



(43) **Pub. Date:** **Aug. 26, 2004**

Publication Classification

(52) U.S. Cl. 62/256

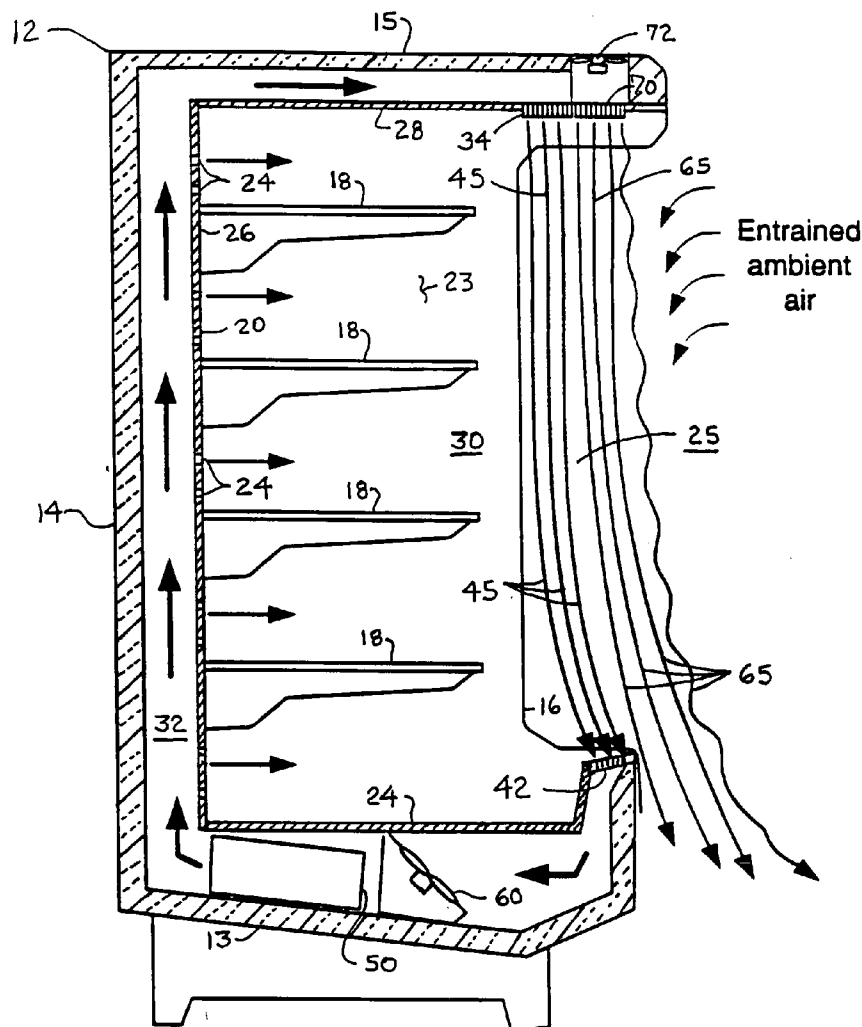
(57) **ABSTRACT**

(22) Filed: **Jan. 6, 2004**

A refrigerated merchandiser includes a display case defining a product display region having an open-front isolated from the ambient air of the store by means of a downwardly directed inner air curtain of relatively cold refrigerated air and a downwardly directed outer air curtain of relatively warmer air. The inner air curtain discharges through a first air outlet at a first discharge velocity and the outer air curtain discharges through a second air outlet at a second discharge velocity, the second discharge velocity being at least about 1.4 times greater than the first discharge velocity, and most advantageously, from about 1.4 to about 1.8 times greater than the first discharge velocity.

Related U.S. Application Data

(63) Continuation-in-part of application No. 10/374,640, filed on Feb. 26, 2003, now abandoned.



