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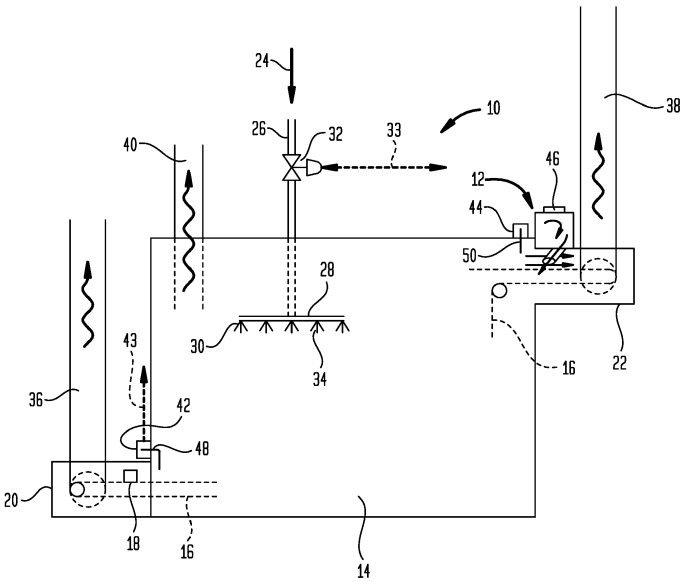
(54) APPARATUS AND METHOD FOR EXHAUSTING CRYOGEN FROM A FREEZER

(57) In order to overcome the limitations and problems that earlier apparatus and methods have experienced, a freezer (10) for a product (18), in particular for a food product, is proposed, said freezer (10) comprising:
- a housing having an internal space (14) with a processing atmosphere for reducing a temperature of the product (18); and
- a pressure balance apparatus (12) in communication with the processing atmosphere to restrict atmosphere external to the freezer (10) from reaching the internal space (14), the pressure balance apparatus (12) comprising at least one sensor (44) exposed to the processing atmosphere for generating a first signal (45) indicating an amount of oxygen (O_2) sensed at the internal space (14), and a blower (46) disposed to direct a pressurized flow of the processing atmosphere to the internal space (14) responsive to the first signal (45).

A related method is also provided.

FIG. 1



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Description

Technical field of the present invention

[0001] The present invention relates to exhausting cryogen from freezers, in particular from food freezers.

Technological background of the present invention

[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 (i. e. 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.

Disclosure of the present invention: object, solution, advantages

[0005] Starting from the disadvantages and shortcomings as described above as well as taking the prior art as discussed into account, an object of the present invention is to overcome the limitations and problems that earlier apparatus and methods have experienced.

[0006] This object is accomplished by an apparatus comprising the features of claim 1 as well as by a method comprising the features of claim 8. Advantageous embodiments, expedient improvements and other optional features of the present invention are set forth herein and disclosed in the respective dependent claims.

[0007] The present invention basically provides for 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.

[0008] 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.

[0009] The oxygen monitor and the balance blower may preferably 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.

[0010] 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.

[0011] A similar arrangement may preferably be 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.

[0012] 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.

[0013] 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.

[0014] Both the inlet and the outlet may continuously be monitored, and the speed of the balance blower(s) may continuously be 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.

[0015] 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 (O_2) 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, said blower in particular disposed at an outlet of the internal space.

[0016] According to an advantageous embodiment of the present invention, a cryogen delivery pipe may be provided in fluid communication with the internal space for delivering liquid cryogen to the internal space. A modulating control valve may favourably be positioned in the pipe to control the introduction of the liquid cryogen to a spray bar having a plurality of spray nozzles mounted thereto.

[0017] According to an expedient embodiment of the present invention, an inlet exhaust may be mounted for fluid communication with the inlet to the internal space, while an outlet exhaust may be mounted for fluid communication with the outlet to the internal space. A central exhaust or main exhaust may be arranged in fluid communication with the internal space. These exhausts may provide for cryogenic gas to be vented from the inlet, the outlet and the internal space, respectively.

