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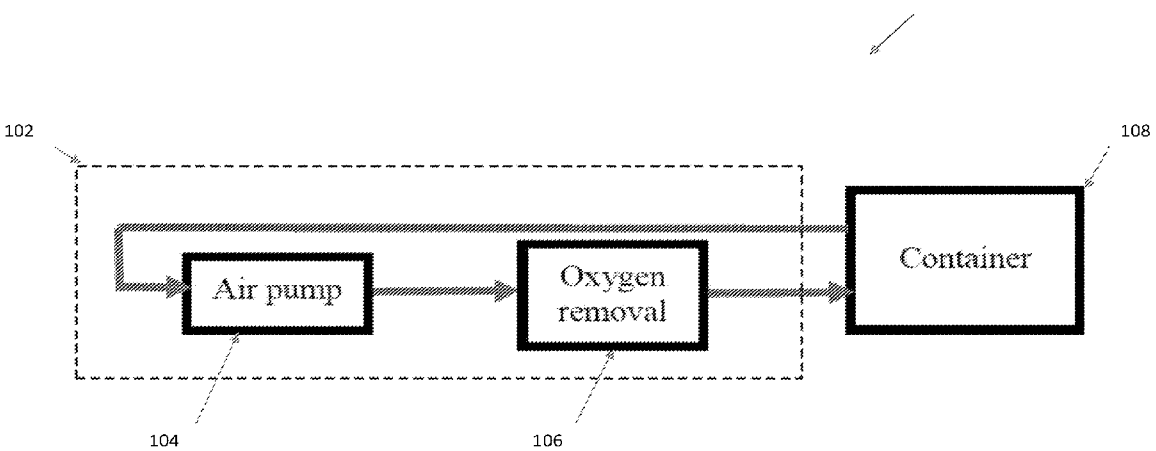
(54) Title: FOOD PRESERVATION METHOD

FIGURE 1



(57) Abstract: In some implementations, a system for removing oxygen from a container includes a recirculation pump and an oxygen removal device. The recirculation pump includes an intake and a discharge, and the intake includes a first connector. The discharge is fluidically connected to an oxygen removal device.

WO 2021/067470 A1

FOOD PRESERVATION METHOD

CLAIM OF PRIORITY

This application claims priority to U.S. Patent Application No. 62/907,904, filed on September 30, 2019, the entire contents of which are incorporated by reference in its entirety.

TECHNICAL FIELD

This invention relates to food preservation.

BACKGROUND

Today there are literally hundreds of patents describing various method or techniques for extending the life of foods and drinks. These patents typically describe three basis techniques or combinations thereof. The intent of just about all of these devices is to reduce the amount of oxygen which makes up 21% of air to which the consumable is exposed. Of course, reducing the temperature, as in refrigeration, slows down the process of bacteria growth and extends the life span of food and drinks, but is not considered is this analysis.

The first technique involves creating a vacuum. In reality, only various degrees of a partial vacuum are created. As the vacuum level is increased (lower pressure), the amount of oxygen available to react with the food or wine is decreased and the life of the material is increased. The challenges associated with this approach are that vacuum systems are expensive, containers to sustain low pressures are expensive, and only a portion of the oxygen is removed providing limited benefits. Even with a high-level vacuum capable of reducing the pressure to 5 psi absolute (approximately one-third of atmospheric pressure), only two-thirds of the oxygen has been removed. In other words, one-third of the oxygen remains.

The second technique, and by far the most popular, is to replace air (21% oxygen) with an inert gas such as nitrogen or argon. The concept around this approach is quite simple. By replacing the air (oxygen) with these inert gases, the amount of oxidation and deterioration of the consumable, is reduced. This technique is used worldwide and does indeed result in the enhanced shelf life of food and wine. Systems that significantly reduce the level of oxygen (0.1 to 1%) have extended the shelf life of wines indefinitely while food has been extended by months. However, there are many issues associated with the technique. The use of inert gas has been found to be a cost-effective means of preserving consumables on a large-scale basis, but most homes and facilities do not have easy access to these types of gases. While there are dedicated businesses already established that bottle and distribute these gases to major consumers of the gases, this method does not lend itself to the typical user because of gas delivery issues as well as the handling of the heavy high-pressure tanks in which the gases are maintained.

