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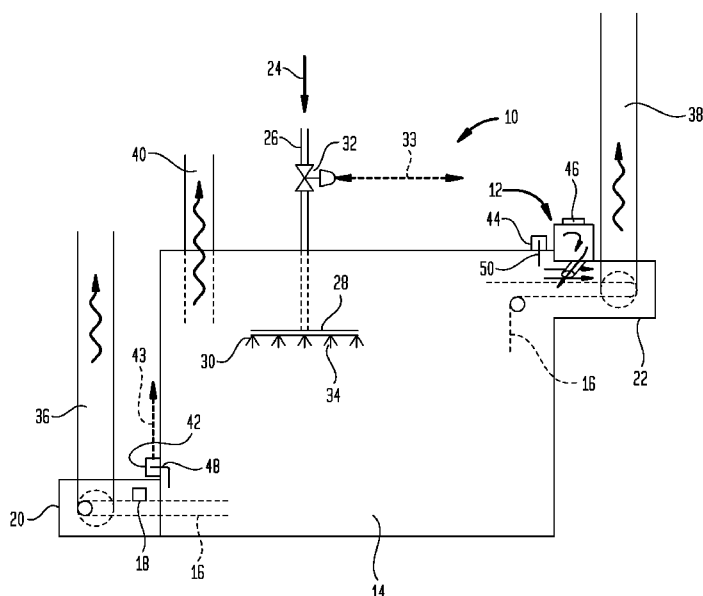
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(54) Title: CRYOGENIC EXHAUST CONTROL SYSTEM AND FREEZER HAVING SAME

FIG. 1



(57) Abstract: A freezer for a food product, includes a housing having an internal space with a processing atmosphere for reducing a temperature of the food product; and a pressure balance apparatus in communication with the processing atmosphere to restrict atmosphere external to the freezer from reaching the internal space, the pressure balance apparatus comprising at least one sensor exposed to the processing atmosphere for generating a first signal indicating an amount of oxygen (O₂) sensed at the internal space, and a blower disposed to direct a pressurized flow of the processing atmosphere to the internal space responsive to the first signal. A related method is also provided.

SPECIFICATION

CRYOGENIC EXHAUST CONTROL SYSTEM AND FREEZER HAVING SAME

BACKGROUND OF THE INVENTION

[0001] The present embodiments relate to apparatus and methods to exhaust cryogen from freezers, such as for example food freezers.

[0002] All current cryogenic food freezing systems require trained personnel to operate and adjust the freezers.

[0003] Proper balance of a cryogenic food freezing system is important, but can be difficult to maintain throughout continuous production of the food products. The term "balance" as used herein refers to an operating status wherein spent gaseous cryogen of the freezing or chilling process is exhausted or leaked from an inlet and/or an outlet of the freezer at a minimal rate in order to prevent room air (ie, atmosphere external to the freezer) from being drawn into the freezer system. When external room air is drawn into a cryogenic freezer, an additional heat load is incurred on the system resulting in an overall reduction of operating efficiency of the freezing system.

[0004] There are no known automatic methods to ensure a cryogenic freezing system stays "balanced" throughout production. Ice and snow accumulation occur in the freezing system which effect the operating conditions in the freezer and the freezer balance. To ensure maximum operating efficiency, the freezer must be constantly monitored and adjusted to maintain the necessary operating balance, especially where perishable products, such as food products are processed.

SUMMARY OF THE INVENTION

[0005] There is therefore provided a cryogenic exhaust control system which automatically balances a freezer throughout production, relieves the operator from the burden of “balancing” the freezer, and provides higher overall efficiencies for the freezing system.

[0006] In general, a cryogenic exhaust control system is provided herein which automatically balances an atmosphere of a freezer, the control system including an oxygen (O_2) monitor at a corresponding inlet and outlet of the freezer, and a balance blower installed at an outlet, an inlet, or both the outlet and inlet of the freezer which draws cold cryogenic gas from within the freezer, pressurizes the gas and reintroduces same via a nozzle across a width of the conveyor belt at the discharge outlet of the freezer. The oxygen monitor and the balance blower coact via a controller, such that when an undesirable amount of oxygen or concentration of same is sensed at the outlet (which means room air or air external to the freezer is being drawn into the freezer at the outlet), a speed of the balance blower is decreased to provide more cryogen gas to be discharged from the outlet of the freezer, thereby inhibiting room air (air external to the freezer) from entering the outlet and into the freezer. As more gas is forced into the discharge outlet of the freezer, more gas is also expelled from the inlet which similarly prevents atmosphere external to the freezer from entering the freezer through the inlet.

