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FR-A- 2 468 308
US-A- 2 251 649
US-A- 2 382 502
US-A- 2 629 587

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Description

This invention relates to cooling apparatus and a method of cooling according to the preambles of claims 1 and 7 respectively.

It is concerned to provide a method and means for cooling produce and in particular fresh fruit and vegetables to a temperature where wilting and other loss of freshness will be prevented or strongly retarded.

Such cooling is by the maintenance of cooled air or other gas (hereinafter "air") around the harvested produce.

The cooling apparatus which cools them may for large and permanent insulations be the type of cooler known as an ice bank cooler such as for example our own Humidicool (trade mark) apparatus. Use of such apparatus ensures not only that the air is cooled to the desired temperature but that it maintains a high humidity, without which drying out or wilting of the produce may well occur even at a lowered temperature.

Any attempt to introduce portable or small scale cooling equipment to such produce stores has however so far been unsuccessful because of the lowering of humidity which they cause in the cooled air.

Conventional portable cooler equipment consists of a battery of tubes through which cooled indirect heat exchange medium flows. The tubes are positioned and separated by vertical plates which are comparatively close together and which both guide the air flow across the tubes and extend the effective heat exchanging surface of the tubes whereby to maximise the indirect heat exchange effect.

As the air is cooled its saturation vapour point lowers and water is condensed onto the tubes or plates. This flows downwardly down the plates and is caught by a drip tray or the like and is removed to a drain.

However, not all air is in direct contact with the tubes or plates and the net relative humidity of the cooled air which is the output from the device will rarely exceed 95% and will often be as low as 90%.

US-A-2,382,502 shows a gas cooling system in which the condensed water formed on the heat exchanger plates is collected by allowing it to drip into a pan and then the collected water is reintroduced into the gas flow by a centrifugal lift.

FR-A-2,468,308 discloses a system in which the condensed water is collected in a reservoir and the cooled gas flow is guided to flow over the surface of the water in the reservoir.

The object of the present invention is to provide an air cooler which while being in principal embodiable as a portable and small device nevertheless will give a cooled air output having a high relative humidity namely one above 95% and preferably in the region of 96 or 97%.

To this end, the present invention provides a gas cooling system characterised by said plates being arranged for conducting water condensed thereon to be impelled towards the downstream end of the heat exchanger by the gas flow, and the condensed water being impelled by that flow into means towards or beyond the downstream end of the exchanger for reintroducing the condensed water into the cooled gas flow by contacting with that flow.

The reintroduction may be in a high-surface-area body such as a cellulose honeycomb.

Preferably the tubular array consists primarily of vertically disposed tubes. A single tube may be disposed in a zig-zag formation across a parallel array of a plurality of plates.

The invention also provides a method of providing cooled gas of high relative humidity characterised by impelling by the gas flow the condensed water from the heat exchanger surfaces to reintroduction means located at the gas output side of the heat exchanger so as to reintroduce the condensed water to the cooled gas. Preferably the method includes distributing the collected liquid throughout a high surface body such as a body of cellulose honeycomb.

A particular embodiment of the invention will be described with reference to the accompanying drawings wherein:

Figure 1 is a plan view of the embodiment and

Figure 2 is an elevation along the line Y to Y in Figure 1.

In this air cooler which should produce air at a temperature of approximately 2.5°C and a relative humidity of 96 to 97%, a plurality of metal plates 1 are stacked horizontally in an array. Indirect heat exchangers 2 are formed by convoluted tubes led though the plates so as to be positioned with the principal straight runs 3 of the convolutions vertical. A plurality of such tubes laterally side by side forms an array 4 and coolant liquid for indirect heat exchange with air is led into the array by duct 5 and out of it by duct 6. Air to be cooled is blown over the array in the direction of the arrows 7 and loses heat to the tubes. In doing so water will be condensed onto the tubes and onto the plates (which being metallic act as an extended heat exchange surface for the tubes). At least most of the water condensed in this way will be caught upon the horizontal plates and will be blown along the plates by the air flow until it reaches the downstream edge 8 of the heat exchange assembly. Here water indicated by droplets 9 will meet a mass 10 of a high-surface-area spongy or open cellular body, in this embodiment the material being a resin-impregnated cellulose honeycomb. Other materials such as wooden slats and formed plastics sheets will also be particularly suitable. Under the influence of the air flowing through this body between extended top and bottom plates 1 the droplets are swept into it and are dispersed upon its high surface area so that they are recontacted with the cooled air. As a result the water is

