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COOLING APPARATUS WITH HUMIDITY MEANS

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2 Sheets-Sheet 1

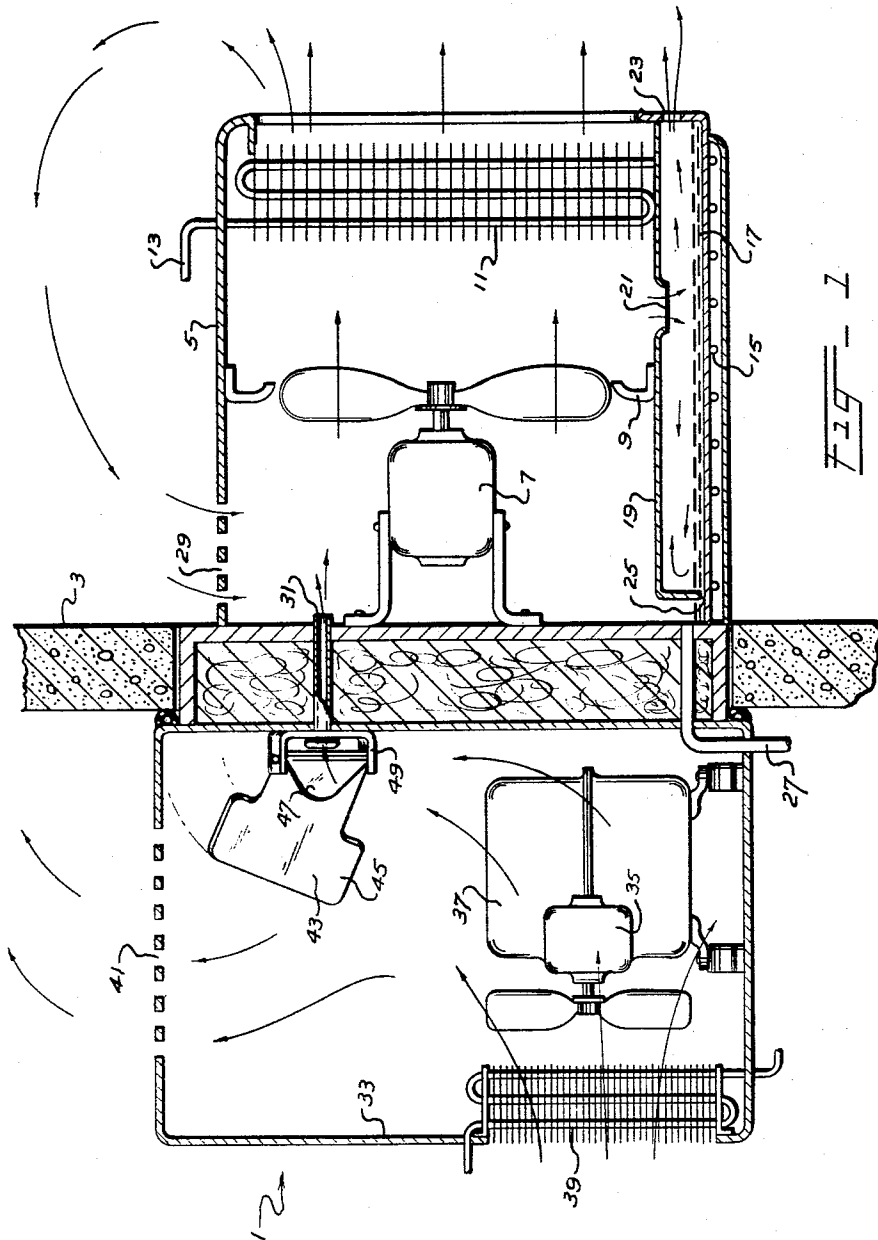


Fig. 1

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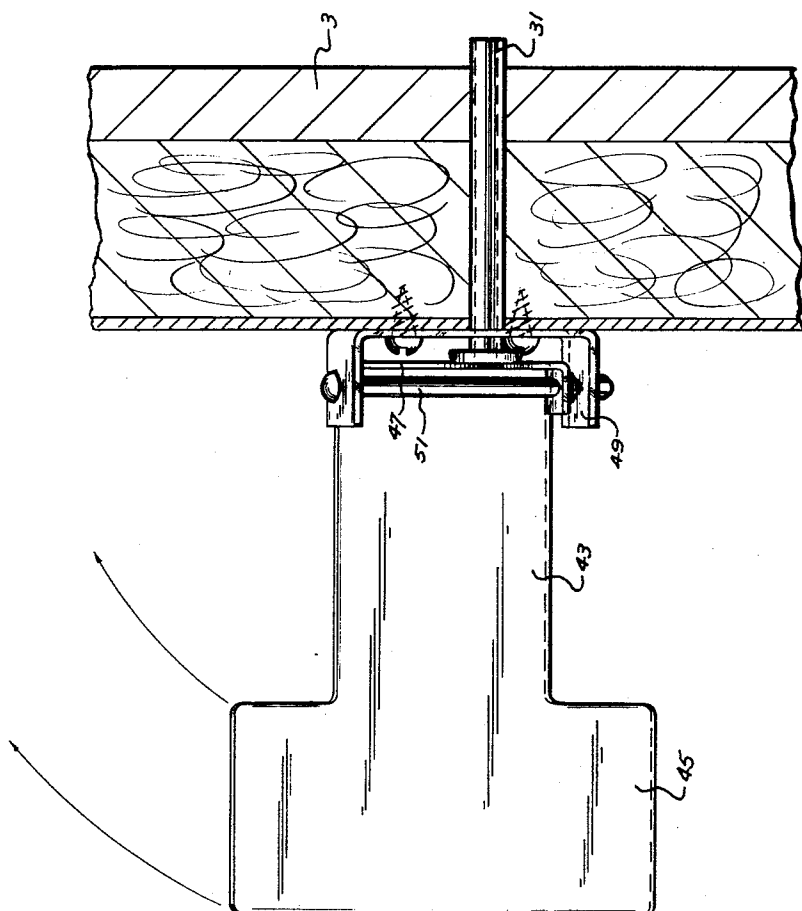


Fig. 2

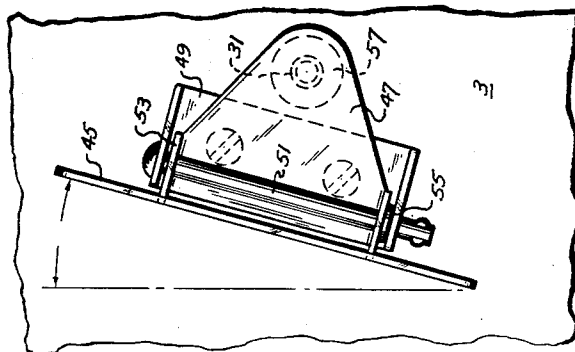


Fig. 3

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COOLING APPARATUS WITH HUMIDITY MEANS

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7 Claims. (Cl. 62—91)

The present invention relates to methods and apparatus for cooling air. The invention has particular application in the maintenance of desirable conditions of temperature and humidity in the cold storage of fresh produce such as eggs.

It is well known that fresh produce must often be stored under refrigeration, and that the conditions of cold storage materially affect the length of time such produce may profitably be stored and the condition of the produce when removed from storage. For example, if a proper temperature-humidity balance is not maintained during the course of such storage, the produce may become dried and withered or may suffer substantial loss in weight, and may thus be reduced in grade or become altogether unsaleable. Although many attempts have heretofore been made to provide proper conditions of temperature and humidity in the art of air cooling, none, as far as I am aware, has been entirely successful when carried into practice commercially on an industrial scale.

Accordingly, it is an object of the present invention to provide methods and apparatus for cooling air embodying maximum thermodynamic efficiency.

Another object of the invention is to provide methods and apparatus for cooling air in which undesirably low humidity of the cooled air will be avoided.

The invention also contemplates providing methods and apparatus for cooling air in which a desirable balance between recycled air and makeup air will be maintained.

