, capable of maintaining a low-pressure state; a vacuum pump; an air evacuation path, connected between the storage space and the vacuum pump; a bypass, connected to the air evacuation path, where when the vacuum pump is in work, the bypass is closed, while when the vacuum pump finishes work, the bypass is opened to transport external air to the air evacuation path; and an electromagnetic valve, for opening or closing the bypass, **characterized in that**, after the vacuum pump finishes work, the electromagnetic valve is powered on and opens the bypass; and after a preset time, the electromagnetic valve is powered off, so that the bypass is closed and remains closed until next time the vacuum pump finishes work.

**[0007]** After the vacuum pump finishes work, a closure component of the electromagnetic valve can be opened under the action of an electromagnetic force to instantly and completely open the bypass, so that external air can quickly enter the air evacuation path to instantly close the low-pressure storage space, avoiding the air-return phenomenon. In addition, the bypass normally remains closed; therefore, even if a valve for closing the low-pressure storage space is damaged, the normally closed bypass is capable of maintaining pressure for the entire low-pressure system to a certain extent.

**[0008]** Other individual features or features, combined with other features, regarded as characteristics of the present invention are described in the following appended claims.

**[0009]** According to a preferred embodiment of the present invention, the preset time is smaller than 30 seconds. More preferably, the preset time is 3 to 5 seconds.

**[0010]** According to a preferred embodiment of the present invention, the preset time is set by a timer.

**[0011]** In another aspect, the present invention provides a working method of a refrigerator, which includes: starting a vacuum pump, so as to extract at least one part of air out of a storage space capable of maintaining a low-pressure state via an air evacuation path connected between the vacuum pump and the storage space; and determining whether to stop the work of the vacuum pump; and if yes, stopping the work of the vacuum pump, **characterized in that**, an electromagnetic valve for opening or closing a bypass connected to the air evacuation path is powered on to open the bypass, so as to transport external air to the air evacuation path; and after a preset time, the electromagnetic valve is powered off, and the bypass remains closed until next time the vacuum pump finishes work.

**[0012]** The structure and other invention objectives

and beneficial effects of the present invention are made more comprehensible through the description of preferred embodiments with reference to the accompanying drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0013]** The following drawings, as a part of the specification and used for further understanding of the present invention, illustrate the specific embodiments of the present invention, and, together with the specification, explain the principles of the present invention, where

FIG. 1 is a schematic view of a refrigerator with an air evacuation system according to a preferred embodiment of the present invention; and

FIG. 2a and FIG. 2b are respectively schematic views of an electromagnetic valve when it is closed and opened according to a preferred embodiment of the present invention.

## DETAILED DESCRIPTION

**[0014]** Referring to FIG. 1, a refrigerator 1 has a heat insulated inner space 10. The inner space 10 may be defined by a cabinet (not shown in FIG. 1) with a heat insulation material, and may be closed or opened through a door (not shown in FIG. 1) connected to the cabinet.

**[0015]** The refrigerator 1 has a storage space 2 capable of maintaining a low-pressure state. The storage space 2 may be formed by a storage unit 11 installed in the inner space 10, or may be directly defined by the inner space 10.

**[0016]** The refrigerator 1 has an air evacuation system 12 used for extracting at least one part of air in the storage space 2 out. The air evacuation system 12 includes a vacuum pump 3 and an air evacuation path 4 connected between the storage space 2 and the vacuum pump 3. The air evacuation path 4 may be defined by at least one pipe and at least one pipe joint.

**[0017]** The air evacuation system 12 includes a mechanical valve 8 located in the air evacuation path 4 and used for preventing external air from entering the storage space 2. The mechanical valve 8 may be disposed on the storage unit 11. The mechanical valve 8 may have a deformable valve plate; under the action of an internal and external pressure difference, the valve plate deforms and closes an air evacuation channel disposed on the storage unit 11. The mechanical valve 8 may adopt an existing solution, for example, the solution disclosed in the Patent Application No. CN200910028963.1 submitted by the applicant earlier, which is not described any more herein.

**[0018]** The air evacuation system 12 includes a detection unit 9 for determining whether the storage space 2 has reached a set pressure. The detection unit 9 may include a pressure sensor for detecting air pressure.

**[0019]** In this embodiment, the detection unit 9 is connected to the air evacuation path 4, and determines pressure inside the storage space 2 by detecting pressure of the air evacuation path 4. In another embodiment, the detection unit 9 may also directly detect pressure in the storage space 2.

**[0020]** The air evacuation system 12 further includes a bypass 5 connected to the air evacuation path 4. One end of the bypass 5 is connected to the air evacuation path 4, and the other end is connected to external air, that is, atmospheric pressure. The function of the bypass 5 is that, after the vacuum pump3 finishes work, the bypass 5 is opened, and thus the atmosphere flows to the air evacuation path 4 through the bypass 5, the pressure inside the air evacuation path 4 is equal to atmospheric pressure, so a pressure difference is created between two sides of the mechanical valve 8, and the mechanical valve 8 can be closed, so as to prevent air from entering the storage space 2 from the air evacuation channel.