Finally the third approach uses chemicals to slow the deterioration of consumables. Needless to say, this is rather risky (possibility of chemicals entering the food chain) and quite costly. Consequently, the method is rarely used beyond well controlled preservatives in food and cosmetics.

SUMMARY

In some implementations, a system for removing oxygen from a container includes a recirculation pump and an oxygen removal device. The recirculation pump includes an intake and a discharge, and the intake includes a first connector. The discharge is fluidically connected to an oxygen removal device.

The system described offers many advantages over previous systems. First, excellent preservation performance as measured in extended shelf life/low oxygen levels is achievable. The performance can be delivered all along the food chain from the farm, through distribution, retail and ultimately home or retail use. This capability can be highly valued in both established as well as emerging markets. Secondly, there are no burdensome gas tanks that continually need to be refilled and/or transported. Thirdly, the final oxygen content of the container can be controlled with no intervention and held to very low levels. Fourthly, the cost can be reasonable. Finally, utilizing oxygen absorbing materials that allows for the discharge of the oxygen back into the environment is politically, commercially and environmentally correct, and very advantageous from a marketing and operational perspective.

The details of one or more embodiments of the invention are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the invention will be apparent from the description and drawings, and from the claims.

DESCRIPTION OF DRAWINGS

FIG 1 is an example food preservation system.

FIG 2 is another example of a food preservation system.

FIG 3 another example of a food preservation system

Like reference symbols in the various drawings indicate like elements.

DETAILED DESCRIPTION

FIG 1 illustrates a food preservation system 100 in accordance with some implementations of the present disclosure. In some implementations, the system 100 can generate a substantially inert gas environment. In these instances, the system 100 can slow the deterioration of the consumables that is not only cost effective but an efficient solution for oxygen removal from food and wine containers. The system 100 can be applied to any items (clothes) adversely affected by the presence of oxygen. A reduced oxygen environment can reduce mold, and its associated smell, and can reduce or eliminate insects from attacking the garment.

Currently, Europe frequently are placed in sealed containers just prior to being fruit ripening. In these instances, the fruit ripens using the trapped oxygen which is depleted, and the fruit then continues to be preserved for months, as long as the container is not opened thereby allowing oxygen to enter. The illustrated system 100 can store ripened fruit and then reduce or remove the oxygen slowing or preventing further ripening and spoilage.

As illustrated, the system 100 includes a circulating system 102 that extracts oxygen from air resulting in an inert gas or substantially inert gas in an atmospheric pressure environment. The circulating systems includes a circulating pump 104 that includes a canister 106 filled with oxygen reducing material (one time disposable or rechargeable multi use material) from which the oxygen reduced gas is pumped into the enclosed container 108 including, for example, food, bottled goods, clothes, or other items. The gas from the container 108 is then recirculated through the air pump 104 and the oxygen removal process is repeated for the specific container 108. The process can be repeated for other containers.

The system 100 include an oxygen reducing material, other techniques not yet known could be developed in the future and subsequently applied to the proposed system 100. These might be vacuum based or electric field based as examples.

The recirculation can provide multiple advantages. First, the oxygen removal in the container 108 will not be 100% efficient for any practical system. If only a portion of the oxygen is removed as it passes through the container 108, a lower limit of a final oxygen content in the container108 can be set. As an example, 60% oxygen removal can result in 8% oxygen (40% of the original 20% oxygen content in air) remaining in the container 108. Even if the oxygen removal was 90%, the gas in the container 108 can still have 2% oxygen. But recycling the oxygen deprived gas exiting the container 108 can result in a continually reduced oxygen content. Table 1 is an example that demonstrates the residual oxygen after each cycle.

