ABSTRACT: In order to provide an open refrigerated display case in which the product zone remains frost-free and in which the evaporator coils remain ice-free, a small secondary evaporator unit is utilized to dry ambient air which is stored under pressure and metered into the air flow path of the primary cooling system. The display case is coilless, the depressed temperature being maintained primarily through conduction panels forming the bottom and walls of the product zone, which conduction panels are disposed in intimate contact with the refrigerated air supply from the primary evaporator unit. Apertures through the conduction panels are provided to leak cold dry air into the product display zone to attain spillage at a low rate. System efficiency is increased by providing baffles to insure intimate contact of the dry refrigerated air against the thermally conductive panels comprising the walls as well as the bottom panel of the product zone.
DRY AIR REFRIGERATED DISPLAY CASE SYSTEM

This invention relates to refrigerated food display systems and, more particularly, to such a system which utilizes refrigerated air conveyed from a distinctly separate evaporator unit in the refrigerated display case to achieve defrosting.

Prior art refrigerated display cases which utilize evaporator coils integral with the display case and in intimate heat conducting relationship with the product display zone have certain inherent drawbacks which become particularly acute when the humidity exceeds a rather low threshold value. The product display zone can frost up very quickly to the extent that defrosting activity must take place as often as several times per day. A heating element to melt the frost must be energized, and the heating element must have substantial capacity to achieve defrosting within a reasonable time period. Under severe frosting and icing conditions, the products must be removed from the display zone before the defrosting cycle is initiated. When the defrost cycle is completed, the refrigeration unit is again activated, and the problem is often encountered of refreezing melted ice which has not drained properly because of clogged drains or otherwise inadequate drainage. The icing of the evaporator coils can and does cause repeated damage to the refrigeration system such that the cost of maintenance, coupled with the obvious uneconomical situation created by the necessity for frequent defrosting, gives rise to serious objections to the prior art refrigerator display cases.

Some of these objects were met, to an extent, in the refrigerated display case disclosed in my U.S. Pat. No. 3,230,085, filed Nov. 27, 1964, and issued May 10, 1966. However, my prior art system disclosed therein suffered from certain inefficiencies and drawbacks resulting from the manner in which makeup air was introduced into the system and in which thermal transfer was effected between the product display zone and the refrigeration system per se. It is a broad object of this invention to provide an improved refrigerated display case.

It is another specific object of this invention to provide a refrigerated display case in which no drain is required and in which cooling of the display zone is effected primarily through convection.

These and other objects are achieved, according to a presently preferred embodiment of the invention, by disposing the refrigeration system coils in an airflow path such that cooled and dehydrated air is conveyed from the evaporator coils to the display case and is passed through the display case in intimate contact with the conductive panels comprising the product zone bottom and walls. Apertures are provided in the bottom of the product zone to controllably leak a small amount of the cooled, dehydrated air into the product zone such that a certain amount of constant spillage is achieved. The spillage is made up from a low volume source of dry filtered air. The source of dry filtered air comprises a small secondary evaporator unit and a compressor and storage tank used in conjunction therewith such that a small amount of air is pulled from ambient, dehydrated by the secondary evaporator unit and passed through the compressor for storage in the pressure tank. Makeup air is metered through a capillary tube to the primary system at a rate commensurate with the spillage.

The subject matter of the invention is particularly pointed out and distinctly claimed in the concluding portion of the specification. The invention however, both as to organization and method of operation, may best be understood by reference to the following description taken in conjunction with the accompanying drawing of which:

FIG. 1 is a perspective view of the primary evaporator unit used in a refrigerated display case of the present invention coupled to a single section display case incorporating the air flow principals of the invention;

FIG. 2 is a partially cutaway perspective view of the apparatus comprising the secondary subsystem for providing dried makeup air to the primary system; and

FIG. 3 is a partially cutaway perspective view of a differently arranged primary evaporator system used in conjunction with a shelf-type open top display case incorporating the air flow principals of the invention.

Referring now to FIG. 1, it will be observed that a primary evaporator unit 1 is fixed to one end of a single section open top display case 2. It will become apparent as the description proceeds that the evaporator unit 1 and display case 2 may be physically separated and that additional display area may be realized by adding intermediate, open ended display sections between the display case 2 and the evaporator unit 1.