**[0021]** The bypass 5 is provided with an electromagnetic valve 7 used for controlling opening or closing of the bypass 5. The electromagnetic valve 7 is in work connection with a controller 6, and decides whether to open or close the bypass according to a signal of the controller 6.

**[0022]** As shown in FIG. 2a and FIG. 2b, the electromagnetic valve 7 includes an electromagnetic coil 70, a valve core 71, and a spring 72. The electromagnetic valve 7 is a normally closed valve, and the valve core 71 closes a channel 73 under the action of an elastic force of the spring 72. After power-on, the electromagnetic coil 70 is powered on, and the valve core 71 is capable of instantly displacing and opening the bypass 5 under the action of an electromagnetic force. After power-off, the electromagnetic force disappears, and the valve core 71 displaces and returns to a closed position under the action of a mechanical elastic force.

**[0023]** The refrigerator 1 includes the controller 6, where the controller 6 is in work connection with the vacuum pump 3, the electromagnetic valve 7, and the detection unit 9.

**[0024]** A working method of the air evacuation system 12 of the refrigerator 1 is described in the following in detail.

**[0025]** First, the vacuum pump 3 is started. The vacuum pump 3 may be started based on an input instruction of a user. For example, when the user operates a switch located at a proper position of the refrigerator 1, the vacuum pump 3 starts work. In another embodiment, the vacuum pump 3 may also be started through the controller 6 based on information detected by the detection unit 9 or information of a timer. In this case, the electromagnetic valve 7 is not powered on, and remains in a closed state.

**[0026]** The controller 6 determines whether to stop the work of the vacuum pump 3, and if yes, stops the work of the vacuum pump. The determination may be made based on information of the detection unit 9. For example,

it is determined, through the detection unit 9, whether the storage space 2 has reached a set vacuum degree, and if the detection unit 9 detects that the vacuum degree, that is, the pressure, inside the air evacuation path 4 reduces to a preset value, the vacuum pump 3 is stopped. In an alternative embodiment, it is also possible to stop the work of the vacuum pump after the vacuum pump works for a set time by setting a timer.

**[0027]** Next (almost simultaneously), the electromagnetic valve 7 is powered on. Under the action of the electromagnetic force, the electromagnetic valve 7 instantly and completely opens the bypass 5, external air quickly enters the air evacuation path 4, and pressure inside the air evacuation path 4 can instantly rise to the atmospheric pressure. In this embodiment, the electromagnetic valve 7 can be completely opened within less than 0.5 second after being powered on.

**[0028]** Because a relatively large pressure difference is quickly created between the air evacuation path 4 and the storage space 2, the mechanical valve 8 can be instantly closed. The air-return phenomenon (after the vacuum pump 3 finishes work, external air enters the storage space 2 from the air evacuation channel that fails to be instantly closed by the mechanical valve) can be effectively avoided, and thus the vacuum degree in the storage space 2 can be ensured.

**[0029]** After a preset time, the electromagnetic valve 7 is powered off, the valve core 71 is reset under the action of the elastic force of the spring 72 (the process takes at least 1 to 2 seconds), and the bypass 5 is closed. The bypass 5 remains closed until next time the vacuum pump 3 stops work in a next evacuation procedure.

**[0030]** Preferably, the preset time is smaller than 30 seconds. That is to say, the electromagnetic valve 7 is powered on for less than 30 seconds to close the mechanical valve 8, and then is powered off. In this embodiment, the power-on time of the electromagnetic valve 7 is 3 to 5 seconds (for example, 4 seconds). The power-on time of the electromagnetic valve 7 may be controlled through a timer in work connection with the controller 6.

## Claims

**1.** A refrigerator, comprising:

a storage space (2), capable of maintaining a low pressure state;
a vacuum pump (3),
an air evacuation path (4), connected between the storage space (2) and the vacuum pump (3);
a bypass (5), connected to the air evacuation path (4), wherein when the vacuum pump (3) is in work, the bypass (5) is closed; while when the vacuum pump (3) finishes work, the bypass (5) is opened to transport external air to the air evacuation path (4); and
an electromagnetic valve (7), for opening or closing the bypass (5),
**characterized in that**, after the vacuum pump (3) finishes work, the electromagnetic valve (7) is powered on to open the bypass (5); and after a preset time, the electromagnetic valve (7) is powered off, so that the bypass (5) is closed and remains closed until next time the vacuum pump (3) finishes work.