[0007] A similar arrangement is provided at the inlet of the freezer. The oxygen monitors are used to control the balance blower. Another balance blower of construction similar to the outlet balance blower can be positioned for use at the inlet, depending upon the conditions of the freezer, the plant in which the freezer is operated, and the products being treated by the freezer. However,

installation and use of the outlet balance blower is usually sufficient to impact conditions at the inlet, thereby obviating the need for the inlet balance blower. That is, when a higher oxygen concentration is sensed at the outlet, the balance blower speed decreases to allow more gas to discharge from the freezer at both the inlet and the outlet. The discharging gas prevents atmosphere external to the freezer at the outlet from gaining access to an interior of the freezer through the inlet and the outlet. The same principle applies at the freezer inlet. That is, when the oxygen sensor at the inlet senses that too much oxygen is being permitted entry through the freezer at the inlet, the balance blower speed is correspondingly lowered to force the gas in the freezer through the inlet to prevent the atmosphere external to the freezer from gaining access to the freezer through the inlet.

[0008] Both the inlet and the outlet are continuously monitored and the speed of the balance blower(s) adjusted, thereby maintaining the freezer atmosphere in a “balanced” condition. The system of the present embodiments can be used with many types of freezer, such as for example a spiral food freezer.

[0009] There is therefore provided herein a freezer for a food product which includes a housing having an internal space with a processing atmosphere for reducing a temperature of the food product; and a pressure balance apparatus in communication with the processing atmosphere to restrict atmosphere external to the freezer from reaching the internal space, the pressure balance apparatus comprising at least one sensor exposed to the processing atmosphere for generating a first signal indicating an amount of oxygen (O₂) sensed at the internal space, and a blower disposed to direct a pressurized flow of the processing atmosphere to the internal space responsive to the first signal.

[0010] There is also provided herein a method of balancing a processing atmosphere in an internal space of a freezer for food products, comprising sensing an amount of oxygen (O₂) becoming present in the processing atmosphere; generating a first signal indicating the amount of oxygen sensed; withdrawing a portion of the processing atmosphere and pressurizing said portion responsive to the first signal; and discharging the pressurized portion to the processing atmosphere for pressurizing said atmosphere and preventing additional O₂ from becoming present in said atmosphere.

[0011] Additional features of the present inventive embodiments are set forth in the remaining claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] For a more complete understanding of the present invention, reference may be had to the following description of exemplary embodiments considered in connection with the accompanying drawing Figures, of which:

[0013] FIG. 1 shows a side view in cross-section of a freezer having the cryogenic exhaust control system of the present embodiments; and

[0014] FIG. 2 shows an enlarged cross-sectional view of a portion of the exhaust control system in FIG. 1.

DETAILED DESCRIPTION OF THE INVENTION

[0015] Before explaining the inventive embodiments in detail, it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, if any, since the invention is capable of other embodiments and being practiced

or carried out in various ways. Also, it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

[0016] In the following description, terms such as a horizontal, upright, vertical, above, below, beneath and the like, are to be used solely for the purpose of clarity illustrating the invention and should not be taken as words of limitation. The drawings are for the purpose of illustrating the invention and are not intended to be to scale.

[0017] Referring to FIGS. 1 and 2, a freezer 10, such as by way of example only a food freezer, is provided with a cryogenic exhaust control apparatus (or pressure balance apparatus) shown generally at 12. The freezer 10 may be a spiral food freezer. The apparatus 12 includes elements positioned at different locations of the freezer 10, which elements will be described hereinafter.