The primary evaporator unit 1 comprises a closed housing 3 separated into an upper, high-pressure space 4 and a lower, low-pressure space 5 by a stepped partition 6. The side of the evaporator unit 1 toward the display case 2 is provided with a supply air opening 7 from the high-pressure zone and a return air opening 8 to the low-pressure zone. A centrifugal blower 9, driven by the motor 10, pumps air from the low-pressure zone 5 to the high-pressure zone 4. As the air is circulated through the high-pressure zone 4, it flows across the refrigeration coil unit 11 in heat exchanging relationship such that the air which flows outwardly from the supply air opening 7 is refrigerated. The evaporator coil unit 11 comprises one of the heat exchangers of a refrigeration system including other standard components (not shown) to effect the refrigeration cycle.

The display case 2 comprises a bottom 12, a sidewall 13, an end wall 14, and a cap member 15 extending around the top of the case. The display area or product zone bottom 16, the display area sidewall 17, and the display area end wall 18 comprises panels of thermally conductive material. The space between the case bottom 12 and the product zone bottom 16 and between the sidewalls 13, 17, and between the end walls 14, 18 is divided into a supply air duct 19 and a return air duct 20 by a partition having a horizontal portion 21 positioned between the case bottom 12 and the product zone bottom panel 16 and a vertical portion 22 disposed between the outer case walls 13 and 14 and the product zone wall panels 17 and 18.

The supply air duct 19 of the display case 2 receives refrigerated air from the high-pressure space 4 through the supply air opening 7. The refrigerated air in the supply air duct 19 is forced into intimate contact with the product zone bottom panel 16 and the product zone wall panels 17 and 18 by the confining action of the horizontal portion 21 and the vertical portion 22 of the partition bounding the supply air duct 19 and the return air duct 20. A preponderance of the refrigerated air moves from the supply air duct 19 into the return air duct 20 over the upper portion of the vertical portion 22 of the partition separating the zones whereupon the circulated air passes through the return air duct 20 and through the return air opening 8 into the low pressure space 5 of the primary evaporator unit 1 such that it can again be cooled and circulated into the display case 2.

A small portion of the refrigerated air in the supply air duct 19 is permitted to escape through apertures 23 into the product zone. For reasons which will become apparent below, the refrigerated air introduced into the product zone through the apertures 23 is very dry. Inasmuch as the airflow through the apertures 23 is constant, the product zone is always filled with the cold, dry air which is permitted to spill slowly over the cap member 15 to ambient. Makeup air is introduced into the primary evaporator unit 1 through a conduit 24 communicating between a source of very dry air and the low pressure space 5.

The source of very dry makeup air is depicted in FIG. 2. A secondary evaporator unit 25 is provided with a housing 26 having one or more apertures 27 for admitting ambient air. A secondary evaporator coil 28 of a small, secondary refrigeration system (other components not shown) is utilized to dehumidify the ambient air as it flows across the secondary coil 28.

The intake port 70 of an air compressor 29 is coupled to an opening 30 in the housing 26 of the secondary evaporator unit
by a conduit 31. Thus, the dehumidified ambient air is pulled through the conduit 31 and is compressed by the air compressor 39 which has its discharge port 71 connected, through another conduit 32, to a pressurized air storage tank 33. A copper tube 34 conveys dried compressed air through a filter 23 to a capillary tube 36 which serves to meter the necessary volume of makeup air to the conduit 24 which, as noted above, communicates with the low pressure space 8 of the primary evaporator unit 1.

The makeup air supply apparatus of FIG. 2 may conveniently be disposed remotely from the primary evaporator unit and display case of FIG. 1 and, because of the relatively low volume of makeup air, the apparatus of FIG. 2 may be used with a plurality of primary evaporator units to maintain the circulating air in all such units and in all product zones at a very low humidity level to eliminate frost in the product zones and ice on the primary evaporator unit coils.

Referring now to FIG. 3, a shelf-type open top display case 37 is shown which utilizes a somewhat different ducting arrangement to accommodate the case shape and layout. Similarly, a conventional primary evaporator unit 38 may be utilized to effect a compact and efficient installation. As with the FIG. 1 display case 2, the display case 37 illustrated in FIG. 3 may be lengthened by interposing additional opened sections between the final section provided with an end wall 39 and the primary evaporator unit 38. Evaporator coils 62 are disposed in the airflow path within a high-pressure space 40 which receives return air from a low pressure space 41 by means of a blower 42 driven by a motor 43. The refrigerated air flows through a supply air opening 44 into a refrigerated air duct 45 disposed immediately beneath a horizontal portion 46 of a partition.