taken up again by that air so as to raise its relative humidity. The effect of the high surface area body is not only to cause resumed contact between the water and the air flow but also to ensure homogeneity of temperature in the air flow at a time when it is capable of taking up water to a high relative humidity. In the prior art situation any air which is comparatively uncooled at the time of expulsion from the heat exchanger had no opportunity to take up moisture except from other air thereby leading to a reduced overall relative humidity.

As can be seen from Figure 2 the device is equipped also with a drip tray 11 and drain 12 in a conventional manner so that any water not taken up by the air that leaves the block 10 at 13 may be collected and disposed of as usual.

Claims

1. A gas cooling system having an indirect heat exchanger (2) for cooling a gas flow (7) and being associated with a plurality of essentially parallel plates (1) arranged for guiding the gas flow (7) across the exchanger (2), characterised by said plates (1) being arranged for conducting water condensed thereon to be impelled towards the downstream end of the heat exchanger (2) by the gas flow (7); and the condensed water being impelled by that flow into means (10) towards or beyond the downstream end of the exchanger (2) for reintroducing the condensed water into the cooled gas flow (7) by contacting with that flow.

2. A gas cooling system according to claim 1 wherein the means (10) for reintroducing condensed water is a high-surface-area body.

3. A gas cooling system according to claim 1 or claim 2 wherein the exchanger (2) is one or more tubes convoluted in a direction substantially perpendicular to the plates (1).

4. A gas cooling system according to claim 3 wherein there are a plurality of said convoluted tubes connected between an inflow duct (5) and an outflow duct (6).

5. A gas cooling system according to any one of claims 2 to 4 wherein the plates (1) are substantially horizontal and the reintroduction means (10) are at the downstream end of the plates (1).

6. A gas cooling system according to any one of the preceding claims wherein the reintroduction means (10) is a cellulose honeycomb.

7. A method of providing cooled gas of relatively high humidity which consists of cooling a gas flow (7) by guiding it through an indirect heat exchanger (2); condensing moisture from the cooled gas on surfaces (1) in the heat exchanger which surfaces are parallel to the direction of the gas flow (7); characterised by impelling by the gas flow (7) the condensed water from the heat exchanger surfaces (1) to reintroduction means (10) located at the gas output side of the heat exchanger (2) so as to reintroduce the condensed water to the cooled gas.

8. A method according to claim 7 wherein the collected water is reintroduced in the reintroduction means (10) which is a high-surface-area body (10).

9. A method according to claim 7 or claim 8 wherein the surfaces (1) are substantially horizontal.

Patentansprüche

1. Gaskühlungssystem mit einem indirekten Wärmeaustauscher (2) zum Kühlen eines Gasflusses (7), das mit einer Vielzahl an im wesentlichen parallelen Platten (1) verbunden ist, die zum Lenken des Gasflusses (7) durch den Austauscher (2) angeordnet sind, dadurch gekennzeichnet, daß die genannten Platten (1) angeordnet sind, darauf kondensiertes Wasser zu lenken, um es zum stromabwärtigen Ende des Wärmeaustauschers (2) durch den Gasfluß (7) vorwärtszubefördern; und daß das kondensierte Wasser durch diesen Fluß in ein Mittel (10) zum oder über das stromabwärtige Ende des Austauschers (2) befördert wird, um das kondensierte Wasser durch das In-Kontakt-Bringen mit diesem Fluß wieder in den gekühlen Gasfluß (7) einzuleiten.

2. Gaskühlungssystem nach Anspruch 1, worin das Mittel (10) zum Wiedereinleiten des kondensierten Wassers ein Körper mit großem Oberflächenbereich ist.

3. Gaskühlungssystem nach Anspruch 1 oder Anspruch 2, worin der Austauscher (2) aus einem oder mehreren Rohren besteht, die in einer zu den Platten (1) im wesentlichen senkrechten Richtung gewunden sind.