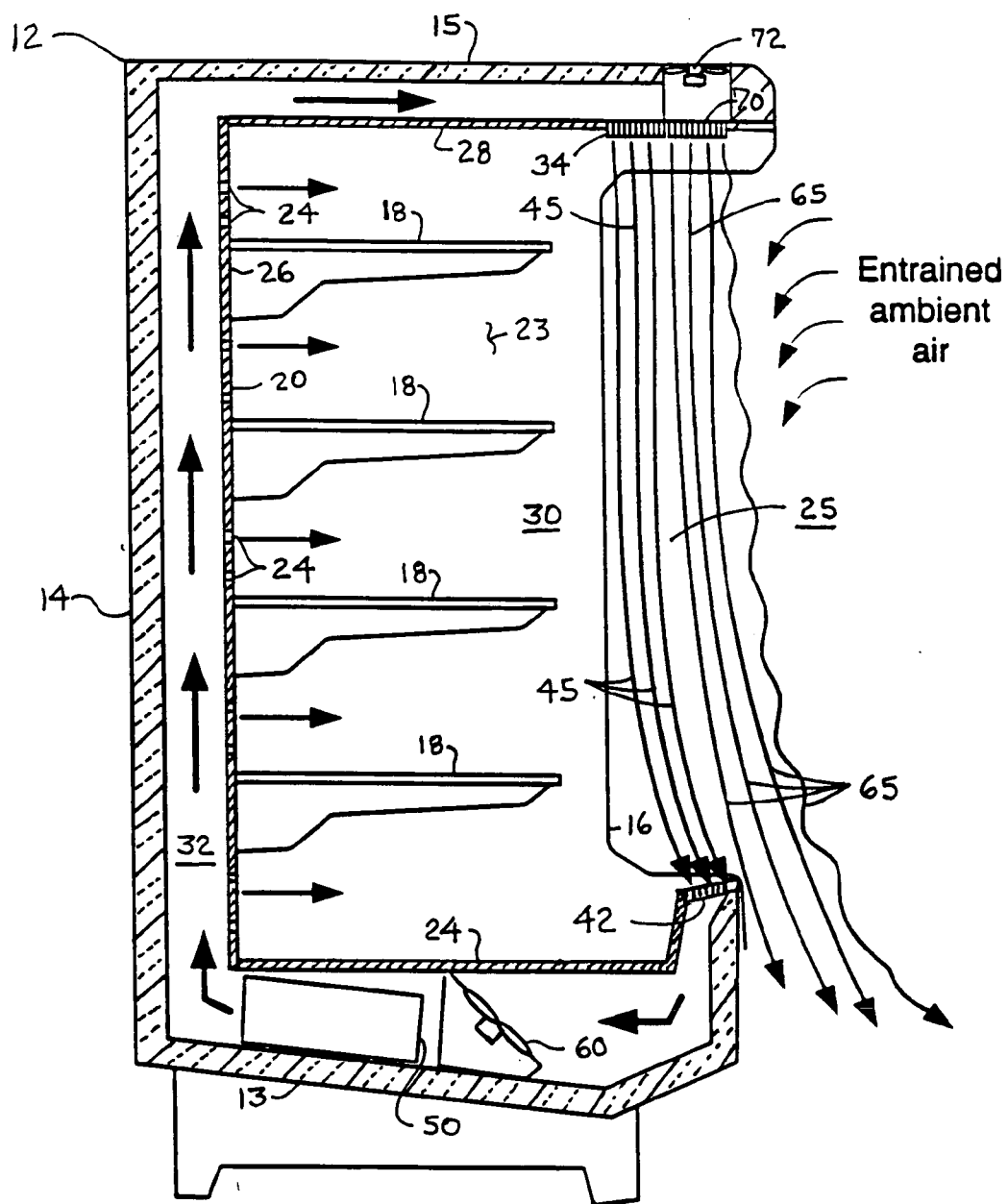


FIG. 1

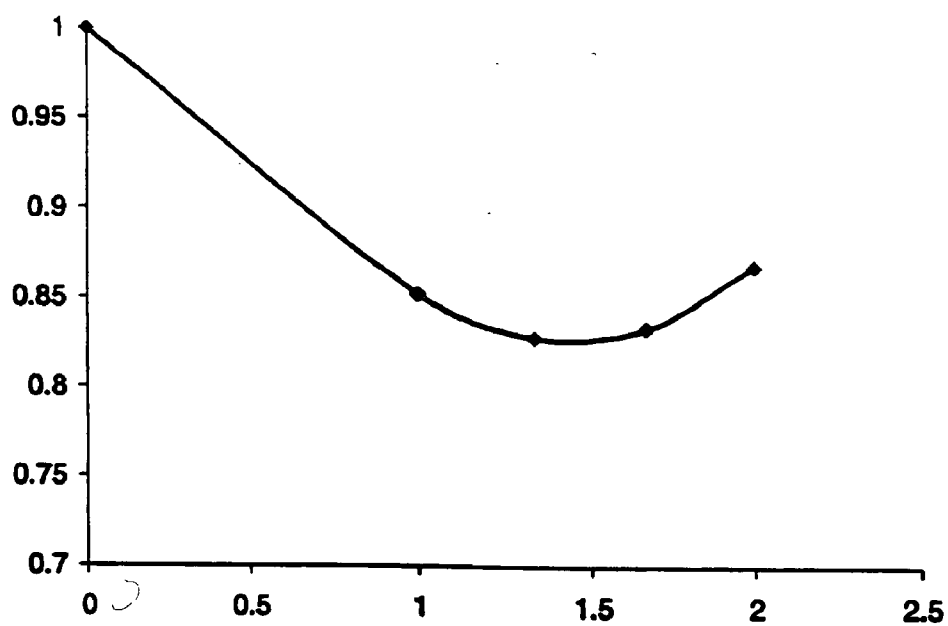


FIG.2

REFRIGERATED DISPLAY MERCHANDISER WITH IMPROVED AIR CURTAIN

[0001] This application is also a continuation-in-part of copending application Ser. No. 10/374,640, filed Feb. 26, 2003.

BACKGROUND OF THE INVENTION

[0002] The present invention relates generally to refrigerated display merchandisers of the type used in supermarkets, mini-marts, convenience stores and other commercial establishments for displaying and merchandising refrigerated or frozen products for sale. More particularly, the present invention relates to open-front refrigerated display merchandisers of the type wherein a curtain of cold refrigerated air is passed downwardly across the open front product display region of the merchandiser.

[0003] Refrigerated display merchandisers, also commonly referred to as display cases, having open front display regions are commonly used in supermarkets, mini-marts, convenience stores and other commercial establishments for displaying and merchandising refrigerated or frozen products for sale. The open front nature of such display cases permits the consumer to simply reach into the product display region to select and remove a product for purchase without the inconvenience of needing to open a door to access the product. Customarily, a curtain of cold refrigerated air is passed downwardly at a relatively high velocity across the open front of the display case to form an invisible boundary between the product display region and the region of the store in front of the display case. This air curtain not only helps retain cool refrigerated air within the product display region of the display case, thereby cooling the display product on the shelves of the display case, but also functions to isolate, to a certain extent, the product display region from the ambient air within the store. Ambient air that does enter into open product display region undesirably causes increased energy consumption by increasing the cooling demand on the refrigeration system associated with the display case. Further, such ambient air may also cause a local temperature rise within the product display region sufficient to result in an undesirable rise in product temperature that could adversely impact upon product quality.

[0004] A problem encountered with when passing a curtain of refrigerated air downwardly across the open front of the product display region of the display case lies in the entrainment of ambient air into the stream of refrigerated air forming the air curtain. Turbulence exists at the boundary between the relatively high velocity curtain air and the generally quiescent ambient air lying in front of the display case. As a result of such turbulence, some ambient air is undesirably entrained into the air curtain. Multiple air curtain display cases have been developed in the prior art to address this entrainment problem. For example, display cases having two adjacent, parallel, but independently generated, air curtains of refrigerated air are common in the art. Typically, such as disclosed by Machara in U.S. Pat. No. 4,633,677, the outermost air curtain has a slightly higher temperature than the innermost air curtain, so as to protect the colder innermost air curtain from the impact of ambient air entrainment.