[0018] The freezer 10 includes an internal space 14 or chamber through which a conveyor belt 16 transits conveying products 18 such as for example food products through the internal space for chilling and/or freezing. For the sake of brevity and clarity of FIG. 1, only a portion of the conveyor belt 16 is shown at an inlet 20 and an outlet 22 of the freezer 10. The inlet 20 and the outlet 22 are in communication with the internal space 14.

[0019] Liquid cryogen 24 is introduced into a pipe 26 which extends into the internal space 14 of the freezer 10, and to a spray bar 28 having a plurality of spray nozzles 30 mounted thereto. A modulating control valve 32 is positioned in the pipe 26 to control the introduction of the liquid cryogen 24 to the spray bar 28 and the nozzles 30. The control valve 32 can transmit and receive (transeive) a valve signal 33 which indicates its actuated position in the pipe 26, and to have

such position altered as described below. The liquid cryogen may be liquid nitrogen (LIN), carbon dioxide (CO₂) or cold air. Jet streams 34 of cryogen are injected into the internal space 14 from the nozzles 30. The jet streams 34 may include LIN, solid CO₂ and gaseous cryogen.

[0020] An inlet exhaust 36 is mounted for fluid communication with the inlet 20, while an outlet exhaust 38 is mounted for fluid communication with the outlet 22, as shown in particular in FIG. 1. A main exhaust 40 is arranged in fluid communication with the internal space 14 of the freezer 12. The exhausts 36, 38, 40 provide for cryogenic gas to be vented from the inlet 20, the outlet 22 and the internal space 14, respectively.

[0021] An inlet oxygen sensor 42 is mounted for sensing the presence or concentration of oxygen at the inlet 20, while an outlet oxygen sensor 44 is mounted for sensing the presence or concentration of oxygen at the outlet 22.

[0022] A balance blower 46 is mounted proximate the outlet 22, as shown with more particularity in FIG. 2, and in fluid communication with the outlet. The balance blower 46 can transmit and receive (transeive) a blower signal 47 to indicate its operating rpms and pressure, and to have such altered as described below.

[0023] A basic operation of the apparatus and freezer embodiments is described hereinafter. A spiral freezer, by way of example only, is described with respect to FIGS. 1 and 2 for such operation.

[0024] The food products 18 are deposited on the conveyor belt 16 and transported to the internal space 14 of the freezer 10. The inlet oxygen and outlet oxygen sensors 42, 44 sense an amount or concentration of oxygen at the

corresponding inlet 20 and outlet 22, respectively. The inlet exhaust 36 and the outlet exhaust 38 each capture cryogenic gas to be expelled from the internal space 14 of the freezer 10. The modulating control valve 32 provides for an increase in liquid cryogen delivered to the spray bar 28, which valve coacts with the central exhaust 40. That is, as the control valve 32 opens to provide an increase in the liquid cryogen 24 through the pipe 26, the central exhaust 40 increases its speed, i.e., its pull rate increases to pull more gas from the internal space 14 and discharge the gas from the space. Such discharge facilitates the freezer maintaining a mass balance for processing the food products at the internal space 14. The central exhaust 40 operates to withdraw approximately 80% of spent cryogen gas from the internal space 14. Accordingly, there is also no ingress or entry of external atmosphere into the freezer through the exhaust 40. By way of example only, nitrogen is the cryogenic gas, and the liquid cryogen 24 being introduced is liquid nitrogen (LIN).

[0025] The oxygen sensors 42, 44 have corresponding ports 48, 50, respectively, located in an area of the internal space 14 proximate the inlet 20 and the outlet 22, respectively, where a cryogen environment of 100% is present. The ports 48, 50 are positioned approximately 12-24 inches into the interior space 14 of the freezer 10. The oxygen sensor 42 generates an oxygen concentration signal 43, while the oxygen sensor 44 generates an oxygen concentration signal 45.

