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(54) Fresh air supply system for holds in a ship

Belüftungssystem für Laderäume auf Schiffen

Installation pour la ventilation des cales d'un navire

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(56) References cited:
EP-A- 0 136 042
DE-A- 2 556 567
SE-C- 181 618
EP-A- 0 205 979
JP-A-58 168 866
US-A- 3 360 380

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Description

[0001] The invention relates to a fresh air supply system for holds in a ship, particularly for holds accommodating cargo refrigerating plants, according to the precharacterising part of Claim 1.

[0002] During the last thirty years most fresh air supply systems for cargo refrigerating plants in ships have been equipped with a high pressure system which was developed in the fifties when oil costs were less pronounced - or perhaps not given a though of at all. Today, the operating costs for a ship are considerable, which, among other things, calls for keeping the energy consumption as low as possible.

[0003] The reason for the need to ventilate the refrigerating plant is that fruit, berries and vegetables which are to be transported consume oxygen present in the air during the ripening process while at the same time giving off heat, CO_2 and water. Bananas also produce ethylene. The higher the temperature during the transportation of a cargo, the faster will be the ripening process. It is therefore desired always to transport the cargo at as low a temperature as possible without subjecting the cargo to freeze damage and without stopping the ripening process. If the ripening is stopped, it can never be revived. To achieve a maximum storage time and maximum quality of the products, it has been found that certain values of the CO_2 concentration in the air in the storage facilities of the refrigerating plant are suitable.

[0004] As examples the following can be mentioned:

Bananas	0.3 - 0.6% (per cent by weight)
Pears, apples	2 - 3% (per cent by weight)
Citrus fruits	0.1% (per cent by weight)

[0005] Of the above-mentioned fruits, bananas are by far the greatest carbon dioxide producer at the correct transport temperature. A few approximate standard values are given as follows:

Fruit	Transport temperature (°C)	Produced weight of CO_2 per ton of supplied fresh air and day
Bananas	11.5 - 14.5 °C	300 - 500 g
Pears	-1.5 - -0.5 °C	90 g
Apples	-1.0 - ±0 °C	100 g
Oranges	±0 - +1 °C	100 g

[0006] From these tables it is clear that the fresh air requirement varies most considerably depending on the kind of fruit that is transported.

[0007] The fresh air supply systems which are presently available must, of course, be able to fulfill the highest demands that may be placed on them although these extreme conditions very seldom occur in reality. Furthermore, it should be noted that each unnecessary cubic meter of fresh air supplied to the cargo space causes extra costs for oil for generator operation to produce the current necessary for operating the fans and, above all, for defrosting of the air coolers in the refrigerating spaces.

[0008] The instruments used at present for measuring the CO_2 concentration in the hold of a ship are self-calibrating precision instruments which enable a regulation of the CO_2 concentration around a mean value. Previously existing control devices have suffered from such great inherent uncertainties that many fresh air plants, in the case of fruit transportation, have been allowed to operate at full capacity during the whole voyage, irrespective of whether this was necessary or not, with resultant unnecessarily heavy operating costs.

[0009] The SE-C-181 618 describes an arrangement for conditioning various load departments in a ship whereby each department, which is isolated from the adjoining departments can be conditioned individually. This is achieved by a central air processing plant which comprises a pressure chamber and a suction chamber. Each individual cargo department is connected via an intake pipe to said pressure chamber and via and outtake pipe to said suction chamber. Fresh air is taken in from outside and is processed in the central air processing plant with respect to temperature and

humidity. The pipes are connected to the respective chambers by controllable flaps. In dependence on the readings of temperature and humidity taken in the various departments and displayed in the central air processing plant, fresh air is delivered to the departments by controlling the afore-said flaps. This has to be done manually. The only automatic adjustment taking place is the maintenance of a static pressure in the pressure and the suction chamber in the central air processing plant.

