

PATENT SPECIFICATION

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(54) COLD STORAGE APPARATUS

(71) I, MASAHIKO IZUMI, a Japanese Subject, of 8, 26-ban, 5-chome, Hiikawa, Nishi-ku, Fukuoka-shi, Fukuoka-ken, Japan, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to cold storage apparatus.

An object of the present invention is to provide cold storage apparatus for allowing cold storage for a long period of time without freezing of perishables such as vegetables, fruits and meats at a temperature of from 0.5°C to 5°C in a moisture-rich atmosphere.

A further object of the present invention is to provide a refrigerator wherein biochemical products such as vaccine, microbe products, serum and so on can be preserved for a long period of time at a temperature between 0.5°C and 1°C without causing any freezing thereof.

A further object of the present invention is to provide a cold storage apparatus wherein foodstuffs in a grocery store, such as vegetables and meats, can be preserved for a long period without change of quality thereof, while dusts, infectious microbes and any offensive odours are removed.

In accordance with the present invention, I provide cold storage apparatus comprising a cold storage chamber having an intake from and an outlet to an external gas circulation system incorporating a cold water spraying mixer through which gas being circulated is sprayed with cold water to leave same as low-temperature moisture-rich gas a cyclone separator downstream of said mixer to remove water droplets from said low-temperature moisture rich gas prior to flow of the latter through said intake.

The cold storage chamber may be a container, a room, or a storage room which has a cooling pipe surrounding it. The cooling pipe has circulated therethrough water or an aqueous solution of a constant low temperature to remove any atmosphere temperature effect and thereby make the cold storage apparatus of the present invention more efficient. The cooling aqueous solution consists of water, salt water and potassium chloride, and these liquids are stored in a large capacity tank at a temperature of from -1°C to 1°C and always circulated to maintain the wall face of the cold storage chamber at a temperature of -1°C to 1°C thereby minimizing heat loss of the circulated gas.

The cold water spraying mixer may have a cooling pipe wound within the peripheral wall thereof and adapted to circulate cooling liquid therethrough to cool the cold water spraying mixer. This cold water spraying mixer may be provided with a cooling pipe wound around it and through which water, salt water or potassium chloride solution etc. cold at a temperature of -1°C to 0.5°C is circulated.

Two or more successive cold water spraying mixers, for example three, may be arranged in series to enable gas of any high temperature to be converted made to a moisture-rich cooling gas at a temperature of -1°C to 0.5°C which is the optimum for cold storage.

The gas in circulation is caused to dwell for a relatively long period in the cold water spraying mixer and is sprayed with cold water, so that dusts, infectious microbes and any offensive odours in the cold storage chamber can be removed and thereby cleaned gas is produced.

The cyclone separator for removing water droplets is of conventional shape, and has supplied thereinto the low-temperature

moisture-rich gas obtained in the cold water spraying mixer, whereby any excess water can be removed in the form of droplets by centrifugal force during the through-passage of the gas.

5 The circulation system preferably includes a bypass pipe communicating between a point between the cold storage chamber and the cold water spraying mixer and another point between the cyclone separator and the cold storage chamber, so that the quantity of gas to be fed to the cold storage chamber is adjusted and also a constant quantity of gas is fed to the cold water spraying mixer at a constant flow rate so as not to cause reduction in the efficiency of the mixer.

10 In the present invention, the quantity of cooling water to be fed to the cold water spraying mixture is large, and accordingly a storage tank therefor is provided, and water therein is cooled to a temperature near 0°C by means of a freezer or by contact with ice. In the case of cooling by ice, ice is made by an ice-making machine, and the temperature of the water is reduced to from 0°C to +0.5°C through contact with the ice, the water approaching the temperature 0°C automatically and never falling therebelow, so that no control mechanism is required.

15 Gas for circulation in the cold storage apparatus of the present invention is air, nitrogen gas or carbon dioxide gas, and that gas which is most suitable for objects to be stored is selected.