4. Gaskühlungssystem nach Anspruch 3, worin eine Vielzahl der genannten gewundenen Rohre vorhanden ist, die zwischen einem Zuflußrohr (5) und einem Abflußrohr (6) verbunden sind.

5. Gaskühlungssystem nach einem der Ansprüche 2 bis 4, worin die Platten (1) im wesentlichen horizontal sind und sich die Wiedereinleitungsmittel

(10) am stromabwärtigen Ende der Platten (1) befinden.

6. Gaskühlungssystem nach einem der vorhergehenden Ansprüche, worin das Wiedereinleitungsmittel (10) eine Zellulose-Honigwabe ist.

7. Verfahren zum Erzeugen von gekühltem Gas relativ hoher Feuchtigkeit umfassend das Kühlen eines Gasflusses (7), indem er durch einen indirekten Wärmeaustauscher (2) gelenkt wird; das Kondensieren von Feuchtigkeit aus dem gekühlten Gas auf Oberflächen (1) im Wärmeaustauscher, welche Oberflächen zur Richtung des Gasflusses (7) parallel sind; dadurch gekennzeichnet, daß das kondensierte Wasser durch den Gasfluß (7) von den Wärmeaustauscheroberflächen (1) zum Wiedereinleitungsmittel (10) vorwärtsbefördert wird, das an der Gasausstoßseite des Wärmeaustauschers (2) angeordnet ist, um das kondensierte Wasser dem gekühlten Gas wiederzuzuführen.

8. Verfahren nach Anspruch 7, worin das gesammelte Wasser im Wiedereinleitungsmittel (10) wiederzugeführt wird, das ein Körper (10) mit großem Oberflächenbereich ist.

9. Verfahren nach Anspruch 7 oder Anspruch 8, worin die Oberflächen (1) im wesentlichen horizontal sind.

Revendications

1. Système de refroidissement à gaz, possédant un échangeur de chaleur indirect (2) pour refroidir un flux de gaz (7) et associé à une pluralité de plaques essentiellement parallèles (1) agencées pour guider le flux de gaz (7) à travers l'échangeur (2), caractérisé en ce que lesdites plaques (1) sont agencées de façon à conduire l'eau condensée sur celles-ci pour qu'elle soit forcée vers l'extrémité aval de l'échangeur de chaleur (2) par le flux de gaz (7); et l'eau condensée étant forcée par ce flux dans des moyens (10) vers ou au-delà de l'extrémité aval de l'échangeur (2) pour réintroduire l'eau condensée dans le flux de gaz refroidi (7) par une mise en contact avec ce flux.

2. Système de refroidissement à gaz conformément à la revendication (1), dans lequel le moyen (10) pour réintroduire l'eau condensée est un corps de zone de surface élevée.

3. Système de refroidissement à gaz conformément à la revendication 1 ou 2, dans lequel l'échangeur (2) est constitué d'un ou de plusieurs tubes en spires suivant une direction sensiblement perpendiculaire aux plaques (1).

4. Système de refroidissement à gaz selon la revendication 3, dans lequel il est prévu une pluralité desdits tubes en spires connectés entre un conduit d'entrée (5) et un conduit de sortie (6).

5. Système de refroidissement à gaz conformément à l'une des revendications 2 à 4, dans lequel les plaques (1) sont sensiblement horizontales et les moyens de réintroduction (10) se trouvent à l'extrémité aval des plaques (1).

6. Système de refroidissement à gaz conformément à l'une des revendications précédentes, dans lequel les moyens de réintroduction (10) sont constitués par un nid d'abeilles en cellulose.

7. Procédé pour réaliser un gaz refroidi d'une humidité relativement élevée qui consiste à refroidir un flux de gaz (7) en le guidant à travers un échangeur de chaleur indirect (2); à condenser l'humidité du gaz refroidi sur des surfaces (1) dans l'échangeur de chaleur, ces surfaces étant parallèles à la direction du flux de gaz (7); caractérisé en forçant par le flux de gaz (7) l'eau condensée des surfaces (1) de l'échangeur de chaleur aux moyens de réintroduction (10) situés au côté de sortie de gaz de l'échangeur de chaleur (2), de façon à réintroduire l'eau condensée dans le gaz refroidi.