[0010] The EP-A-0 136 042 describes an individual container being equipped with its own autonomic air conditioning system. The container is substantially shielded against the ambient atmosphere. The container may be shipped on a freight train or a lorry or may form part of the cargo of a ship. The entire conditioning equipment is installed inside the container. In addition to the temperature, the oxygen content inside said container is automatically controlled and kept on a level below that of the outside atmosphere in order to slow down the ripening process of the plant or fruit cargo. The means for adjusting the oxygen content to its desired level consists in inserting air from the outside into the container. In addition to the control of the oxygen content there may also be provided means to control the carbon dioxide content in the container. This is achieved by a carbon dioxide scrubber installed inside the container.

[0011] The DE-A-2 556 567 also describes a ventilation system for individual containers which are transported in the hold of a ship. Each container is connected to a cooler unit of its own comprising a fan and a heat exchanger. The inner spaces of the cooler unit and the container are completely separated from the space in the hold of the ship. In order to keep the carbon dioxide level in the container at a preset level a CO_2-sensor in the container senses the CO_2-level therein and causes a valve to be opened when the CO_2-level exceeds a preset value. The valve connects the container to a central fresh air supply conduit, which is separated from the space in the hold. Fresh air is introduced in the region of the fan of the container's cooler unit and is channelled through the heat exchanger. At the outlet side of the heat exchanger there is a connection to an outlet conduit of the fresh air supply system. Since the entrance of this outlet conduit is positioned at the outlet side of the heat exchanger the air that leaves the container loop through the outlet conduit carries off cooling energy and causes an additional pressure drop across the heat exchanger.

[0012] The DE-A-2 556 567 describes a number of unspecified hold compartments in which a predetermined carbon dioxide content is upheld by the supply of fresh air. This is achieved by measuring the CO_2-level in each hold compartment and supplying individually fresh air by means of a fan to each compartment in which the CO_2-level exceeds the preset level. No circulating systems inside the hold compartments are provided.

[0013] The document "THE AGRICULTURAL ENGINEER" Summer 1981, page 51f describes a system for automatic control of the oxygen content during the storage of apples under ultra low oxygen conditions. Apart from this oxygen-level control, the document also mentions the measuring of the CO_2-level and mentions CO_2-scrubber to reduce the CO_2-level.

[0014] The invention aims at developing a fresh air supply system for holds in a ship of the above-mentioned kind in which the carbon dioxide content in the hold of a ship is automatically maintained at a preset level at a minimum of costs for additional energy and equipment.

[0015] To achieve this aim the invention suggests a fresh air supply system according to the introductory part of Claim 1, which is characterized by the features of the characterizing part of Claim 1.

[0016] Further developments of the invention are characterized by the features of the additional claims.

[0017] To bring about a particularly accurate control, automatically controllable, fully sealing valves-are arranged in both the supply pipe and the outlet pipe.

[0018] Furthermore, since the fans arranged in holds do not always have sufficient capacity to effect the necessary change of air, additional fans can be arranged in both the supply conduit and the outlet conduit. The revolution rate of these fans is controlled by the member sensing the carbon dioxide content via, for example, a computer, whereby too high a carbon dioxide content leads to increased rotational speed of these fans.

[0019] The invention will now be described in greater detail with reference to the accompanying drawing showing - by way of example - in

Figure 1 a schematic cross-section of the cargo spaces of a ship,
Figure 2 schematically a vertical cross-section through the cargo space shown in Figure 1.

[0020] Figure 1, shows the sides 1 of the ship and the insulated decks 2 in the ship. The insulated decks 2 divide the shown part of the ship into two separate refrigerating spaces. These, in turn, are divided by perforated decks 3 and 4 into two spaces so as to form a total of four holds, 5,6,7 and 8.

[0021] As will be clear from Figure 2, circulation fans 10 (producing about 350-500 Pa) and air coolers 11 can be arranged at a bulkhead 9 defining the holds.

[0022] The outlet conduit 12 for the holds 5,6 and the outlet conduit 13 for the holds 7,8 are connected onto the respective air-cooler units, between the fans 10 and the air cooler 11. These outlet conduits 12,13 run inside the supply conduits 14,15, that is to say, the conduits with the colder air run inside the conduits with warmer air, which means that the insulation of these conduits can be dispensed with. By the arrangement with pipes running inside each other, an

additional advantage is gained, namely, that only half as many holes in the deck are needed, although the diameter of these holes will be somewhat greater than normal. At the outlets of the outlet conduits 12 and 13 there are arranged variable-speed controlled fans 16 and 17, respectively, and immediately inside of these there are arranged the motor-controlled valves 18 and 19, respectively, which are capable of closing the outlets completely. In similar manner, at the inlets of the supply conduits 14,15, there are arranged similar fans 20 and 21, respectively, and controllable valves 22 and 23, respectively.