[0005] Also, it is well known in the art to establish a third air curtain of relatively high temperature ambient air out-

wardly of one or two refrigerated air curtains as a means of reducing entrainment of ambient air from the store into the refrigerated air curtains. Abraham, in U.S. Pat. No. 4,267,706, discloses establishing an ambient air curtain outwardly of an innermost refrigerated air curtain, with the outer ambient air curtain being directed downwardly parallel to and adjacent to the inner refrigerated air curtain. Beckwith et al, in U.S. Pat. Nos. 3,648,482 and 3,850,003, MacMaster et al, in U.S. Pat. No. 3,827,254 and Roberts, in U.S. Pat. Nos. 5,345,778 and 5,357,767, each disclose establishing an ambient air curtain outwardly of a pair of refrigerated air curtains. The curtain closest the product display region of the display case is coolest, while the center curtain is at a temperature slightly warmer than the innermost curtain, but substantially cooler than the outermost ambient air curtain. The center curtain of warmer refrigerated air serves to buffer the innermost colder refrigerated air curtain from warm air intrusion from the outermost ambient air curtain. The outermost curtain of ambient air is directed substantially vertically downwardly, either parallel to and adjacent the center air curtain or slightly inwardly toward the center air curtain, so as to preclude refrigerated air from the center and innermost refrigerated air curtains from spilling out of the product display region of the display case. The outermost ambient air curtain itself ideally spills into the store near the base of the display case so as to not be drawn into the air return inlets through which the refrigerated air curtains return to the evaporator compartment.

[0006] Although generally effective to substantially reduce the amount of entrainment of ambient air into the recycled refrigerated air as compared to a single air curtain design, significant entrainment still occurs in the case of refrigerated merchandisers having two or three air curtains. It is generally recognized that entrainment is reduced when adjacent air curtains in such multiple air curtain designs have relatively the same velocity so that shear instabilities at the interface between air curtains is minimized. Therefore, in typical prior art merchandisers, the respective discharge velocities of the separate air curtains, that is the discharge velocities of the respective air streams as they pass out of their respective nozzles at the top of the display case, are designed to be substantially equal, be there two or three air curtains present. However, as the air curtains flow downwardly, the outer air curtain tends to spread and spill into the store thereby reducing in velocity, while the inner air curtain tends to increase in velocity due to buoyancy effects and the addition of air from within the refrigerated display case. As a result, as the air curtains pass downwardly, the shear instabilities at the interface of adjacent air curtains increase, resulting in increased entrainment of higher temperature, moister air into the inner air curtain of refrigerated. Consequently, a need exists for an improved air curtain system that addresses the problem of entrainment into the inner air curtain of refrigerated air without significant expense.

SUMMARY OF THE INVENTION

[0007] The refrigerated merchandiser of the present invention includes a display case defining a product display region having an open-front isolated from the ambient air of the store by means of a downwardly directed inner air curtain of relatively cold refrigerated air and a downwardly directed outer air curtain, most advantageously of relatively warmer air. In accordance with the present invention, the discharge velocity of the outer air curtain is maintained at a velocity at

least 1.4 times the discharge velocity of the inner air curtain, and most advantageously in the range of about 1.4 to about 2.4 times greater than the discharge velocity of the inner air stream. In a preferred embodiment, the outer air curtain comprises ambient air.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] **FIG. 1** illustrates a side elevation profile of a preferred embodiment of a refrigerated merchandiser having an open-front display case with a dual stream air curtain separating a first environment within the display case from a second environment external of the display case; and