	Number of Cycles				
% Oxygen Removal	1	2	3	4	5
40	12%	7.20%	4.32%	2.59%	1.56%
50	10%	5.00%	2.50%	1.25%	0.63%
60	8%	3.20%	1.28%	0.51%	0.20%
70	6%	1.80%	0.54%	0.16%	0.05%
80	4%	0.80%	0.16%	0.03%	0.01%
90	2%	0.20%	0.02%	0.00%	0.00%

Even with an oxygen absorption efficiency of only 70%, the oxygen content in the container can drop below 0.6% in, for example, 3 cycles and below 0.1% in, for example, 5 cycles.

The system 100 can be closed to more efficiently use the oxygen absorbing material. When recycling the gas through the canister 108, less oxygen is typically removed with each cycle. No matter how many times the cycle is performed, the amount of oxygen removed is from the original 20% of the container 108. That said, the container 108 may have insignificant leaks that contribute additional oxygen to the system 100. To be technically accurate, due to pressure equalization (final pressure of container to be approximately atmospheric), the amount of oxygen removed can equal to about 25% of the original volume of air.

In some implementations, the oxygen removal material (ORM) can be rechargeable. In some instances, the ORM can be treated with perhaps heat or UV so that the oxygen is released and then the ORM is reused to remove oxygen again. In these instances, the recharging can occur within the system 100.

FIG 2 is another example food preservation system 200 for automating the preservation method. As illustrated, the system 200 includes locking snap connectors 202a-d on the input and output of the container 108. In these instances, the recycling unit 102 can be quickly connected and disconnected to the container 108. The system 200 includes electronics 204 to control the operation (On/Off, timing, etc.) of the pump 104. One-way valves can be used in place of ON/OFF valves or the snap connectors 202 can be also be used. As an example, a one-way valve can be used to allow air into the system 200 as the oxygen is removed. The cost of these items is typically less than $1. The current system 200 includes a low pressure bleeder valve 206.

Proper controls could be implemented in order to optimize performance of the system 200. As an example, the system 200 can be set to run for a given period of time. With different size containers, the operator can select a container size or simply allow the system 200 to run for extended periods of time (e.g., minutes, hours) to most or all the oxygen.

FIG 3 illustrates a preservation system 300 in accordance with some implementations with the present disclosure. As illustrated, the system 300 includes an oxygen sensor, which then allows the controller to turn off the pump when the oxygen level falls below a certain level.

An indirect and more cost-effective means of monitoring the oxygen level could be through the use of a pressure sensor 302. As the oxygen level is reduced, the pressure inside the closed system/container will be reduced. Monitoring this pressure reduction, as well as the rate change in pressure, allows for an accurate determination of the oxygen content. This technique would circumvent having to know the container volume or the efficiency of the oxygen absorbing material, which could change with usage.

Table 2 is listed below and lists estimates for medium quantities, and based upon the assumption that the material used to extract oxygen from the air will be rechargeable (heat or light used to discharge the oxygen).

Items	**Cost**
Two lock connectors and stopper	$ 2.00
Two lock connectors	$ 1.50
Pump	$ 6.00
Filter housing	$ 3.00
Low pressure valve	$ 0.75
Tubing	$ 0.50
Housing	$ 5.00
Electronics/panel	$ 4.00
Oxygen absorbing material	$ 6.00
Assembly labor	$ 2.50
Total	$ 31.25

Although the systems 100-300 has been described as standalone, it should be noted that this could be a subsystem included into other systems. As an example, today's refrigerators have enclosed storage containers to store vegetables, fruits, etc. The proposed systems 100-300 can be built into the refrigerator such that when the containers are opened and subsequently closed, the oxygen reduction recirculating system 102 would be activated either manually or by sensing the closure. As the refrigerator becomes more “intelligent”, this subsystem can be built directly into and monitored by the refrigerator.

WHAT IS CLAIMED IS:

1. A system for removing oxygen from a container, the system comprising:

a recirculation pump comprising an intake and a discharge, wherein the intake comprises a first connector, and the discharge is fluidically connected to an oxygen removal device; and

the oxygen removal device comprising:

an inlet fluidically connected to the discharge of the recirculation pump;

an outlet including a second connector; and

oxygen removal material (ORM) embedded in the oxygen removal device and along a flowpath from the inlet to the outlet, wherein the ORM absorbs oxygen on contact.