[0023] For controlling the controllable valves and fans, a member 24 is provided for monitoring the carbon dioxide content in the holds. This member 24, in turn, delivers control signals by means of a computer 25 to the above-mentioned valves and fans. The member 24 also communicates with a container 26 containing carbon dioxide of a known content for self-calibration of the sensing member 24.

[0024] The fans 10 operate both during intake and exhaust of air since - as will be clear from the figures - the outlet conduits 12,13 have been connected onto the air-cooler units between the fans 10 and the air cooler 11. The fans 10 are suitably allowed to run at full speed and control the air flow through the holds by means of the valves 18,19 and 22,23. If the fans 10 should not have sufficient capacity to keep the carbon dioxide content at the desired value, even with the valves fully open, the computer 25 is allowed to deliver a starting signal to the fans 16,17 and 20,21, which are controlled to run at a suitable speed. Otherwise, of course, numerous combinations of control are possible since both controllable valves and fans are available.

Claims

1. Fresh air supply system for holds in a ship comprising means for automatic regulation and control of the concentration of carbon dioxide in a hold by controlling the current of fresh air through a channel which is formed by a supply conduit (14,15) to the hold, the hold (5,6;7,8) itself, and an outlet conduit (12,13) from the hold, **characterized** in that at least at one location in said supply conduit (14,15) or said outlet conduit (12,13) there is arranged a regulating valve (18,19;22,23) provided with an operating device as well as a member (24) for sensing the concentration of carbon dioxide, the member (24) being adapted to deliver, in the case of a sensed increase in the concentration of carbon dioxide, a control impulse to said operating device to enlarge the passage through said regulating valve (18,19;22,23) thus bringing about increased supply of fresh air, that the hold is provided with an air cooler unit comprising a circulation fan (10) and an air cooler (11), and that the outlet conduit (12,13) is connected to said air cooler unit between the fan (10) and air cooler (11).

2. Fresh air supply system according to Claim 1, **characterized** in that automatically controllable, fully sealing valves (18,19;22,23) are mounted in both the supply conduit and the outlet conduit.

3. Fresh air supply system according to Claim 1 or 2, **characterized** in that additional fans (20,21;16,17) are arranged in both the supply conduit (14,15) and the outlet conduit (12,13), said fans being controlled in dependence on control impulses received from the sensing member (24).

4. Fresh air supply system according to any of the preceding claims, **characterized** in that the sensing member (24) for self-calibration includes a calibration tube (26) containing a known concentration of carbon dioxide.

Patentansprüche

1. Frischluftversorgungssystem für Laderäume von Schiffen mit einer Einrichtung zur automatischen Regelung und Steuerung der Konzentration von Kohlendioxyd in einem Laderaum durch Steuerung des Frischluftstromes durch einen Kanal, der gebildet wird von einer Eintrittsleitung (14, 15) zu dem Laderaum, dem Laderaum (5, 6; 7, 8) selbst und einer Austrittsleitung (12, 13) von dem Laderaum, **dadurch gekennzeichnet**, daß zumindest an einer Stelle der genannten Eintrittsleitung (14,15) oder der genannten Austrittsleitung (12,13) ein Regulierventil (18, 19; 22, 23) mit einem Betätigungsglied sowie ein Glied (24) zur Messung der Kohlendioxydkonzentration vorhanden ist, wobei das Glied (24) im Falle eines gemessenen Anstiegs der Kohlendioxydkonzentration einen Steuerimpuls an das genannte Betätigungsglied zu liefern vermag, um den Durchtritt durch das genannte Regulierventil (18, 19; 22, 23) zu vergrößern, wodurch die Zufuhr von Frischluft vergrößert wird, daß der Laderaum mit einer Luftkühlereinheit ausgerüstet ist, zu der ein Zirkulationsventilator (10) und ein Luftkühler (11) gehören, und daß die Austrittsleitung (12, 13) an die genannte Luftkühler-Einheit zwischen dem Ventilator (10) und dem Luftkühler (11) angeschlossen ist.