It is a further object of the invention to provide apparatus for cooling air, which, when idle, will prevent escape of cooled air.

Finally, the invention further contemplates providing apparatus for cooling air which will be simple and relatively inexpensive in construction, easy to service and maintain, and rugged and durable in use.

Other objects and advantages will become apparent from the following description taken in conjunction with the accompanying drawings, in which:

Figure 1 is a somewhat diagrammatic cross-sectional elevational view of air cooling apparatus according to my invention;

Figure 2 depicts a side elevational view of a novel shutoff valve assembly according to my invention; and

Figure 3 shows an end elevational view of the structure of Figure 2 taken from the left side thereof.

Referring now to the drawings in greater detail, I have shown in Figure 1 an air cooling device indicated generally at 1, comprising a cooling chamber 3 extending to the right of the concrete wall shown in section in Figure 1. Chamber 3 is closed on all sides and contains within it a fan chamber 5 which is also closed except for certain openings to be described later. A fan 7 of conventional construction is mounted within the fan chamber and the fan blades are encompassed by a conventional venturi-ring 9 mounted on the inside walls of the fan chamber. Fan 7 moves output air through chamber 5 and out of the chamber past finned evaporator coils 11

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of a conventional evaporator. The evaporator of course draws heat from the outward air thereby adding to the latent heat of a gaseous refrigerant which has been expanded through a conventional expansion valve (not shown) adjacent the lower end of the evaporator and which discharges through upper end 13 to a compressor in the usual manner.

Warm liquid refrigerant is fed to the evaporator from the condenser as is usual; but in the present invention, I have provided an extended length of circuitous piping 15 in the piping between the condenser to the evaporator, which is arranged in sinuous loops as seen in cross-section in Figure 1. Piping 15 is arranged beneath and in contact with the lower wall of a condensate sump 17 into which condensate from coils 11 falls and is collected. Thus, the liquid refrigerant in piping 15 will be heat exchanged with the condensate in sump 17. Needless to say, the lower wall of sump 17 could be eliminated and piping 15 run directly through the condensate. Sump 17 is covered over with a baffle 19 provided with an entrance port 21 on the downstream side of fan 7. Port 21 permits output to flow into contact with the condensate in sump 17 and out into the cooling chamber through an exit port 23. Baffle 19 is provided with a discharge port adjacent the bottom of the sump through which condensate may flow; and a down pipe 27 is provided to provide overflow for excess condensate.

An aperture 29 is provided in a side wall of chamber 5 and connects the interior of the cooling chamber with the interior of fan chamber 5 on the upstream side of fan 7. Aperture 29 may be designed by a screen or expanded metal grill work; and hence, the term "aperture" is defined as the sum total of the separate openings defined by the grill. The exterior of cooling chamber 3 is connected with the interior of fan chamber 5 on the upstream side of fan 7 through an orifice 31, which may be defined for example by a pipe section as shown in cross-section in Figure 1. The total cross-sectional area of aperture 29 is substantially greater than the cross-sectional area of orifice 31.

Exteriorly of cooling chamber 3, but in lateral alignment with fan chamber 5, is a second fan chamber 33 containing a second fan 35 which may if desired be mounted as a unit with compressor 37. Second fan 35 draws intake air into chamber 33 past finned condenser coils 39 of a conventional condenser on the downstream side of compressor 37, as is usual. It will, of course, be understood that the piping shown at 13 delivers gaseous refrigerant to compressor 37 which compresses the gaseous refrigerant and delivers it to condenser coils 39 where it is condensed to a warm liquid which then flows back through piping 15 to the evaporator to complete the cycle. However, for purposes of clarity, the conventional piping between the various units in the refrigeration cycle has been omitted from Figure 1 of the drawings.

Second fan chamber 33 is provided with a second aperture 41 similar to aperture 29 and on the downstream side of fan 35. Second aperture 41 is of substantially greater total cross-sectional area than orifice 31, which is also on the downstream side of fan 35.