2. The system of claim 1, wherein the first connector and second connector each comprise snap disconnects that prevent fluid flow when disconnected.

3. The system of claim 1, further comprising a low pressure bleeder valve fluidically connected to the inlet of the recirculation pump, wherein the low pressure bleeder valve is configured to introduce additional fluid into the system in response to a pressure in the system being below a predetermined threshold.

4. The system of claim 1, further comprising:

a first valve connected between the first connector and the recirculation pump;

a second valve connected between the second connector and the oxygen removal device;

a pressure sensor configured to sense a pressure in the system and generate a sensed pressure signal; and

a controller configured to open and close the first and second valves, and activate the recirculation pump based on a pressure signal from the pressure sensor.

5. The system of claim 1, further comprising:

an oxygen sensor configured to measure an oxygen concentration in the system.

6. The system of claim 1, wherein the ORM is a pyrogallol based material.

7. The system of claim 1, wherein the oxygen removal device further comprises:

an oxygen release system comprising:

a release path configured to permit fluid flow from the ORM out of the system; and

an energy source configured to impart energy on the ORM sufficient to cause the ORM to release scavenged oxygen.

8. The system of claim 7, wherein the energy source is ultraviolet light.

9. The system of claim 7, wherein the energy source is heat.

10. The system of claim 1 wherein, the system is integral to a containerized storage device, wherein the containerized storage device comprises one or more containers.

11. A method for removing oxygen from a container, the method comprising:

drawing fluid from the container via a recirculation pump;

passing the fluid through an oxygen removal device, wherein the fluid comes into contact with oxygen removal material (ORM) that scavenges oxygen from the fluid, resulting in an oxygen depleted fluid; and

returning the oxygen depleted fluid to the container.

12. The method of claim 11, further comprising:

in response to a pressure in the container falling below a predetermined amount, introducing new fluid to the container.

13. The method of claim 11, further comprising:

receiving an first pressure measurement associated with a pressure in the container;

determining a target pressure for the container associated with removing oxygen from the container;

opening one or more valves to allow fluid flow;

running the recirculation pump;

receiving a second pressure measurement associated with the pressure in the container;

in response to the second pressure measurement being equal to or less than the target pressure:

closing the one or more valves; and

stopping the recirculation pump.

14. The method of claim 11, further comprising:

determining a scavenging efficiency;

in response to the scavenging efficiency being below a predetermined threshold:

opening one or more valves to permit fluid flow from the ORM to an external area; and

exposing the ORM to an energy sufficient to cause the ORM to release scavenged oxygen.

15. The method of claim 14, wherein the energy is ultraviolet light.

16. The method of claim 14, wherein the energy is heat.

17. The method of claim 11, wherein the fluid comprises air, and wherein the container contains food to be preserved.

18. The method of claim 17, wherein the food is further preserved by reducing a temperature in the container.

19. The method of claim 11, wherein the ORM is a pyrogallol based material.

20. The method of claim 11, further comprising controlling a humidity within the container.

21. The method of claim 11, wherein the container is one of one or more containers that form a containerized storage device.

22. A system for removing oxygen from a container, the system comprising:

a recirculation pump comprising an intake and a discharge, wherein the intake comprises a first connector, and the discharge is fluidically connected to an oxygen removal device; and

the oxygen removal device comprising:

an inlet fluidically connected to the discharge of the recirculation pump;

an outlet including a second connector; and

an oxygen removal portion configured to remove oxygen from fluid passing from the inlet to the outlet.

23. The system of claim 22, wherein the first connector and second connector each comprise snap disconnects that prevent fluid flow when disconnected.

24. The system of claim 22, further comprising a low-pressure bleeder valve fluidically connected to the inlet of the recirculation pump, wherein the low pressure bleeder valve is configured to introduce additional fluid into the system in response to a pressure in the system being below a predetermined threshold.

25. The system of claim 22, further comprising:

a first valve connected between the first connector and the recirculation pump;

a second valve connected between the second connector and the oxygen removal device;

a pressure sensor configured to sense a pressure in the system and generate a sensed pressure signal; and a controller configured to open and close the first and second valves, and activate the recirculation pump based on a pressure signal from the pressure sensor.