[0026] As shown with more particularity in FIG. 2, the outlet oxygen sensor 44 transmits a signal 45 to the controller 54 which receives same and determines whether an oxygen concentration at the outlet exceeds a predetermined amount. If the oxygen content at the outlet 22 is non-existent or does not exceed a predetermined amount, and if the inlet oxygen sensor 42 has not transmitted a sensor signal 43 indicating the oxygen level at the inlet 20 has exceeded a

predetermined amount, freezer 10 will continue operating as is, i.e., operating in a balance state. If, however, the outlet oxygen sensor 44 transmits the sensor signal 45 indicating that oxygen at the outlet 22 has exceeded the predetermined limit, and/or if the inlet oxygen sensor 42 transmits the sensor signal 43 to the controller 54 indicating a similar condition at the inlet 20, the controller 54 will transmit a signal 47 to the balance blower 46 to reduce rpms, i.e., reduce the pressure at the outlet 22 so that the cryogen at the internal space 14 can be exhausted to somewhat a greater extent from the outlet 22 and the inlet 20 to prevent external atmosphere from gaining access to the internal space 14. The valve 32 and controller 54 are also in communication via a valve signal 33. Such an arrangement permits the controller 54 to adjust an amount of cryogen introduced through the pipe 26 into the internal space 14.

[0027] In operation, the balance blower 46 withdraws the cold cryogenic gas from the internal space 14 and pressurizes the gas within the blower before reintroducing the gas by way of a nozzle 52 positioned to discharge the cryogenic gas above and across a width of a conveyor belt 16 at the outlet 22. As shown, the nozzle 52 is somewhat angled toward the internal space 14. The speed of the balance blower 46 is adjusted to control a volumetric flow of gas discharged from the nozzle 52. That is, it is desirable to retain as much of the cryogen gas as possible within the internal space 14 for purposes of continuous chilling and freezing of the food product 18. The speed of the blower 46 exhausting the pressurized cryogen gas through the nozzle 52 does just that. However, it is possible that eventually the external atmosphere will become pulled or move into the outlet 22 and to the internal space 14, thereby warming and therefore adversely impacting the effectiveness of the freezer. The balance blower 46 will therefore be effective in balancing the cryogenic freezing occurring at the internal space 14, and this is done by applying a pressure at the outlet 22 of the freezer. That is, as more gas is forced from the balance blower 46 through

the nozzle 52 into the outlet 22, more cryogenic gas at the internal space 14 is expelled from the inlet 20. In both instances, air or atmosphere external to the inlet 20 and the outlet 22 is prevented from gaining entry to the internal space 14 which would compromise the chilling or freezing processes occurring at the internal space 14. In this manner of operation, the freezer is "balanced". Such balancing also results in any oxygen being removed or purged from the internal space 14.

[0028] The inlet and outlet oxygen sensors 42, 44 are used to control a speed of the balance blower 46 by transmitting signals 43, 45 directly to the controller 54, which in turn transmits a blower signal 47 to the balance blower. That is, as a higher oxygen concentration is sensed at the outlet 22 by the outlet sensor 44, a speed of the balance blower 46 is reduced in order to allow more cryogenic gas at the internal space 14 to be discharged at the outlet 22 in order to prevent atmosphere external to the freezer from entering the freezer through the outlet; and at the same time pressurizing the internal space to expel cryogenic gas from the inlet 20 to prevent external atmosphere from gaining entry to the interior space through the inlet.

[0029] A similar principle applies at the inlet. That is, if the inlet oxygen sensor 42 senses an unacceptable amount of oxygen at the inlet, which means that atmosphere external to the freezer is gaining access to the internal space 14 via the inlet 20, two (2) alternate embodiments may be employed. A first embodiment relies upon only the balance blower 46 to balance an atmosphere at the internal space 14 of the freezer 10. Another embodiment calls for using the balance blower 46 at the outlet 22 in conjunction with another balance blower (not shown) mounted for similar operation at the inlet 20. Accordingly, both the inlet 20 and the outlet 22 are continuously monitored for the presence of oxygen and the speed of the balance blower 46 (and an inlet balance blower if used)

adjusted to maintain the "balance" of an atmosphere at the internal space 14 of the freezer 10.

[0030] The controller 54 is positioned for use to monitor concentrations of O₂ at the inlet 20 and the outlet 22, and to adjust operation of the outlet balance blower 46 by generating a signal to this blower, and the inlet balance blower if provided, as necessary to balance the freezer. The central exhaust 40 can also be adjusted to substantially reduce if not eliminate the introduction of air into the internal space 14.