20 Embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

25 Fig. 1 is a diagrammatic view showing one embodiment of cold storage apparatus of the present invention;

30 Fig. 2 is a diagrammatic view showing another embodiment of cold storage apparatus of the present invention;

35 Fig. 3 is a sectional plan view, taken along the line A—A of Fig. 1 of a cold water spraying mixer;

40 Fig. 4 is a longitudinal sectional view of another form of the cold water spraying mixer; and

45 Fig. 5 is a diagrammatic longitudinal sectional view of another form of cold storage chamber and cooling water storage tank.

50 Referring to Fig. 1, a cold storage chamber is denoted 1, and 2 denotes a cooling pipe which is adapted to circulate, through the peripheral wall of the chamber, water at a temperature of +5°C fed from a tank (not shown) to cool the inner wall face 3 of the cold storage chamber 1.

55 30 denotes a fan which, when driven, causes gas in the cold storage chamber 1 to flow out through an outlet 18 provided at

the lower end 20 of the chamber, and thence through conduits 23 and 25 via a four-way change-over valve 22 into a dust-arresting cyclone 34 in which solid matter such as dust coming from the cold storage chamber 1 are separated. The dust-arresting cyclone 34 is provided with a steam pipe 35 through which, as required, steam is ejected to effect sterilization of air. However, for simplification, this dust arresting cyclone 34 can be omitted and then the gas can be directly passed through the conduit 33'. In this case, the steam pipe may open directly into said pipe 33' or into a cold water spraying mixer 36. Removal of dust and offensive smell is effected in the cold water spraying mixer 36. The gas from which dust has been removed by means of the dust-arresting cyclone 34 is fed to the cold water spraying mixer 36 through the conduit 33 which opens into the latter through the peripheral wall thereof. A fixed conduit 37 opens into the mixer 36 through the top of the latter and coaxially attached around that length of the conduit 37 which is within the cold water spraying mixer 36 in an extension portion of a cold water pipe 38, the double-walled pipe 38' so formed having in the outer wall thereof a plurality of spraying openings 39a, 39b... The cold water pipe 38 communicates with the cold water tank 10. 5 denotes a cooling medium compressor of a cooling apparatus for cooling water, 6 denotes a condenser for cooling medium gas coming from the compressor 5, and 7 denotes a conduit connected to an evaporator 8 in the cold water tank 10. Water in the cold water tank 10 is always cooled at +0.5°C by means of the evaporator 8 and stored therein. In the drawings, the cold water tank 10 is shown in a small size, but in practice it is of a large capacity and a large quantity of cold water may be stored therein, so that the cooling water can be maintained at a low constant temperature. Cold water in the form of minute droplets is ejected by means of a pump 29 into the cold water spraying mixer 36 through the spraying openings 39a, 39b... Air fed into the cold water spraying mixer 36 contacts water droplets from the openings 39a, 39b... and exchanges heat therewith rapidly and efficiently, any excess water being condensed due to the cooling while the water absorbed by the air saturates the latter at a temperature approximately the same as the cold water temperature and the saturated air then flows out through the conduit 37. On the other hand, the water taking heat from the air in the mixer 36 and dropping in the latter has an offensive odour and carries therewith, in the form of a dissolution or suspension therein, dust and infectious microbes from the cold storage chamber 1, so that such

5 water is unsuitable for direct re-use, and therefore it is fed to a filter machine 42 via a conduit 41 to filter it, and then returned to the cold water tank 10 via a conduit 41'. The filter machine 42 preferably has a filter layer made of a lamination of absorbing materials, such as active carbon, diatomaceous earth, acid clay, and ion-exchange resin.

10 The cooled gas flowing out of the cold water spraying mixer 36 carries therewith a certain amount of sprayed water which has not been absorbed therein, and this cooled gas is consequently wet, so that it is necessary to remove the "free" water by a water droplet cyclone separator 43. Accordingly, only air from which the water has been removed, and which is saturated, passes through a conduit 47 to the four-way change-over valve 22 and thence through a conduit 24 into the cold storage chamber 1 by way of an inlet 17 provided in the upper end 19 of the cold storage chamber 1. 44 denotes an air pipe through which steam, dried gas and heated gas may appropriately be fed into the cyclone separator 43 to regulate the temperature and humidity in the latter, as required.