26. The system of claim 22, further comprising:

an oxygen sensor configured to measure an oxygen concentration in the system.

27. The system of claim 22, wherein the oxygen removal device further comprises:

an oxygen release system comprising:

a release path configured to permit fluid flow from the oxygen removal portion of the oxygen removal device out of the system; and

an energy source configured to impart energy on the oxygen removal portion of the oxygen removal device sufficient to cause the oxygen removal portion to release scavenged oxygen.

28. The system of claim 27, wherein the energy source is ultraviolet light.

29. The system of claim 27, wherein the energy source is heat.

30. The system of claim 27, wherein the energy source is electric field.

31. The system of claim 27, wherein the energy source is vacuum.

32. The system of claim 22 wherein, the system is integral to a containerized storage device, wherein the containerized storage device comprises one or more containers.

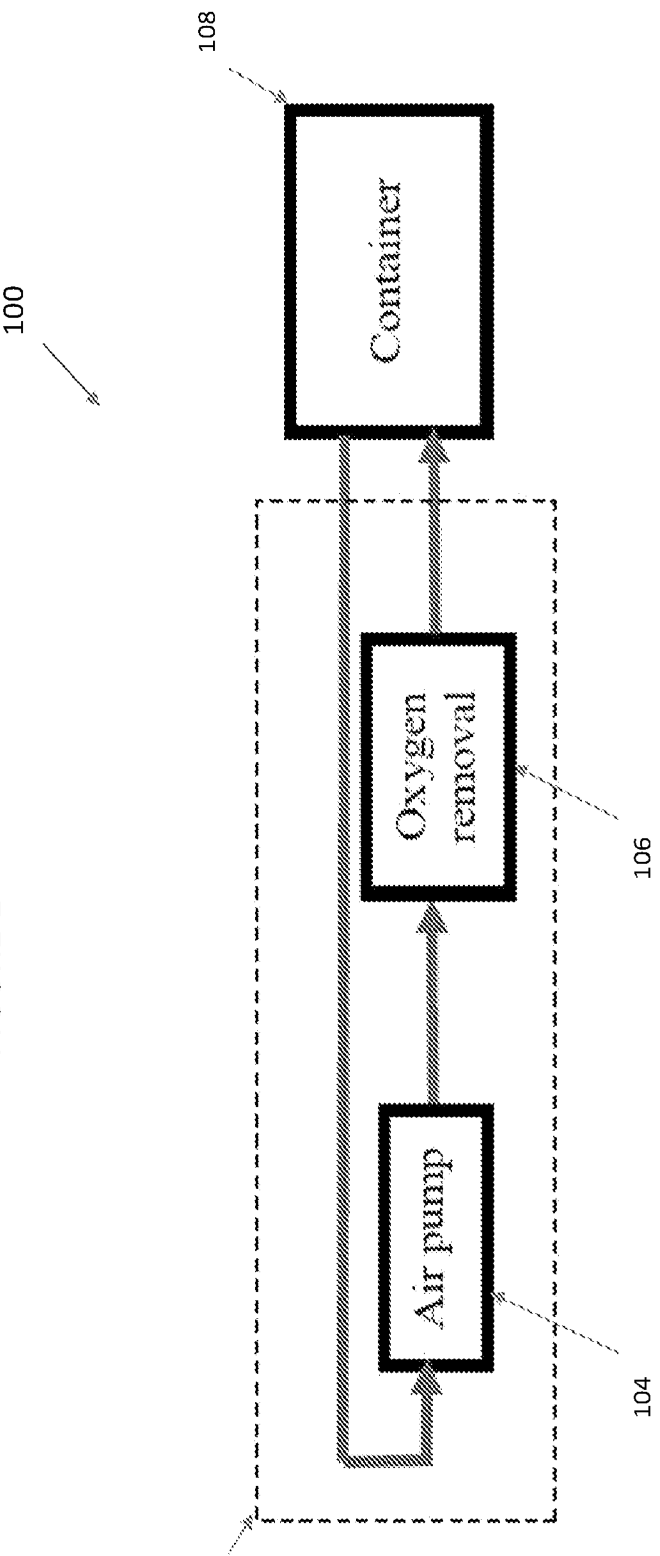
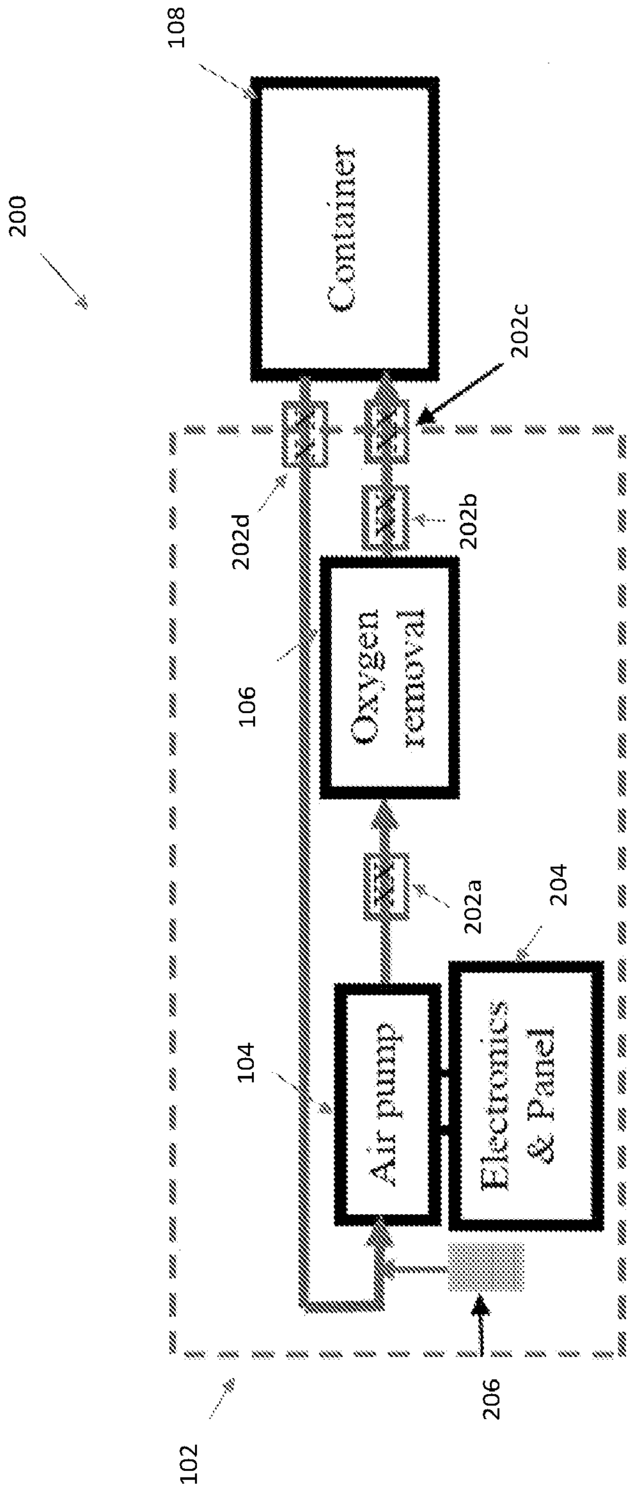


FIGURE 1

FIGURE 2


200
108
Container
202c
202d
202b
106
Oxygen removal
202a
204
104
Air pump
Electronics & Panel
206
102