[0018] According to a preferred embodiment of the present invention, the blower may withdraw the cold cryogenic gas from the internal space and may pressurize the gas within the blower before reintroducing the gas by way of at least one nozzle in fluid communication with the blower and positioned to direct the pressurized flow at the outlet, in particular to discharge the cryogenic gas above and across a width of a conveyor belt at the outlet, said conveyor belt expediently conveying the product through the processing atmosphere.

[0019] In an advantageous embodiment of the present invention, a controller may be provided in communication with the at least one sensor and the blower, the controller expediently arranged to receive the first signal from said at least one sensor and to generate a second signal to said blower responsive to said first signal for controlling the blower.

[0020] There is also provided herein a method of balancing a processing atmosphere in an internal space of a freezer for a product, in particular for a food product, 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; and discharging the pressurized portion to the processing atmosphere for pressurizing said atmosphere and preventing additional oxygen (O_2) from becoming present in said atmosphere.

[0021] In particular, a second signal may be generated responsive to the first signal to control the discharging of the pressurized portion to the processing atmosphere.

[0022] According to an advantageous embodiment of the present invention, a cryogenic substance, in particular liquid nitrogen (LIN), carbon dioxide (CO_2), or cold air, may be injected into the processing atmosphere.

[0023] In an expedient embodiment of the present invention, a portion or portions of the processing atmosphere may be exhausted from at least one location or from a plurality of locations of the internal space within the freezer, said plurality of locations favourably including at least an inlet and an outlet for the processing atmosphere within the freezer.

[0024] Air or atmosphere external to the inlet and the outlet may be prevented from gaining entry to the internal space which would compromise the chilling or freezing processes occurring at the internal space. In this manner of operation, the freezer may be "balanced". Such balancing may also result in any oxygen (O_2) being removed or purged from the processing atmosphere or from the internal space.

[0025] Additional optional features of the present inventive embodiments are set forth in the remaining claims.

Brief description of the drawings

[0026] For a more complete understanding of the present embodiment disclosures and as already discussed above, there are several options to embody as well as to improve the teaching of the present invention in an advantageous manner. To this aim, reference may be made to the claims dependent on claim 1; further improvements, features and advantages of the present invention are explained below in more detail with reference to particular and preferred embodiments by way of non-limiting example and to the appended drawing figures taken in conjunction with the following description of exemplary embodiments, of which:

FIG. 1 shows a side view in cross-section of a freezer having the cryogenic exhaust control system of the present embodiments, said freezer working according to the method of the present invention; and

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

[0027] In the appended drawing figures, like equipment is labelled with the same reference numerals throughout the description of FIG. 1 and FIG. 2.

Detailed description of the drawings; best way of embodying the present invention

[0028] Before explaining the inventive embodiments in detail, it is to be understood that the present invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the present 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.

[0029] In the description above and below, terms such as horizontal, upright, vertical, above, below, beneath and the like, are used solely for the purpose of clarity illustrating the present invention and should not be taken as words of limitation. The drawings are for the purpose of illustrating the present invention and are not intended to be to scale.

[0030] Referring to FIG. 1 and to FIG. 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.

[0031] 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 14 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.

[0032] 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.

[0033] 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 24 may be liquid nitrogen (LIN), carbon dioxide (CO_2) 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 CO_2 and gaseous cryogen.

[0034] 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 10. 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.

[0035] 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.

[0036] 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 22. 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.

[0037] 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 FIG. 1 and to FIG. 2 for such operation.

[0038] 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.

[0039] The modulating control valve 32 provides for an increase in liquid cryogen 24 delivered to the spray bar 28, which valve 32 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 14.

[0040] Such discharge facilitates the freezer 10 maintaining a mass balance for processing the food products 18 at the internal space 14. The central exhaust 40 operates to withdraw approximately eighty percent of spent cryogen gas from the internal space 14. Accordingly, there is also no ingress or entry of external atmosphere into the freezer 10 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).