[0009] **FIG. 2** is a graphical presentation showing the variation of load demand on the cooling system associated with the refrigeration merchandiser as the air curtain velocity ratio changes.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0010] Referring now to **FIG. 1**, the refrigerated merchandiser **10** includes an outer cabinet **12** and an inner cabinet liner **20** that defines within its bounds an open-front product display region **30**. The outer cabinet has a base **13**, a rear wall **14** extending upwardly from the back of the base **13**, a top wall **15** extending forwardly from the rear wall and a pair of side walls **16** extending vertically from the base **13** to the top wall **15** and forwardly from the rear wall **14**. The inner cabinet liner **20** has a top panel **28**, a back panel **26**, a bottom panel **24** and opposed side panels **23** which together bound the open-front product display region **30**. Each of the cabinet base **13**, rear wall **14**, top wall **15** and side walls **16** is insulated, as in conventional practice, to thermally isolate the interior of the cabinet **12**, including the product display region **30**, from excessive heat transfer therethrough.

[0011] Perishable product **80** being merchandized may be displayed on shelves **18** disposed within the product display region **30** and upon the upper surface of the bottom panel **24**. The product display region **30** has an open front **25** so as to permit consumers to not only view, but also reach into the product display region **30** to select and remove items of product **80** that they desire to purchase. Product display region **30** is cooled in a conventional manner to a desired product temperature, typically to a temperature between -10° F. to less than about 40° F., depending upon what product is being merchandised therein and whether the product is frozen or non-frozen.

[0012] The refrigerated merchandiser **10** further includes a refrigeration compartment **40**, typically disposed in the portion of the display cabinet **12** between the base **13** and the bottom panel **24**, as depicted in **FIG. 1**, wherein components of the refrigerant system, typically a tube coil evaporator **50** and an air mover **60**, such as for example one or more fans, are housed. However, it is to be understood that the specific type of air mover employed is not relevant to or limiting of the present invention. As in conventional practice, refrigerant passing through the tubes of the evaporator **40** cools air passing over the surface of the evaporator tubes. The refrigerant is typically supplied from a remote refrigeration unit located elsewhere within the store. However, it is to be understood that the present invention may also be employed on stand-alone refrigerated merchandisers that include their own refrigeration unit for providing the cold refrigerant.

[0013] An air circulation duct **32** is formed between the rear wall **14** and the top wall **15** of the outer cabinet **12** and the back panel **26** and top panel **28**, respectively, of the inner cabinet liner **20**. Air mover **60** serves to direct air from air inlet **42** through the compartment **40** so as to traverse evaporator **50**, and thence through duct **32** to a first air outlet **34**. As noted before, this circulating air has been cooled to a desired temperature as it traverses the evaporator **50**. From the first air outlet **34**, the cool refrigeration air is directed via vanes provided within the first air outlet **34** downwardly along first path across the open front **25** of the product display region back to air inlet **42**. Thus, the refrigerating air is recycled and repeatedly recirculated through the compartment **40** and duct **32** to converse energy expended in cooling the refrigeration air. Further, through the afore-described cooling arrangement, a cool air curtain **45** is formed across the open-front product display region **30** from top to bottom thereof. To provide further cooling air directly to the product display region **30**, a plurality of openings **24** may be provided in the back panel **26** through which a portion of cold refrigerating air circulating through duct **32** may pass directly into the product display region **30**. This refrigerating air will also be drawn by the air mover back through the air inlet **42** into the compartment **40** to be recirculated.

[0014] A second air outlet **70** is provided outwardly of the first air outlet **34** at the top front of the cabinet **12**. In contrast to existing refrigerated merchandisers, second air outlet **70** serves to direct relatively warm air generally downwardly along a second path lying outwardly of the first path followed by the cool refrigerating air. In this manner, a relatively warm outer air curtain **65** is formed outside, i.e. further away from the product display region **30**, of the relatively cool inner air curtain **45**. The relatively warm outer air curtain **65** serves as a buffer between the relatively cool inner air curtain **45** and the ambient environment of the store. Further, when the outer air curtain **65** reaches the base region of the display cabinet **12**, it spills outwardly into the store rather than into the air inlet **42** in the forward end of the base portion of the cabinet. Consequently, the entrainment of warm air into the relatively cool inner air curtain and subsequent passage through inlet **42** into the compartment **40** is minimized, thereby reducing energy consumption in cooling the recirculating refrigeration air.