30 A bypass pipe 48 is provided between the conduit 25, communicating between the four-way change-over valve 22 and the fan 30, and the conduit 47 from the water droplet cyclone separator 43, and an air flow rate controlling device 49 is provided in this bypass pipe 48.

35 On the other hand, detecting devices A1, A2 for chamber temperature and detecting devices B1, B2, for chamber humidity are provided within the cold storage chamber 1, and, external of the chamber 1 and operatively connected, on the one hand, with the air flow rate controlling device 49 and, on the other hand, with the devices A1, A2, B1 and B2, is a regulating device responsive to signals from the detecting devices A1, A2, B1 and B2 and regulating the device 49 in accordance therewith, whereby any temperature change within the chamber 1 due to entry thereinto and exit therefrom of gas compensated by modifying the quantity of air flowing through the bypass pipe 48 and hence diverted from the conduit 47 on its way to the change-over valve 22 the conduit 24 and the chamber 1.

55 C also denotes a temperature-detecting device, which is within the cooling water tank 10 and is electrically connected to the compressor 5, whereas the temperature-detecting devices A1, and A2 are electrically connected to a power source (not shown) of the fan 30.

60 The four-way change-over valve 22 reverse the gas transfer lines when rotated through 90° with the result that air can be fed from the outlet 18 at the lower end 20 of

the chamber 1 and discharged from the inlet 17 in the upper end 19 of the chamber.

Referring now to Fig. 2, which illustrates another embodiment of the present invention, 101 denotes a cold storage chamber and 102 denotes a cooling pipe which circulates water of +0.5°C fed from a cold water tank 127 through a conduit 112 by a pump 128 and cools the inner wall face of the chamber 101. 115 and 116 denote drain discharge grooves in the inner wall face at the lower end 120 of the chamber 101.

130 denotes a fan and, when operating this fan, air in the cold storage chamber 101 passes through an outlet 118 provided in the lower end 120 of the chamber and through a conduit 123 and a conduit 125 via a four-way change-over valve 122 into a dust-arresting cyclone 134. For simplification, it may bypass the cyclone 134 through a conduit 133'. The air is fed to a cold water spraying mixer 136 through a conduit 133.

The conduit 133 extends from the dust-arresting cyclone 134 and opens into the cold water spraying mixer 136 through the peripheral wall thereof, and a downwardly-extending conduit 137 opens into the mixer 136 through the top of the latter. Co-axially attached around that length of the conduit 137 which is within the cold water spraying mixer 136 is an extension portion of a cold water pipe 138, the double-walled pipe 138' so formed having in the outer wall thereof a number of spraying openings 139a, 139b, 139c...

The cold water pipe 138 communicates with an ice water tank 127 through a pump 128 and a pipe 129. Within the ice water tank 127 there is stored a large quantity of cold water cooled to near 0°C by ice, and the interior thereof is stirred by means of a screw S to make the temperature uniform. This cold water is sprayed out through the spraying openings 139a, 139b... to cool the air in the mixer 136 and load it with moisture.

The water taking heat from the air in the mixer 136 and dropping through the latter also has an offensive odour and carries therewith in dissolution or suspension therein minute dust from the interior of the cold storage chamber 1, so that such water is unsuitable for direct re-use, and therefore it is fed to a filter machine 142 through a conduit 141 to filter it, and thereafter is returned to a cold water tank 104 through a conduit 111. The filter machine 142 preferably has filter layer composed of a lamination of absorption materials such as active carbons, diatomaceous earth, acid clay and ion-exchange resin.