[0041] 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 hundred percent is present. The ports 48, 50 are positioned approximately twelve inched to 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.

[0042] 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 22 exceeds a predetermined amount.

[0043] If the oxygen content at the outlet 22 is nonexistent 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.

[0044] 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 below 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.

[0045] 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 introduce through the pipe 26 into the internal space 14.

[0046] In operation, the balance blower 46 withdraws the cold cryogenic gas from the internal space 14 and pressurizes the gas within the blower 46 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.

[0047] 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.

[0048] 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 10. 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 10. 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.

[0049] 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.

[0050] 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 46. 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 10 from entering the freezer 10 through the outlet 22; and at the same time pressurizing the internal space 14 to expel cryogenic gas from the inlet 20 to prevent external atmosphere from gaining entry to the interior space 14 through the inlet 20.

[0051] A similar principle applies at the inlet 20. That is, if the inlet oxygen sensor 42 senses an unacceptable amount of oxygen at the inlet 20, which means that atmosphere external to the freezer 10 is gaining access to the internal space 14 via the inlet 20, two (2) alternate embodiments may be employed.

[0052] A first embodiment relies upon only the balance blower 46 to balance an atmosphere at the internal space 14 of the freezer 10.

[0053] 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.

[0054] 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.

[0055] The controller 54 is positioned for use to monitor concentrations of oxygen (O_2) at the inlet 20 and the outlet 22, and to adjust operation of the outlet balance blower 46 by generating a signal 47 to this blower 46, and the inlet balance blower if provided, as necessary to balance the freezer 10. The central exhaust 40 can also be adjusted to substantially reduce if not eliminate the introduction of air into the internal space 14.

[0056] The present embodiments provide for increased efficiencies of the freezing process and the reduction in manual labor necessary for same.

[0057] 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 present invention. All such variations and modifications are intended to be included within the scope of the present invention as described above and defined the appended claims. Further, it should be understood that all embodiments disclosed are not necessarily in the alternative, as various embodiments of the present invention may be combined to provide the desired result.

List of reference numerals

[0058]

10	freezer, in particular food freezer, for example spiral food freezer
12	pressure balance apparatus, in particular cryogenic exhaust control apparatus
14	interior space or internal space or chamber
16	conveyor belt
18	product, in particular food product
20	inlet of freezer 10
22	outlet of freezer 10
24	cryogenic substance, in particular liquid cryogen, for example liquid nitrogen (LIN), carbon dioxide (CO_2) or cold air
26	pipe, in particular delivery pipe, for example cryo-

gen delivery pipe
28 spray bar
30 nozzle, in particular spray nozzle, of spray bar 28
32 valve, in particular control valve, for example modulating control valve
33 valve signal
34 jet stream
36 inlet exhaust
38 outlet exhaust
40 central exhaust or main exhaust
42 inlet oxygen sensor
43 oxygen concentration signal of inlet oxygen sensor 42
44 outlet oxygen sensor
45 first signal or oxygen concentration signal of outlet oxygen sensor 44
46 blower, in particular balance blower
47 second signal or blower signal
48 port of inlet oxygen sensor 42
50 port of outlet oxygen sensor 44
52 nozzle
54 controller

Claims

1. A freezer (10) for a product (18), in particular for a food product, comprising:

- a housing having an internal space (14) with a processing atmosphere for reducing a temperature of the product (18); and
- a pressure balance apparatus (12) in communication with the processing atmosphere to restrict atmosphere external to the freezer (10) from reaching the internal space (14), the pressure balance apparatus (12) comprising at least one sensor (44) exposed to the processing atmosphere for generating a first signal (45) indicating an amount of oxygen (O_2) sensed at the internal space (14), and a blower (46) disposed to direct a pressurized flow of the processing atmosphere to the internal space (14) responsive to the first signal (45).

2. The freezer according to claim 1, further comprising

- a cryogen delivery pipe (26) in fluid communication with the internal space (14) for delivering a cryogenic substance (24) to said internal space (14), and
- another sensor (42) mounted proximate an inlet (20) to the internal space (14).