**2.** The refrigerator (1) according to claim 1, **characterized in that**, the preset time is smaller than 30 seconds.

**3.** The refrigerator (1) according to claim 1, **characterized in that**, the present time is 3 to 5 seconds.

**4.** The refrigerator (1) according to claim 1, 2 or 3, **characterized in that**, the preset time is set by a timer.

**5.** A working method of a refrigerator, comprising:

starting a vacuum pump (3), so as to evacuate at least a part of air out of a storage space (2) capable of maintaining a low pressure state via an air evacuation path (4) connected between the vacuum pump (3) and the storage space (2); and
determining whether to stop the work of the vacuum pump (3); and if yes, stop the work of the vacuum pump (3),
**characterized in that**, an electromagnetic valve (7) for opening or closing a bypass (5) connected to the air evacuation path (4) is powered on to open the bypass (5), so as to transport external air to the air evacuation path (4); and after a preset time, the electromagnetic valve (7) is powered off, and the bypass (5) remains closed until next time the vacuum pump (3) finishes work.

**6.** The method according to claim 5, **characterized in that**, the preset time is 3 to 5 seconds.

**7.** The method according to claim 5 or 6, **characterized in that**, the preset time is set by a timer.

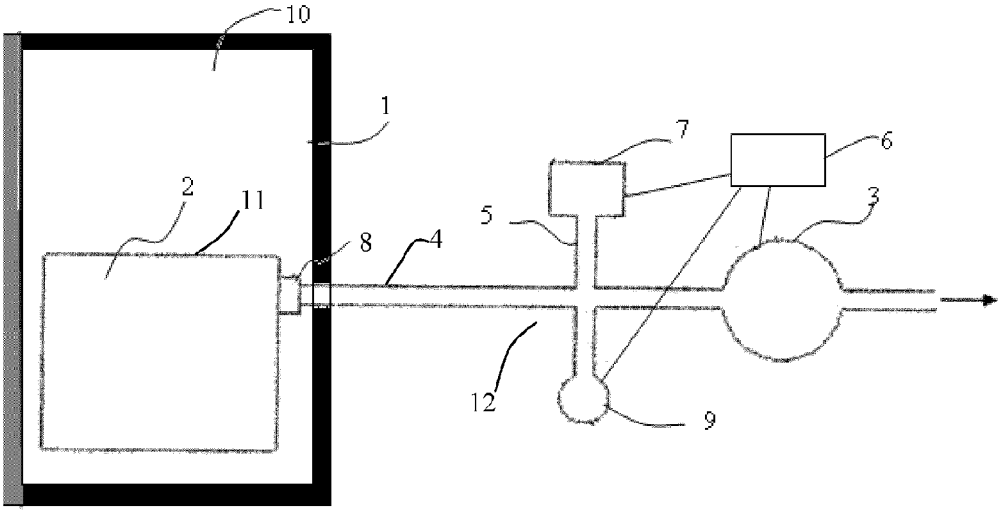


FIG. 1

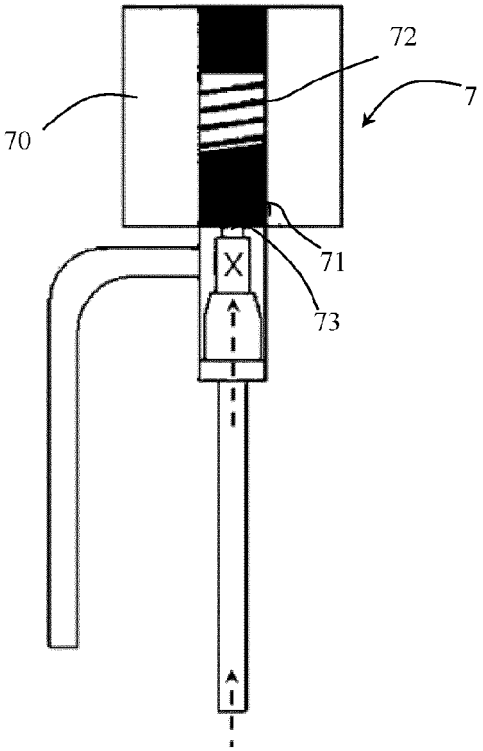


FIG. 2a

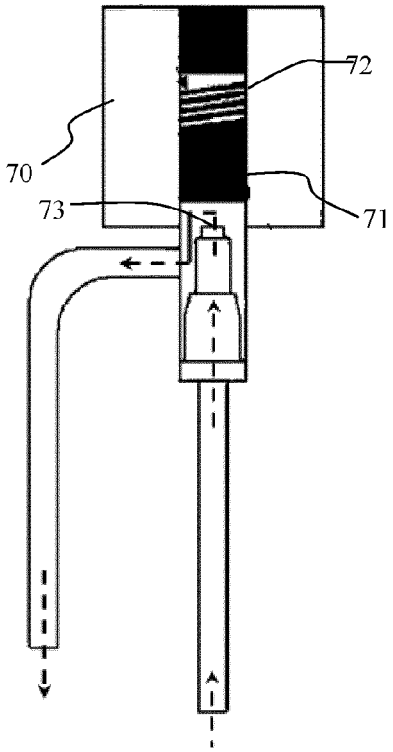


FIG. 2b

## REFERENCES CITED IN THE DESCRIPTION

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### Patent documents cited in the description


- CN 101331970 B **[0003]**
- CN 200910028963 **[0017]**