The cooled air leaving the cold water spraying mixer 136 carries therewith a certain amount of sprayed water which has

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not been absorbed therein, and this cooled air is consequently wet, so that it is necessary to remove the "free" water by means of a water droplet cyclone separator 143. Accordingly, only air from which water droplets have been removed and which is saturated, passes through a conduit 147 to the chamber 101 via a four-way change-over valve 122, and thence through a conduit 124 into the cold storage by way of an inlet 117 in the upper-end of 119 of the cold storage chamber 101. 144 denotes an air pipe through which steam, dried air, and heated air may be fed into the cyclone separator 143, to regulate the temperature and humidity in the latter as required.

148 denotes a bypass pipe which is provided between the conduit 125, communicating between the four-way change-over valve 122 and the fan 130, and the conduit 147 from the water droplet cyclone separator 143, and an air flow rate controlling device 149 is provided in the bypass pipe 148, so as to adjust the quantity of air flow to the cold storage chamber 101. There are provided within the cold storage chamber 101 temperature detecting devices A1 and A2 and humidity detecting devices B1 and B2 and also there is provided external of the chamber 1 and operatively connected, on the one hand, with the air flow rate controlling device 149 and, on the other hand with the detecting devices A1, A2, B1 and B2, is a regulating device responsive to signals from the detecting devices A1, A2, B1 and B2 and regulating the device 49 in accordance therewith, and thus when the chamber temperature changes due, *inter alia*, to opening and closing of the door, the operation of the air flow rate controlling device 149 provides a control of the quantity of saturated cooled air bypassing to the conduit 125 from the conduit 147, so that a large quantity of air having an adjusted temperature and humidity is caused to circulate temporarily, thereby effecting control of the temperature and humidity in the chamber 1.

Cold water subjected to heat-exchange with the air in the cold water spraying mixer 136 is recovered into the cold water tank 104 through a pipe 141, a filter 142 and a conduit 111. The cold water is fed from the cold water tank 104 through the pipes 108 and 107 into an ice-making machine 109 and an ice-water mixing chamber 110 by means of a pump 105. In this case, the flowing direction may be controlled by a valve 106 to either the ice-making machine 109 or the ice-water mixing chamber 110. Ice-water in the ice-water mixing chamber 110 is fed into an ice-water tank 127 through a pipe 126.

In the ice-water tank 127, ice is usually floating in water, and a pipe 129 is attached at a point of the boundary between ice and

water, the mouth of the pipe 129 being screened so that only the water is fed into the aforementioned cold water pipe 138 from the pipe 129 by a pump 128.

A conduit 112 branches off at a point D from the conduit 129 downstream of the pump 128 and the cold water flowing through the conduit 112 is supplied to the cooling pipe 102 of the cold storage chamber 101, so that the cold water is circulated to cool the inner wall face of the chamber 101. The water leaving the chamber 101 from the cooling pipe 102 is fed out through a conduit 113 and joins with the water showing through the conduit 111 at a point E and is then recovered in the cold water tank 104 and is thereafter again circulated from the tank 104 as just described, the circulation being continuous.

Fig. 3 is a sectional plan view of the cold water spraying mixer 36 of Fig. 1, taken along the line A—A of Fig. 1, and therein 33 denotes a conduit and 39b, 39c... denote spraying openings for cold water. Also, Fig. 4 is a longitudinal sectional view of a further form of the cold water spraying mixer for use in apparatus according to the present invention, and therein 233 denotes a conduit, and 238 denotes a cold water pipe which extends into a spraying mixer 236. 237 denotes a conduit which is surrounded by the length of the cold water pipe 238 within the mixer 236, the aforesaid length forming a double-walled pipe 238'. Spraying openings 239a, 239b, 239c... are provided in the outer wall of the double-walled pipe 238', and cold water is sprayed out through these openings. Also, there is wound within the peripheral wall of the cold water spraying mixer 236, a cooling pipe 201 through which a coolant such as water, salt water, calcium chloride or potassium chloride solution may be circulated. Due to this, the gas in the cold water spraying mixer can be cooled approximately to a temperature of 0°C to -1°C, and, when fed into the cold storage chamber, such gas does not cause a sudden rise of temperature in the chamber and consequently does not impair the efficiency of the cold storage.