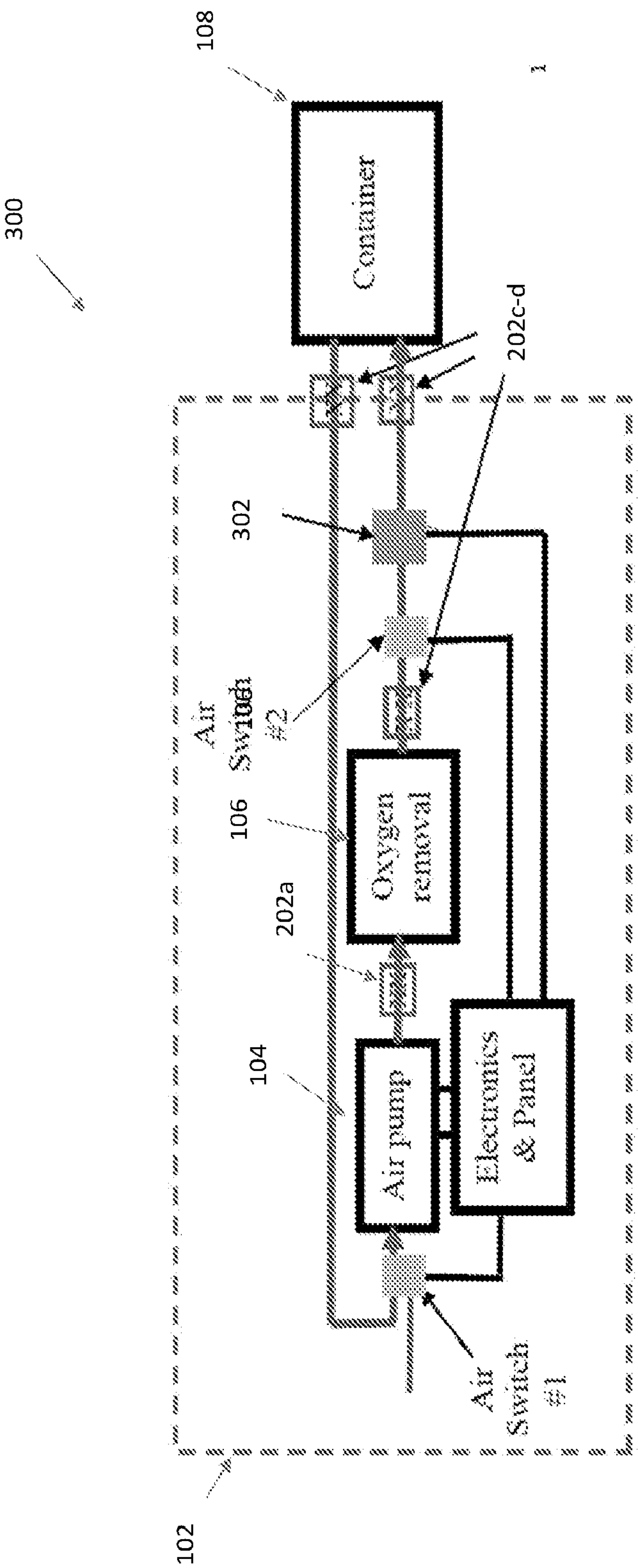

300
108
Container
202c-d
302
Air Switch #2
106
Oxygen removal
202a
104
Air pump
Electronics & Panel
Air Switch #1
102

FIGURE 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2020/053592

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - A23L 3/3418; A23L 3/3427; A23L 3/3436; B01D 53/14; B65D 81/18; B65D 81/20 (2020.01)

CPC - A23B 7/14; A23B 7/144; A23B 7/152; B01D 53/14; B65D 81/18; B65D 81/20; F04B 49/022; F04B 49/03 (2020.08)

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

see Search History document

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

see Search History document

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

see Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	CN 101322575 B (HENAN FRESTECH ELECTRIC APPLIANACE CO LTD) 12 January 2011 (12.01.2011) see machine translation and original document	1-3, 7-11, 14-18, 20-24, 27-32 --- 4-6, 12, 13, 19, 25, 26
Y	US 2018/0245835 A1 (DAIKIN INDUSTRIES LTD) 30 August 2018 (30.08.2018) entire document	4, 5, 12, 13, 25, 26
Y	JP 2015-054315 A (MITSUBISHI HEAVY IND LTD) 23 March 2015 (23.03.2015) see machine translation	6, 19
A	US 2014/0065274 A1 (BELL) 06 March 2014 (06.03.2014) entire document	1-32
A	US 6,230,614 B1 (DEL GALLO et al) 15 May 2001 (15.05.2001) entire document	1-32

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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

"&" document member of the same patent family

Date of the actual completion of the international search

06 December 2020

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