[0031] The present embodiments provide for increased efficiencies of the freezing process and the reduction in manual labor necessary for same.

[0032] It will be understood that the embodiments described herein are merely exemplary, and that a person skilled in the art may make variations and modifications without departing from the spirit and scope of the invention. All such variations and modifications are intended to be included within the scope of the invention described herein and provided in the appending claims. It should be understood that the embodiments described above are not only in the alternative, but can be combined.

CLAIMS

What is claimed is:

1. A freezer for a food product, comprising:

a housing having an internal space with a processing atmosphere for reducing a temperature of the food product; and

a pressure balance apparatus in communication with the processing atmosphere to restrict atmosphere external to the freezer from reaching the internal space, the pressure balance apparatus comprising at least one sensor exposed to the processing atmosphere for generating a first signal indicating an amount of oxygen (O₂) sensed at the internal space, and a blower disposed to direct a pressurized flow of the processing atmosphere to the internal space responsive to the first signal.

2. The freezer of claim 1, wherein the blower is disposed at an outlet of the internal space.

3. The freezer of claim 2, further comprising a cryogen delivery pipe in fluid communication with the internal space for delivering cryogen to said internal space, and another sensor mounted proximate an inlet to the internal space.

4. The freezer of claim 2, further comprising: an inlet exhaust in fluid communication with an inlet to the internal space, an outlet exhaust in fluid communication with the outlet to the internal space; and a main exhaust in fluid communication with the internal space.

5. The freezer of claim 2, further comprising a nozzle in fluid communication with the blower for directing the pressurized flow at the outlet.

6. The freezer of claim 5, wherein the nozzle is mounted to direct the pressurized flow toward the internal space.

7. The freezer of claim 1, further comprising a controller in communication with the at least one sensor and the blower, the controller arranged to receive the first signal from said at least one sensor and generate a second signal to said blower responsive to said first signal for controlling the blower.

8. A freezer for a food product, comprising:

a housing having an internal space with a processing atmosphere for reducing a temperature of the food product; and

a pressure balance apparatus in communication with the processing atmosphere to restrict atmosphere external to the freezer from reaching the internal space, the pressure balance apparatus comprising at least one sensor exposed to the processing atmosphere for generating a first signal indicating an amount of oxygen (O₂) sensed at the internal space,

a blower disposed to direct a pressurized flow of the processing atmosphere to the internal space responsive to the first signal, and

a controller in communication with the blower for balancing the processing atmosphere and removing oxygen therefrom to an exterior of the internal space.

9. A method of balancing a processing atmosphere in an internal space of a freezer for food products, comprising:

sensing an amount of oxygen (O₂) becoming present in the processing atmosphere;

generating a first signal indicating the amount of oxygen sensed;

withdrawing a portion of the processing atmosphere and pressurizing said portion responsive to the first signal; and

discharging the pressurized portion to the processing atmosphere for pressurizing said atmosphere and preventing additional O₂ from becoming present in said atmosphere.

10. The method of claim 9, further comprising injecting a cryogenic substance into the processing atmosphere.

11. The method of claim 10, wherein the cryogenic substance is selected from the group consisting of liquid nitrogen (LIN), carbon dioxide (CO₂), and cold air.

12. The method of claim 9, further comprising exhausting a portion of the processing atmosphere from at least one location of the internal space within the freezer.

13. The method of claim 9, further comprising exhausting portions of the processing atmosphere from a plurality of locations of the internal space within the freezer.

14. The method of claim 13, wherein the plurality of locations include at least an inlet and an outlet for the processing atmosphere within the freezer.

15. The method of claim 9, further comprising conveying the food products through the processing atmosphere.

16. The method of claim 9, further comprising generating a second signal responsive to the first signal to control the discharging of the pressurized portion to the processing atmosphere.

17. The method of claim 9, further comprising purging any oxygen from the processing atmosphere.

18. A method of balancing a processing atmosphere in an internal space of a freezer for food products, comprising:

sensing an amount of oxygen (O_2) becoming present in the processing atmosphere;

generating a first signal indicating the amount of oxygen sensed;

withdrawing a portion of the processing atmosphere and pressurizing said portion responsive to the first signal;

discharging the pressurized portion to the processing atmosphere for pressurizing said atmosphere and preventing additional O_2 from becoming present in said atmosphere; and

removing existing oxygen from the processing atmosphere.