Fig. 5 is a diagrammatic view of another embodiment, wherein cooling of the cold storage chamber is performed in another way. 301 denotes a large capacity tank in which water, salt water, calcium chloride solution is stored in large quantities and is cooled by an evaporator 302 of a freezing machine to cool same approximately to a temperature of -1°C to 1°C. A pump 303 causes the coolant to flow through a conduit 313 and circulate in the cooling pipe of the cold storage chamber.

WHAT I CLAIM IS:—

1. Cold storage apparatus comprising a



not been absorbed therein, and this cooled air is consequently wet, so that it is necessary to remove the "free" water by means of a water droplet cyclone separator 143. Accordingly, only air from which water droplets have been removed and which is saturated, passes through a conduit 147 to the chamber 101 via a four-way change-over valve 122, and thence through a conduit 124 into the cold storage by way of an inlet 117 in the upper-end of 119 of the cold storage chamber 101. 144 denotes an air pipe through which steam, dried air, and heated air may be fed into the cyclone separator 143, to regulate the temperature and humidity in the latter as required.

148 denotes a bypass pipe which is provided between the conduit 125, communicating between the four-way change-over valve 122 and the fan 130, and the conduit 147 from the water droplet cyclone separator 143, and an air flow rate controlling device 149 is provided in the bypass pipe 148, so as to adjust the quantity of air flow to the cold storage chamber 101. There are provided within the cold storage chamber 101 temperature detecting devices A1 and A2 and humidity detecting devices B1 and B2 and also there is provided external of the chamber 1 and operatively connected, on the one hand, with the air flow rate controlling device 149 and, on the other hand with the detecting devices A1, A2, B1 and B2, is a regulating device responsive to signals from the detecting devices A1, A2, B1 and B2 and regulating the device 49 in accordance therewith, and thus when the chamber temperature changes due, *inter alia*, to opening and closing of the door, the operation of the air flow rate controlling device 149 provides a control of the quantity of saturated cooled air bypassing to the conduit 125 from the conduit 147, so that a large quantity of air having an adjusted temperature and humidity is caused to circulate temporarily, thereby effecting control of the temperature and humidity in the chamber 1.

Cold water subjected to heat-exchange with the air in the cold water spraying mixer 136 is recovered into the cold water tank 104 through a pipe 141, a filter 142 and a conduit 111. The cold water is fed from the cold water tank 104 through the pipes 108 and 107 into an ice-making machine 109 and an ice-water mixing chamber 110 by means of a pump 105. In this case, the flowing direction may be controlled by a valve 106 to either the ice-making machine 109 or the ice-water mixing chamber 110. Ice-water in the ice-water mixing chamber 110 is fed into an ice-water tank 127 through a pipe 126.

In the ice-water tank 127, ice is usually floating in water, and a pipe 129 is attached at a point of the boundary between ice and

water, the mouth of the pipe 129 being screened so that only the water is fed into the aforementioned cold water pipe 138 from the pipe 129 by a pump 128.

A conduit 112 branches off at a point D from the conduit 129 downstream of the pump 128 and the cold water flowing through the conduit 112 is supplied to the cooling pipe 102 of the cold storage chamber 101, so that the cold water is circulated to cool the inner wall face of the chamber 101. The water leaving the chamber 101 from the cooling pipe 102 is fed out through a conduit 113 and joins with the water showing through the conduit 111 at a point E and is then recovered in the cold water tank 104 and is thereafter again circulated from the tank 104 as just described, the circulation being continuous.