3. The freezer according to claim 1 or 2, wherein the blower (46) is disposed at an outlet (22) of the internal space (14).

4. The freezer according to claim 2 and 3, further comprising

- an inlet exhaust (36) in fluid communication with the inlet (20) to the internal space (14),
- an outlet exhaust (38) in fluid communication with the outlet (22) to the internal space (14), and
- a main exhaust (40) in fluid communication with the internal space (14).

5. The freezer according to claim 3 or 4, further comprising a nozzle (52) in fluid communication with the blower (46) for directing the pressurized flow at the outlet (22).

6. The freezer according to claim 5, wherein the nozzle (52) is mounted to direct the pressurized flow toward the internal space (14).

7. The freezer according to at least one of claims 1 to 6, further comprising a controller (54) in communication with the at least one sensor (44) and the blower (46), the controller (54) arranged to receive the first signal (45) from said at least one sensor (44) and to generate a second signal (47) to said blower (46) responsive to said first signal (45) for controlling the blower (46).

8. A method of balancing a processing atmosphere in an internal space (14) of a freezer (10) for a product (18), in particular for a food product, comprising:

- sensing (44) an amount of oxygen (O_2) becoming present in the processing atmosphere;
- generating a first signal (45) indicating the amount of oxygen (O_2) sensed (44);
- withdrawing a portion of the processing atmosphere and pressurizing said portion responsive to the first signal (45); and
- discharging the pressurized portion to the processing atmosphere for pressurizing said atmosphere and preventing additional oxygen (O_2) from becoming present in said atmosphere.

9. The method according to claim 8, further comprising injecting a cryogenic substance (24) into the processing atmosphere.

10. The method according to claim 9, wherein the cryogenic substance (24) is selected from the group consisting of liquid nitrogen (LIN), carbon dioxide (CO_2), and cold air.

11. The method according to at least one of claims 8 to 10, further comprising exhausting

- a portion of the processing atmosphere from at least one location of the internal space (14)

within the freezer (10), or
- portions of the processing atmosphere from a plurality of locations of the internal space (14) within the freezer (10).

12. The method according to claim 11, wherein the plurality of locations include at least an inlet (20) and an outlet (22) for the processing atmosphere within the freezer (10).

13. The method according to at least one of claims 8 to 12, further comprising conveying (16) the product (18) through the processing atmosphere.

14. The method according to at least one of claims 8 to 13, further comprising generating a second signal (47) responsive to the first signal (45) to control (54) the discharging of the pressurized portion to the processing atmosphere.

15. The method according to at least one of claims 8 to 14, further comprising purging any oxygen (O_2) from the processing atmosphere.