FIG. 1

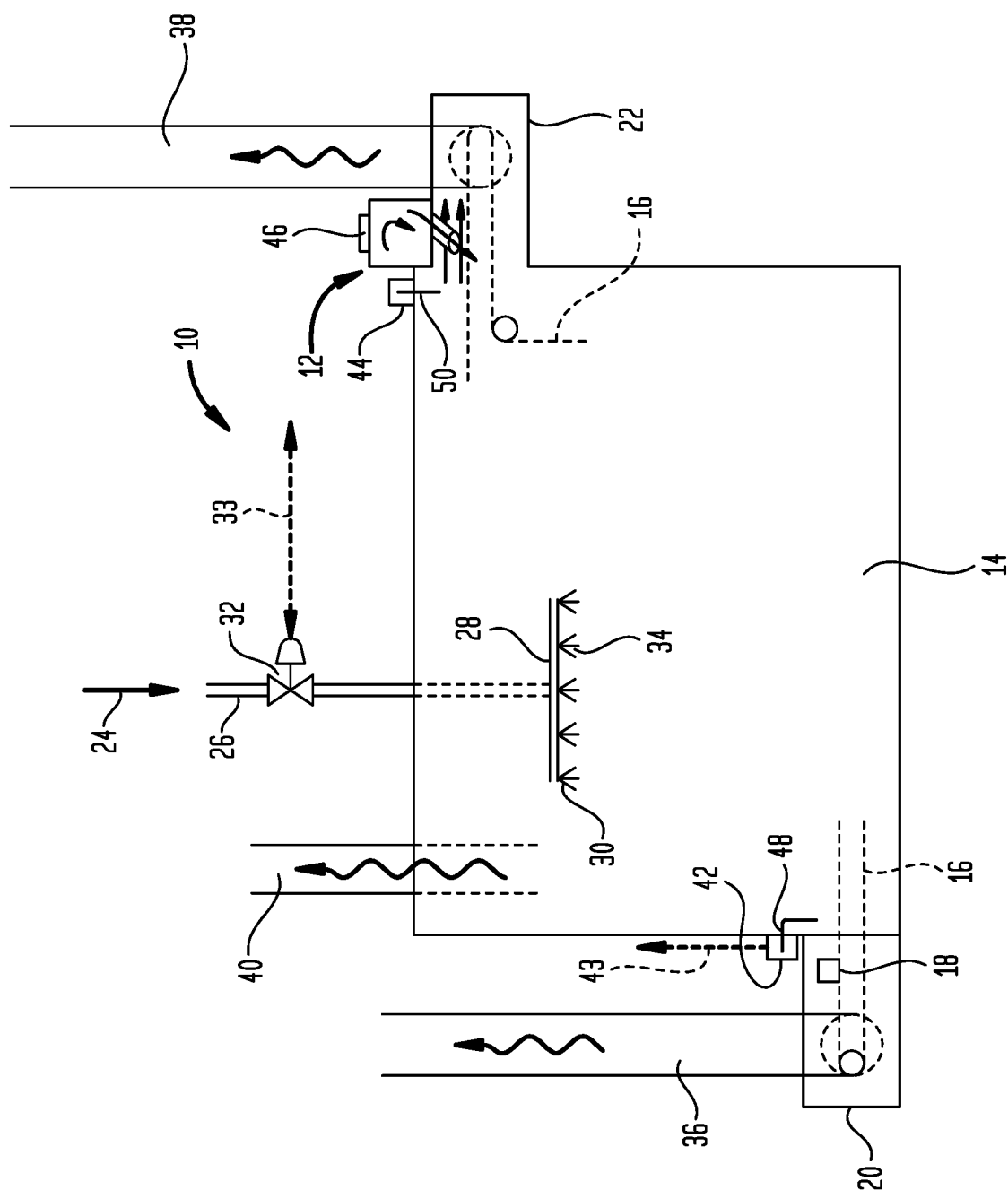
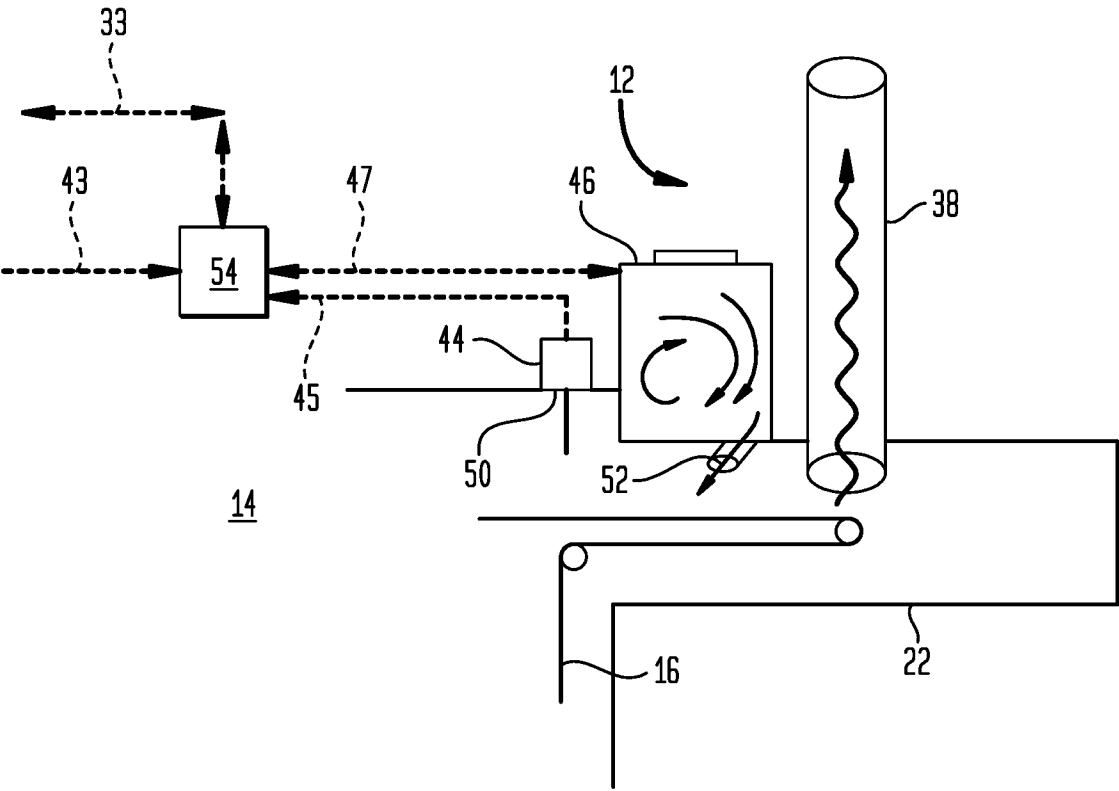


FIG. 2



INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2017/026788

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - F25D 3/11; A23L 3/36; A23L 3/375; F25D 3/10 (2017.01)

CPC - F25D 3/11; A23L 3/36; A23L 3/375 (2017.05)

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

USPC - 62/52.1; 62/63; 62/374; 62/380 (keyword delimited)

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.
Y	WO 2013/034827 A1 (L'AIR LIQUIDE, SOCIÉTÉ ANONYME POUR L'ÉTUDE ET L'EXPLOITATION DES PROCÉDÉS GEORGES CLAUDE et al) 14 March 2013 (14.03.2013) see machine translation	1-18
Y	US 4,354,549 A (SMITH) 19 October 1982 (19.10.1982) entire document	1-18
Y	US 5,879,732 A (CARACCILOLO, JR. et al) 09 March 1999 (09.03.1999) entire document	4, 8, 12-14
Y	US 6,332,325 B1 (MONFORT) 25 December 2001 (25.12.2001) entire document	17, 18
A	US 4,866,946 A (KLEE) 19 September 1989 (19.09.1989) entire document	1-18
A	US 2010/0319365 A1 (NEWMAN) 23 December 2010 (23.12.2010) entire document	1-18

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

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

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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

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