8. Procédé selon la revendication 7, dans lequel l'eau collectée est réintroduite dans le moyen de réintroduction (10) qui est un corps de zone de surface élevée (10).

9. Procédé selon la revendication 7 ou la revendication 8, dans lequel les surfaces (1) sont sensiblement horizontales.

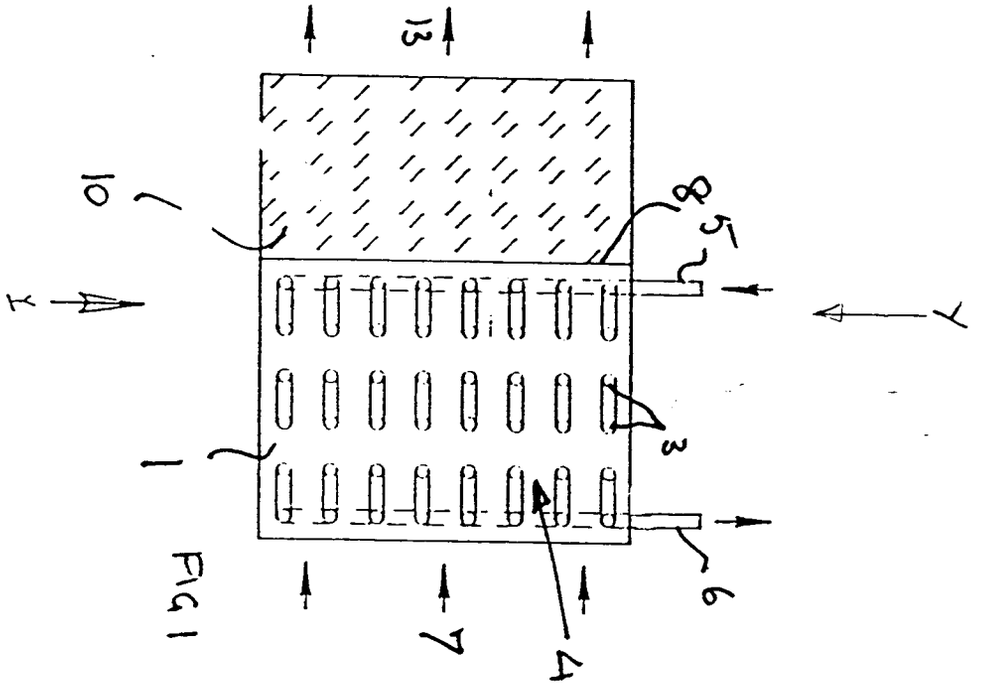


Fig 1

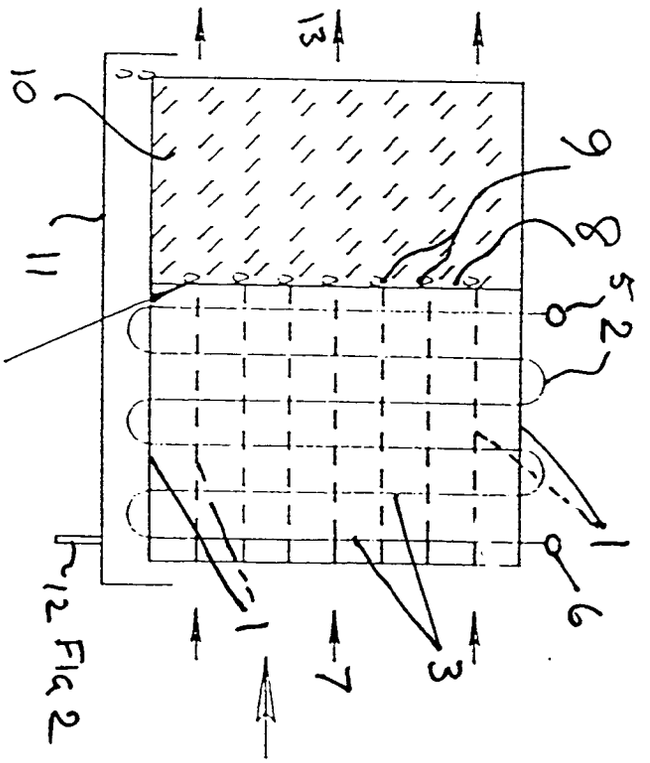


Fig 2