FIG. 1

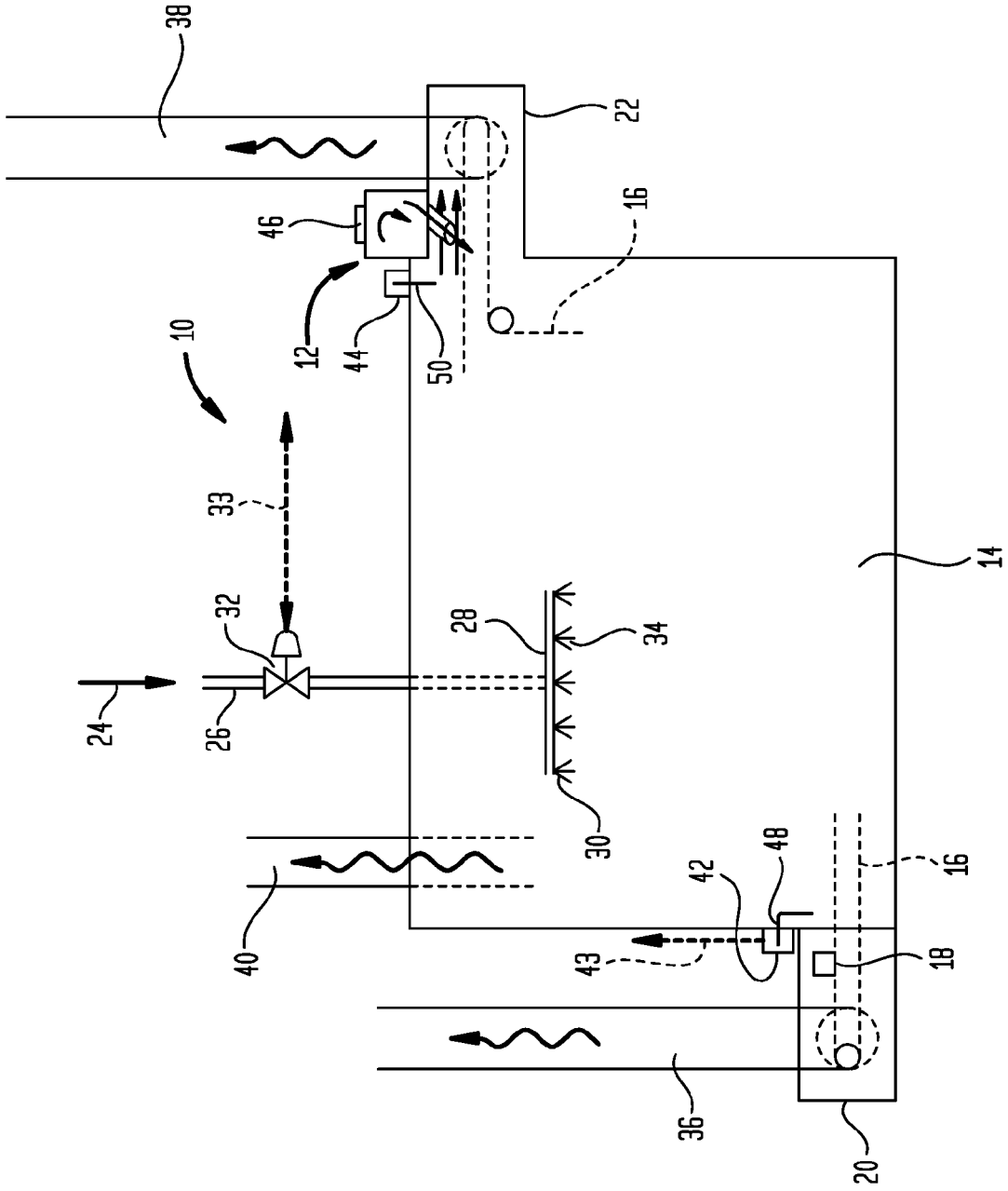
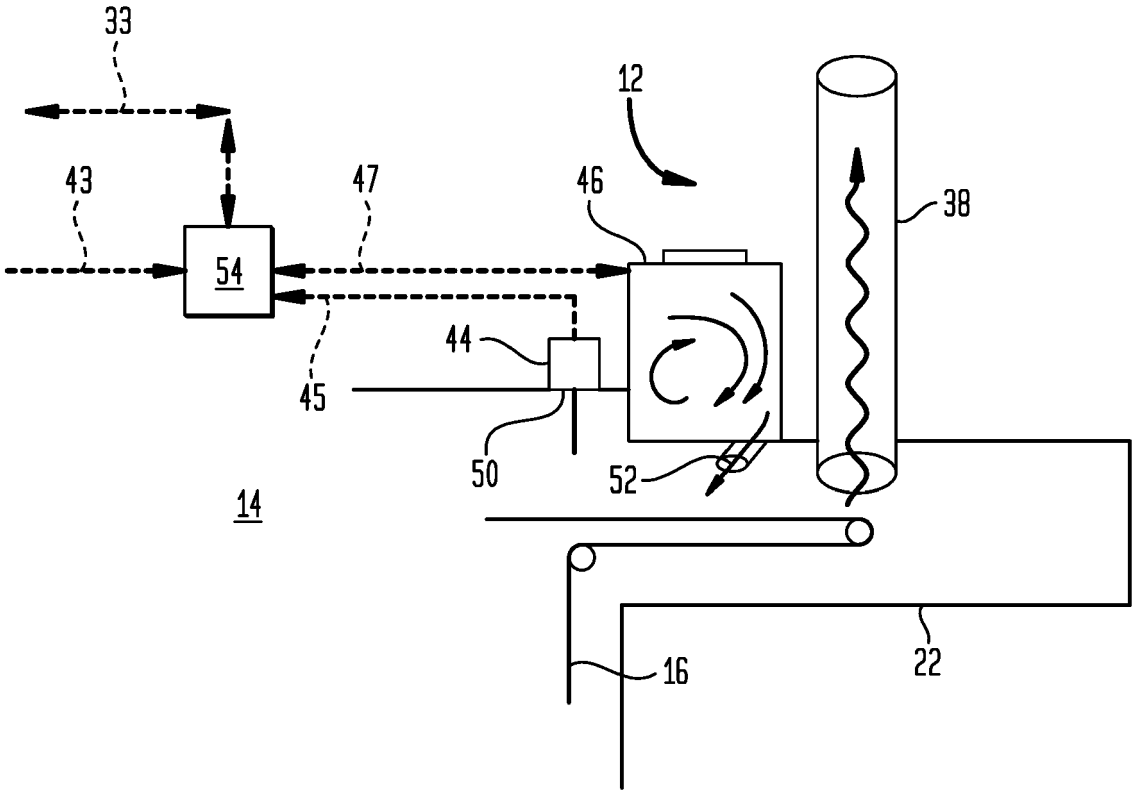