2. Frischluftversorgungssystem nach Anspruch 1, **dadurch gekennzeichnet**, daß automatisch steuerbare vollständig schließende Ventile (18, 19; 22, 23) sowohl in der Eintrittsleitung wie in der Austrittsleitung angeordnet sind.

3. Frischluftversorgungssystem nach Anspruch 1 oder 2, **dadurch gekennzeichnet**, daß zusätzliche Ventilatoren (20, 21; 16, 17) sowohl in der Eintrittsleitung (14,15) wie in der Austrittsleitung (12,13) angeordnet sind, die in Abhängigkeit eines Steuerimpulses gesteuert werden, der von dem Meßglied (24) geliefert wird.

4. Frischluftversorgungssystem nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet**, daß das Meßglied (24) zur Selbsteichung ein Eichrohr mit einer bekannten Kohlendioxydkonzentration enthält.

Revendications

1. Système d'alimentation en air frais des cales d'un navire, comprenant des moyens de régulation automatique et de commande de la concentration du dioxyde de carbone, dans une cale, en réglant le courant d'air frais dans un canal formé d'un conduit d'alimentation (14,15) allant à la cale, de la cale (5,6;7,8) elle-même et d'un conduit de sortie (12,13) issu de la cale, caractérisé en ce qu'il est disposé au moins en un point du canal une vanne de régulation (18,19;22,23), munie d'un dispositif de manoeuvre et, en outre, d'un élément (24) de détection de la concentration du dioxyde de carbone, l'élément (24) étant apte à envoyer, dans le cas d'une détection d'une augmentation de la concentration de dioxyde de carbone, une impulsion de commande au dispositif de manoeuvre pour agrandir le passage dans la vanne de régulation (18,19,22,23) et provoquer ainsi une augmentation de l'alimentation en air frais et la cale est muni d'une unité de refroidissement de l'air comprenant un ventilateur de circulation (10) et un refroidisseur (11) de l'air et en ce que le conduit de sortie (12,13) communique avec le refroidisseur (11) de l'air entre le ventilateur (10) et le refroidisseur (11) de l'air.

2. Système d'alimentation en air frais, selon la revendication 1, caractérisé en ce que des vannes (18,19;22,23), pouvant être commandées automatiquement et fermant entièrement, sont montées à la fois sur le conduit d'alimentation et sur le conduit de sortie.

3. Système d'alimentation en air frais, suivant la revendication 1 ou 2, caractérisé en ce que des ventilateurs (20,21,16,17) supplémentaires sont prévus, a la fois sur le conduit d'alimentation et sur le conduit de sortie, ces ventilateurs étant commandés en fonction d'impulsions de commande reçues de l'élément (24) de détection.

4. Système d'alimentation en air frais, suivant l'une quelconque des revendications précédentes, caractérisé en ce que l'élément (24) de détection comprend, pour un auto-jaugage, un tube de jaugage (26) contenant une concentration connue de dioxyde de carbone.