Means are provided for preventing air entering through orifice 31 when fan 35 is idle and refrigeration is interrupted. This is necessary for the reason that fan 7 is continuously operated and produces a reduced pressure in the area of the orifice 31. The means comprises a vane 43 in the form of a dihedral member having a pair of legs meeting in a dihedral corner angle, leg 45 comprising a sail to be contacted by the air stream from fan 35 and leg 47 comprising a closure member adapted to close orifice 31.

As perhaps better seen in Figures 2 and 3, vane 43

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is supported for pivotal movement in a U-shaped bracket mounted on the outside of cooling chamber 3 adjacent orifice 31, and has pivotal movement about a pin 51 inclined at an angle from the vertical. The vane is provided with upstanding ears 53 engageable about pin 51 and is spaced from the leg of bracket 49 by a nylon bearing washer 55. An annular ring-like seal 57 of elastic-deformable material such as neoprene or the like is provided about the adjacent end of orifice 31, upon which leg 47 sealingly engages to seal the orifice 31 when the fan 35 is idle.

The operation of my novel device is as follows:

When compressor 37 is actuated, fluid refrigerant will flow through the closed refrigeration system in the conventional condensation-evaporation cycle. Fans 7 and 35 are turned on; and the air, drawn into chamber 33 and passed through the condenser coils 39 to condense the refrigerant, will be propelled toward orifice 31, leg 45 of vane 43, and out through aperture 41. The air stream striking leg 45 will cause vane 43 to swing up about an axis parallel to its dihedral corner angle, whereupon leg 47 will uncover orifice 31. The intake air passing through aperture 41 will meet with a slight resistance causing a pressure rise in chamber 33 slightly above atmospheric, on the downstream side of fan 35.

In fan chamber 5, fan 7 draws the cooled air in the cooling chamber in through aperture 29 on the upstream side of the fan and propels it through evaporator coils 11 out into the cooling chamber again, in a continuous recycling. However, the resistance of aperture 29 provides that the air pressure on the upstream side of fan 7 within chamber 5 will be slightly lower than atmospheric. Thus, the pressure differentials between adjacent parts of chambers 5 and 33 will assure a small flow of fresh makeup air through orifice 31 into chamber 5. However, a substantially greater quantity of air will be recycled through chamber 5 than will be added from the outside, due to the differential cross-sectional areas of aperture 29 and orifice 31, just as a substantially greater volume of intake air will be vented through aperture 41 than will pass through orifice 31, for the same reason.

Fan 7 propels the output air past evaporator coils 11, where the air gives up part of its moisture in the form of condensate, which collects on the coils and then falls by gravity to sump 17 where a body of condensate is collected. The condensate is substantially cooler than the warm liquid refrigerant passing through piping 15 toward the evaporator; and hence, the condensate is warmed by the liquid refrigerant and the liquid refrigerant is pre-cooled by the condensate. The resistance of coils 11 to the passage air assures that the air pressure in chamber 5 on the downstream side of fan 7 will be slightly higher than atmospheric, with the result that a portion of the output air will seek a path through ports 21 and 23 and thus out into cooling chamber 3. In so doing, this portion of the output air is brought into contact with the condensate in sump 17 by the baffle 19. This portion of the chilled output air traveling at a high speed agitates the warmed condensate causing a rapid evaporation of condensate to take place. Thus, the air exiting through port 23 will have a very high humidity which when mixed with the air passing coils 11 will raise the humidity of the total mass of air within cooling chamber 3 so that the produce or the like stored within chamber 3 will not dry out.

Apart from raising the humidity of the air exiting through port 23, the arrangement of elements 15, 17 and 19 performs the second useful function of pre-cooling the refrigerant fed toward the evaporator. Obviously, if the sensible heat of the liquid refrigerant passing from the condenser to the evaporator is reduced, the latent heat capacity of the gaseous refrigerant in the evaporator will be correspondingly raised. In this way, the thermodynamic efficiency of the cooling device as a whole will be improved.

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Thus, it will be seen that I have achieved all of the objects of my invention recited above.

