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(12) # EUROPEAN PATENT APPLICATION

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(71) Applicant: **THERMAL ENGINEERING SYSTEMS LIMITED**
Uffculme
Cullompton, Devon EX15 8AJ (GB)

(72) Inventor: **Reed, Peter Sutherland, c/o Thermal Engineering Systems Limited, Uffculme Cullompton, Devon EX15 8AJ (GB)**

(74) Representative: **Harrison, David Christopher et al**
MEWBURN ELLIS 2 Cursitor Street London EC4A 1BQ (GB)

(54) **Cooling apparatus and method.**

(57) A gas cooling system has a tube or tubes (2) for a heat exchange medium. A gas to be cooled is flowed across the tube or tubes (2), being guided by a plurality of parallel plates (1). Water which is condensed on the plates (1) as the gas cools is collected and reintroduced into the gas to provide a cooled gas of high relative humidity.

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This invention relates to cooling apparatus and a method of cooling.

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%.

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 an indirect heat exchange gas cooler in which the cooling medium is led through a tubular array for contact with the gas to be cooled, the tubular array being associated with a plurality of essentially horizontal plates, there being means beyond the downstream end of the tubular array for re-introducing condensed water to contact with the cool gas stream. 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 which consists of cooling gas by passing it through an indirect cooling heat exchanger, collecting moisture condensed from the cooled gas on horizontal surfaces in the exchanger and reintroducing the condensed and collected water to the cooled gas at an output side of the heat exchanger. Preferably the method includes distributing the collected liquid throughout a high surface body such as a body of cellulose honeycomb. Movement of the condensed water to the downstream side of the heat exchanger may be assured by the gas flow itself.

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 through 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 that 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 is 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 equip-

ped 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) arranged for contact with a gas to be cooled, and being associated with a plurality of essentially parallel plates (1) for guiding flow (7) of the gas across the exchanger (2), there being means (10) towards or beyond the end of the exchanger (2) which is downstream in the gas flow for reintroducing water condensed in the heat exchanger (2) into the cooled gas flow.

2. A gas cooling system according to claim I 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), whereby the plates (1) act to conduct water to the means (10) under the influence of the gas flow (7).

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

7. A method of providing cooled gas of relatively high humidity which consists of cooling gas by cooling it in an indirect heat exchanger (2), collecting moisture condensed from the cooled gas on surfaces (1) in the exchanger which surfaces are parallel to the direction of flow (7) of the gas to be cooled, and reintroducing condensed and collected water to the cooled gas at the gas output side of the heat exchanger (2).

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

9. A method according to claim 7 or claim 8 wherein the surfaces are substantially horizontal and the collected water is impelled towards the gas output side of the heat exchanger (2) by the gas flow (7).

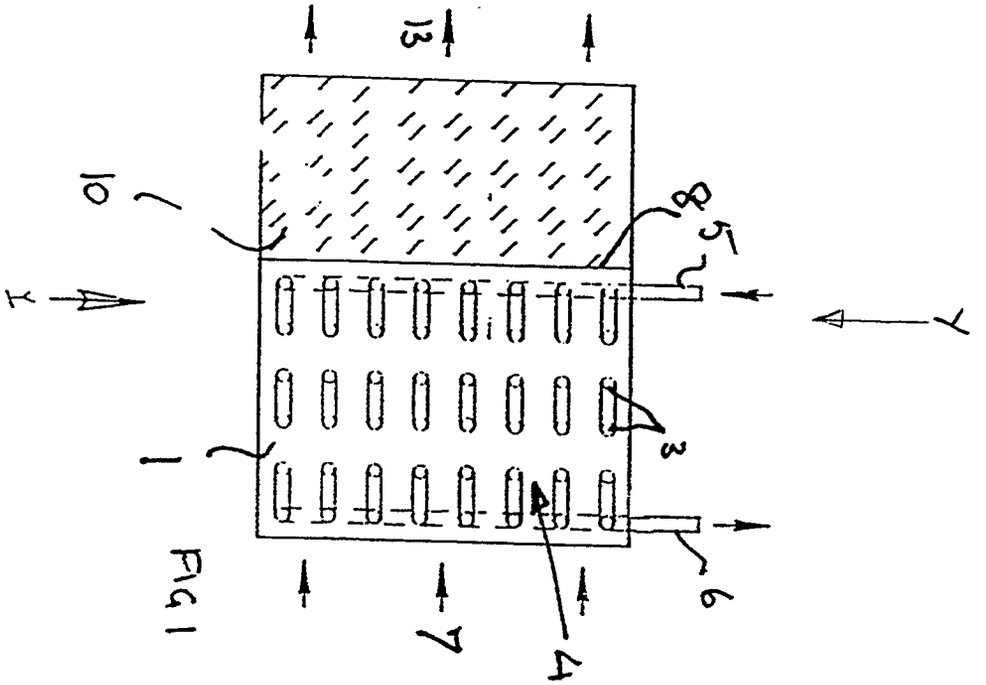

Fig 1

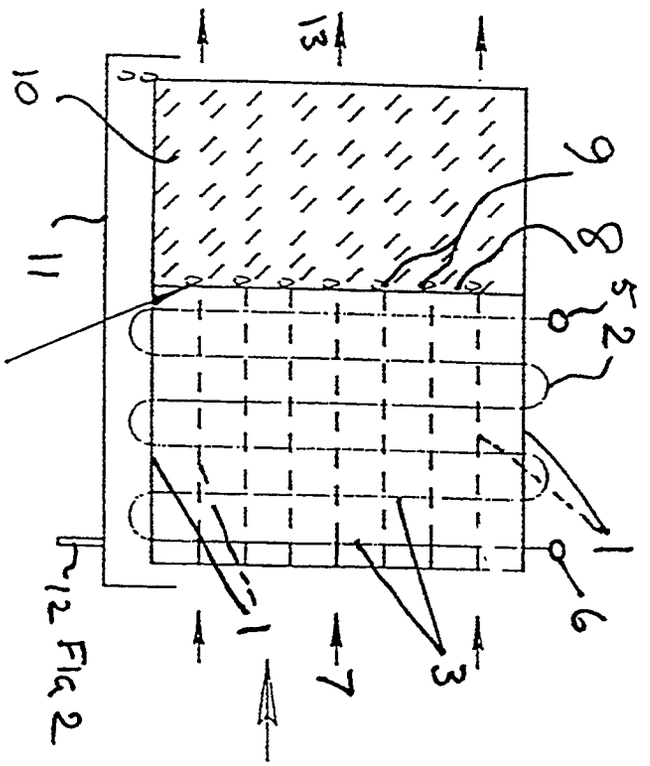

Fig 2