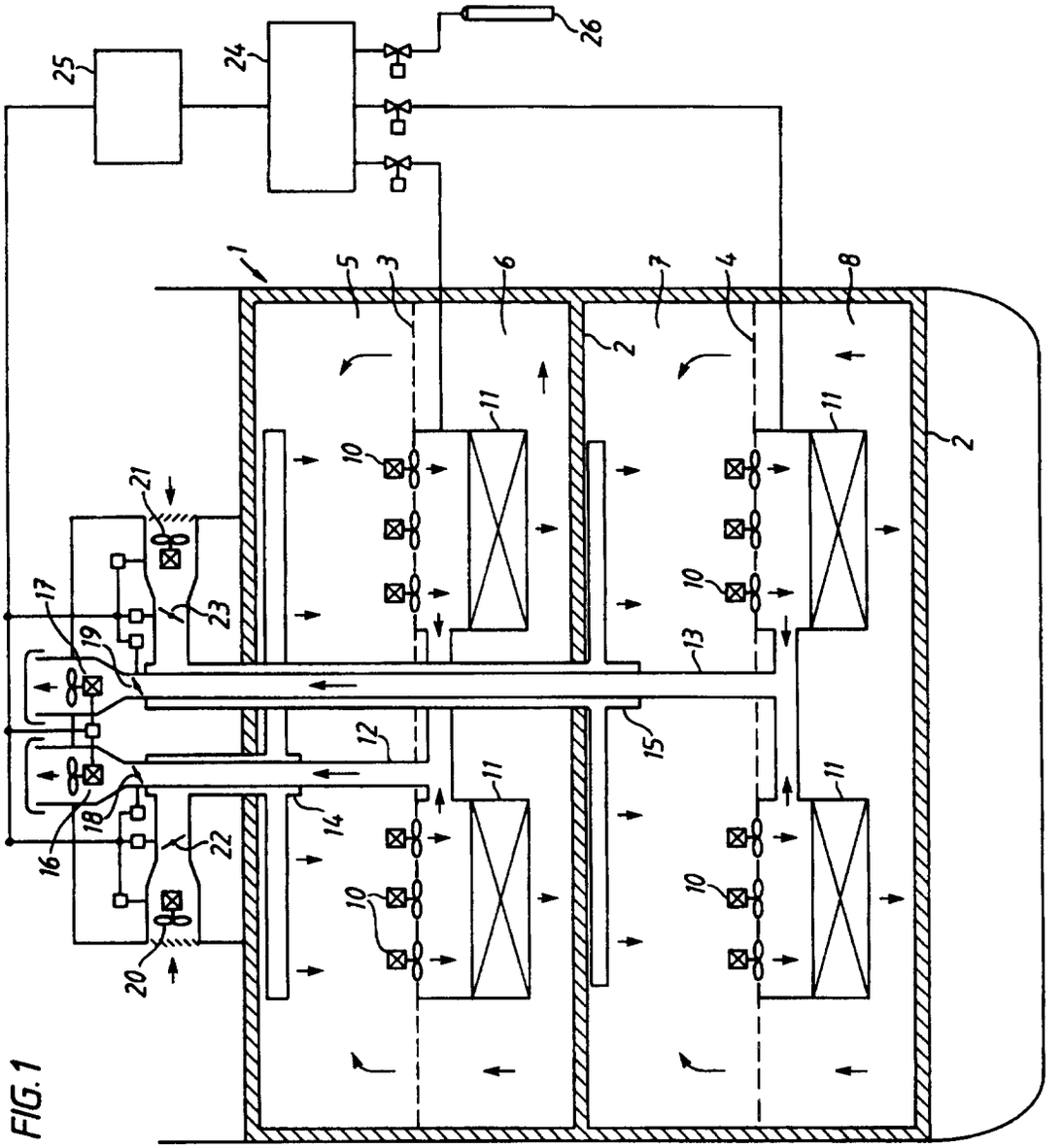
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FIG. 1

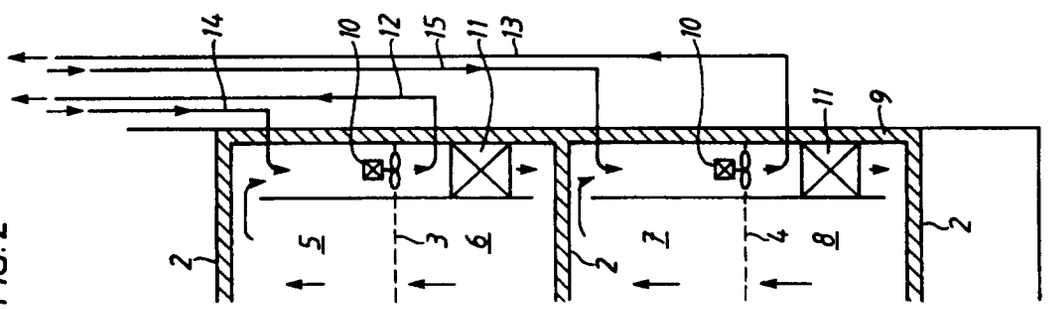
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FIG. 2