Similar to the airflow configuration described previously for the display case illustrated in FIG. 1, the refrigerated air in the display case 37 is forced to flow upwardly over a vertical portion 48 of the partition. However, in order to convey sufficiently cold air to the vertical backwalls 49 of the shelves 50, the refrigerated air is directed upwardly between the vertical portion 48 of the partition and the front wall 51 of the case and back downwardly to flow horizontally through a relatively narrow space 52 bounded by the horizontal portion 46 and a horizontal panel 53 of heat conductive material comprising the bottom of a product display zone. The refrigerated air flows rearwardly through the space 52 and returns upwardly through a similar, vertically disposed space 54 bounded by the backwall 49 of the product zone and an interior baffle 55 to exhaust at the terminus of a thermal baffle 56 into the return air duct 56. The return air duct 56 conveys the circulated air at a somewhat lower pressure back to the low-pressure space 41 of the primary evaporator unit 38 where it is again pumped through the blower 42 and chilled prior to reentry into the display case 37.

A plurality of apertures 57, corresponding to the apertures 23 of the display case 2 depicted in FIG. 1, are provided in the horizontal heat conductive panel 53 to admit, dry, refrigerated air into the product zone of the display case 37. Additionally, conduit 58 disposed between the refrigerated air duct 45 and discharge units 59 permit additional refrigerated, dry air to spill over the shelves 50 at a controlled rate. The cold, dry air supplied to the discharge units 59 is taken from the refrigerated air duct 45 in order to insure superatmospheric pressure at the discharge apertures 60 to guard against the possible entry of heated ambient air into the system.

The conduit 61 may be coupled directly to the capillary tube metering apparatus 36 depicted in FIG. 2 to supply makeup air lost through the apertures 57 and 60 which maintain a constant low volume spillage of refrigerated, dry air within the product display zone of the display case 37. While the principles of the invention have now been made clear in an illustrative embodiment, there will be immediately obvious to those skilled in the art many modifications of structure, arrangement, proportions, the elements, materials, and components, used in the practice of the invention which are particularly adapted for specific environments and operating requirements without departing from those principles.

I claim:

1. A refrigerated display system comprising:
   A. a first evaporator unit including a first housing having return air and supply air access openings therein, first evaporator coil means disposed in said first housing, and forced air-circulating means in said first housing for circulating air from said return air opening across said coil means to cool and dehumidify the air and direct the air to said supply air opening.
   B. a second evaporator unit including a second housing, second evaporator coil means disposed in said second housing, and means for introducing ambient air into said second housing;
   C. compressor means for forcing a low-pressure inlet and a high-pressure outlet, means coupling said low-pressure inlet to said second housing such that ambient air drawn across and dried by said second evaporator coil enters said low-pressure inlet, a compressed air storage tank communicating with said high-pressure outlet to receive and store the dried ambient air under superatmospheric pressure, and metering means coupled between said storage tank and said first housing such that the dried ambient air is introduced into said first housing at a controlled rate; and
   D. an open display case having no coils therein, said open display case being coupled to said first evaporator unit to receive refrigerated air from said supply air opening and to return air to said return air opening, said display case having a bottom wall, sidewalls, and at least one end wall collectively defining an upwardly opening space between said walls, thermally conductive panel means within said space, said thermally conductive panel means having a bottom portion disposed in substantially parallel relationship with said bottom wall and a plurality of upwardly extending side portions, said thermally conductive panel means being spaced from said walls to divide said space into air-circulating duct means and a product display zone disposed above at least a portion of said air-circulating duct means, a divider partition in said air-circulating duct means dividing said air-circulating duct means into a refrigerated air supply duct and an air return duct, said divider partition configured such that said refrigerated air supply duct is partially defined by said bottom portion of said thermally conductive panel means.

2. The refrigerated display system of claim 1 in which said bottom portion of said thermally conductive panel means is provided with a plurality of apertures such that dry refrigerated air is controllably leaked into said product display zone.

3. The refrigerated display system of claim 2 in which said metering means comprises a capillary tube.

4. The refrigerated display system of claim 2 in which said refrigerated air supply duct is entirely disposed directly above said air return duct.