[0015] The first air outlet **34** and second air outlet **70** are located at top and forward region of display case **12**, with the second air outlet **70** being located outwardly of the first air outlet **34**, that is, closer to the front of the display cabinet **12**. As noted previously, first air outlet **34** is in communication with duct **32** and directs relatively cool air driven by air mover **60** downwardly across open front of the product display region **30** to form the inner air curtain **45**. The second air outlet **70** is in fluid communication with a source of relatively warm air, for example ambient air from the store, and directs relatively warm air driven by a second air mover **72** associated therewith downwardly to form an outer air curtain **65**.

[0016] The outer air curtain **65** is directed downwardly at a discharge velocity that is at least 1.4 times greater than the discharge velocity of the inner air curtain **45**. The term discharge velocity refers to the velocity of the air stream discharging from its respective air outlet at the top of the display case **30**. Ergo, the discharge velocity of the inner air curtain **45** is the velocity of the air stream discharging from

air outlet **34** and the discharge velocity of the outer air curtain **65** is the velocity of the air stream discharging from air outlet **70**. Most advantageously, the discharge velocity of the outer air curtain **65** is maintained at a level of about 1.4 to about 2.4 times faster than the discharge velocity of the inner air stream **45**.

[0017] Referring now to **FIG. 2**, the vertical axis thereof represents the load reduction factor, which is the refrigeration load of the dual air curtain compared to the load for an inner air curtain only, and the horizontal axis represents the ratio of the velocity of the outer air curtain in that of the inner air curtain. Accordingly, the lower the load reduction factor, the more effective is the dual air curtain. As illustrated in **FIG. 2**, the effectiveness of dual parallel air curtains as a barrier in reducing passage of flow across the air curtain is maximized by maintaining the ratio of the discharge velocity of the outer curtain to the discharge velocity of the inner curtain within the range of from about 1.4 to about 1.8. Maintaining the air curtain velocity ratio within this range minimizes the velocity gradient, and therefore shear instabilities, between the adjacent air curtains along the length of the interface between the adjacent air curtains, thereby resulting in less entrainment of air from the higher velocity air curtain into the lower velocity air curtain. Therefore, an very effective separation barrier may be maintained between two environments through use of the present invention through a dual air curtain of parallel streams of a first and a second fluid by maintaining the discharge velocity of the outer air stream a level of about 1.4 to about 1.8 times faster than the discharge velocity of the inner air stream.

[0018] The aforementioned description is exemplary rather than limiting. Many modifications and variations of the present invention may be recognized by those skilled in

the art in light of the above teachings that will fall within the spirit and scope of the present invention. The preferred embodiments of this invention have been disclosed. Accordingly, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described. For this reason the following claims should be studied to determine the true scope and content of this invention.

What is claimed is:

1. A refrigerated merchandiser including a display case defining a product display region having an open-front viewing area, a first air outlet associated with said display case for directing a first air stream air generally downwardly across the front viewing area along a first path, and a second air outlet associated with said display case for directing a second air stream air generally downwardly across the front viewing area along a second path outwardly of the first air stream; said refrigerated merchandiser characterized in that the first air stream exits the first air outlet at a first discharge velocity and the second air stream exits the second air outlet at a second discharge velocity, said second discharge velocity being at least about 1.4 times greater than said first discharge velocity.

2. A refrigerated merchandiser as recited in claim 1 further characterized in that the ratio of said second discharge velocity to said first discharge velocity is in the range from about 1.4 to about 1.8.

3. A refrigerated merchandiser as recited in claim 1 wherein the first air stream comprises relatively cooler air and the second air stream comprises relatively warmer air.

4. A refrigerated merchandiser as recited in claim 1 wherein the second air stream comprises ambient air.

* * * * *