Fig. 3 is a sectional plan view of the cold water spraying mixer 36 of Fig. 1, taken along the line A—A of Fig. 1, and therein 33 denotes a conduit and 39b, 39c... denote spraying openings for cold water. Also, Fig. 4 is a longitudinal sectional view of a further form of the cold water spraying mixer for use in apparatus according to the present invention, and therein 233 denotes a conduit, and 238 denotes a cold water pipe which extends into a spraying mixer 236. 237 denotes a conduit which is surrounded by the length of the cold water pipe 238 within the mixer 236, the aforesaid length forming a double-walled pipe 238'. Spraying openings 239a, 239b, 239c... are provided in the outer wall of the double-walled pipe 238', and cold water is sprayed out through these openings. Also, there is wound within the peripheral wall of the cold water spraying mixer 236, a cooling pipe 201 through which a coolant such as water, salt water, calcium chloride or potassium chloride solution may be circulated. Due to this, the gas in the cold water spraying mixer can be cooled approximately to a temperature of 0°C to -1°C, and, when fed into the cold storage chamber, such gas does not cause a sudden rise of temperature in the chamber and consequently does not impair the efficiency of the cold storage.

Fig. 5 is a diagrammatic view of another embodiment, wherein cooling of the cold storage chamber is performed in another way. 301 denotes a large capacity tank in which water, salt water, calcium chloride solution is stored in large quantities and is cooled by an evaporator 302 of a freezing machine to cool same approximately to a temperature of -1°C to 1°C. A pump 303 causes the coolant to flow through a conduit 313 and circulate in the cooling pipe of the cold storage chamber.

WHAT I CLAIM IS:—

1. Cold storage apparatus comprising a

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- 5 cold storage chamber having an intake from and an outlet to an external gas circulation system incorporating a cold water spraying mixer through which gas being circulated is sprayed with cold water to leave same as low-temperature moisture-rich gas and a cyclone separator downstream of said mixer to remove water droplets from said low-temperature moisture rich gas prior to flow of the latter through said intake.
- 10 2. Cold storage apparatus as claimed in Claim 1, in which the circulation system includes a bypass pipe communicating between a point between the cold storage chamber and the cold water spraying mixer and another point between the cyclone separator and the cold storage chamber.
- 15 3. Cold storage apparatus as claimed in Claim 1 or 2, wherein the cold water spraying mixer has a cooling pipe wound within the peripheral wall thereof and adapted to circulate cooling liquid therethrough to cool the cold water spraying mixer.
- 20 4. Cold storage apparatus as claimed in any one of Claims 1 to 3, and including at least two successive cold water spraying mixers arranged in series.
- 25 5. Cold storage apparatus as claimed in any one of Claims 1 to 4, including a dust arresting cyclone upstream of the cold water spraying mixer.
- 30 6. Cold storage apparatus as claimed in any one of Claims 1 to 5, wherein cold water to be sprayed in the cold water spraying mixer is circulated to and through from a water storing tank upstream of which is a freezer, and, after having been sprayed, said cold water is returned via said freezer to said tank.
- 35 40

7. Cold storage apparatus as claimed in any one of Claims 1 to 5, wherein cold water to be sprayed in the cold water spraying is circulated to and through a water storing tank upstream of which is a chamber in which the water is cooled by contact with ice, and after having been sprayed, said cold water is returned via said chamber to said tank.
- 45 8. Cold storage apparatus as claimed in any one of Claims 1 to 7, wherein a cooling pipe is adapted to circulate through the peripheral wall of the chamber cooling water solution fed from a cooling water solution storing tank.
- 50 9. Cold storage apparatus as claimed in any one of Claims 1 to 8, wherein the circulating gas is air, nitrogen gas or carbon dioxide gas.
- 55 10. Cold storage apparatus substantially as hereinbefore described with reference to Figs. 1 to 3 of the accompanying drawings.
- 60 11. Cold storage apparatus substantially as hereinbefore described with reference to Figs. 1 to 3 when modified by Fig. 4 of the accompanying drawings.
- 65 12. Cold storage apparatus substantially as hereinbefore described with reference to Figs. 1 to 3 when modified by Fig. 5 of the accompanying drawings.
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