FIG. 2



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EUROPEAN SEARCH REPORT

Application Number
EP 16 18 0252

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y A	US 4 955 206 A (LANG GARY D [US] ET AL) 11 September 1990 (1990-09-11) * column 11, line 35 - column 12, line 21; figure 12 *	1-14 15	INV. F25D3/11 F25D29/00
Y A	WO 2013/034827 A1 (AIR LIQUIDE [FR]; PATHIER DIDIER [FR]; DUBREUIL THIERRY [FR]; DALLAIS) 14 March 2013 (2013-03-14) * page 9, line 4 - line 22; claims 3,4; figures 3,4a,4b,5 *	1-14 15	
A	US 5 966 946 A (GIRARD JOHN MARTIN [US] ET AL) 19 October 1999 (1999-10-19) * column 9, line 31 - column 10, line 40; figure 12 *	1-14	
A	US 4 947 654 A (SINK BRIAN EVAN [US] ET AL) 14 August 1990 (1990-08-14) * figures 1,2 *	1,8	
A	US 3 255 608 A (MACINTOSH HAMISH K) 14 June 1966 (1966-06-14) * the whole document *	1,8	TECHNICAL FIELDS SEARCHED (IPC) F25D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	6 February 2017	de Graaf, Jan Douwe

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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E : earlier patent document, but published on, or after the filing date
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L : document cited for other reasons

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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 16 18 0252

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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06-02-2017

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4955206 A	11-09-1990	CA 2025030 A1	31-05-1991
		US 4955206 A	11-09-1990
WO 2013034827 A1	14-03-2013	FR 2979696 A1	08-03-2013
		WO 2013034827 A1	14-03-2013
US 5966946 A	19-10-1999	BR 9901787 A	04-01-2000
		CA 2274417 A1	08-12-1999
		CN 1238446 A	15-12-1999
		EP 0964213 A2	15-12-1999
		ES 2195532 T3	01-12-2003
		ID 23256 A	05-04-2000
		KR 20000005980 A	25-01-2000
		MY 115411 A	31-05-2003
		US 5966946 A	19-10-1999
US 4947654 A	14-08-1990	AU 6536290 A	26-06-1991
		CA 2072152 A1	31-05-1991
		MX 167827 B	14-04-1993
		US 4947654 A	14-08-1990
		WO 9108429 A1	13-06-1991
US 3255608 A	14-06-1966	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82