Although the present invention has been described in conjunction with preferred embodiments, it is to be understood that modifications and variations may be resorted to without departing from the spirit and scope of the invention, as those skilled in the art will readily understand. Such modifications and variations are considered to be within the purview and scope of the invention and appended claims.

I claim:

1. In a method of cooling air with a closed fluid refrigerant system which comprises the cyclic steps of feeding gaseous refrigerant toward a condenser, heat exchanging said refrigerant in said condenser with intake air to condense said refrigerant to a liquid, feeding said liquid toward an evaporator, expanding said liquid to a gas in said evaporator, heat exchanging said gas in said evaporator with output air whereby a portion of the moisture of said output air condenses on and falls by gravity from said evaporator as condensate, and compressing said gas to repeat the cycle; the improvement in cooling recirculated air and adding moisture thereto which comprises the steps of cooling said condensate, heat exchanging said cooled condensate with said liquid fed toward said evaporator to warm said cooled condensate and pre-cool said liquid, by-passing said evaporator with a minor portion of the recirculated air, and contacting said by-passed air with said warm condensate to increase the humidity of the total recirculated air.

2. A device for cooling and recirculating air within a cooling chamber, comprising in combination with a cooling chamber, a fan chamber in said cooling chamber, a fan in said fan chamber for moving output air through said fan chamber and a major portion thereof past an evaporator and into said cooling chamber, said fan chamber having an aperture connecting the interior of said cooling chamber with the interior of said fan chamber on the upstream side of said fan and an orifice connecting the exterior of said cooling chamber with the interior of said fan chamber on the upstream side of said fan, the cross-sectional area of said aperture being greater than the cross-sectional area of said orifice so that a greater volume of air will be recycled within said cooling chamber than will be admitted from outside said cooling chamber, means for cooling condensate from said evaporator and means for by-passing a minor portion of said output air around said evaporator and over said condensate for discharge into the total air re-circulated.

3. A device for cooling air comprising a cooling chamber, a fan chamber in said cooling chamber, a fan in said fan chamber for moving output air through said fan chamber past an evaporator and into said cooling chamber, said fan chamber having an aperture connecting the interior of said cooling chamber with the interior of said fan chamber on the upstream side of said fan and an orifice connecting the exterior of said cooling chamber with the interior of said fan chamber on the upstream side of said fan, the cross-sectional area of said aperture being greater than the cross-sectional area of said orifice so that a greater volume of air will be recycled within said cooling chamber than will be admitted from outside said cooling chamber, a second fan chamber outside said cooling chamber, a second fan in said second fan chamber for moving air past a condenser into said second fan chamber, said orifice opening into said second fan chamber on the downstream side of said second fan, and said second fan chamber having a second aperture connecting the exterior both of said second fan chamber and of said cooling chamber with the interior of said second fan chamber on the downstream side of said second fan, the cross-sectional area of said second aperture being greater than the cross-sectional area of said orifice so that a greater volume of air will be vented through said second aperture than will pass through said orifice.

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4. A device as in claim 3, and a vane mounted in said second fan chamber adjacent said orifice for pivotal movement about an axis displaced from the vertical adapted to swing down under the influence of gravity and close said orifice when said second fan is idle and swing up in the airstream from said second fan and open said orifice when said second fan is actuated.

5. In a device for cooling air comprising a cooling chamber having an orifice through a wall thereof for admitting air to said chamber, an evaporator in said chamber, a condenser outside said chamber and a fan outside said chamber to move air past said condenser toward said orifice; the improvement which comprises a vane mounted adjacent said orifice for pivotal movement about an axis displaced from the vertical adapted to swing down under the influence of gravity and close said orifice when the fan is idle and swing up in the airstream from said fan and open said orifice when said fan is actuated.

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6. The invention of claim 5, in which said vane comprises a dihedral member and said axis is parallel to the corner edge of said member, one of the two legs of said member contacting said airstream when said fan is actuated and the other leg closing said orifice when said fan is idle.

7. A device as in claim 3, and means for opening and closing said orifice dependent upon the operation of said said second fan.

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