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MULTI-TIERED OPEN BIN REFRIGERATED SHOWCASES AND IN
METHOD OF REFRIGERATING PERTAINING THERETO

Filed Oct. 17, 1963

3 Sheets-Sheet 1

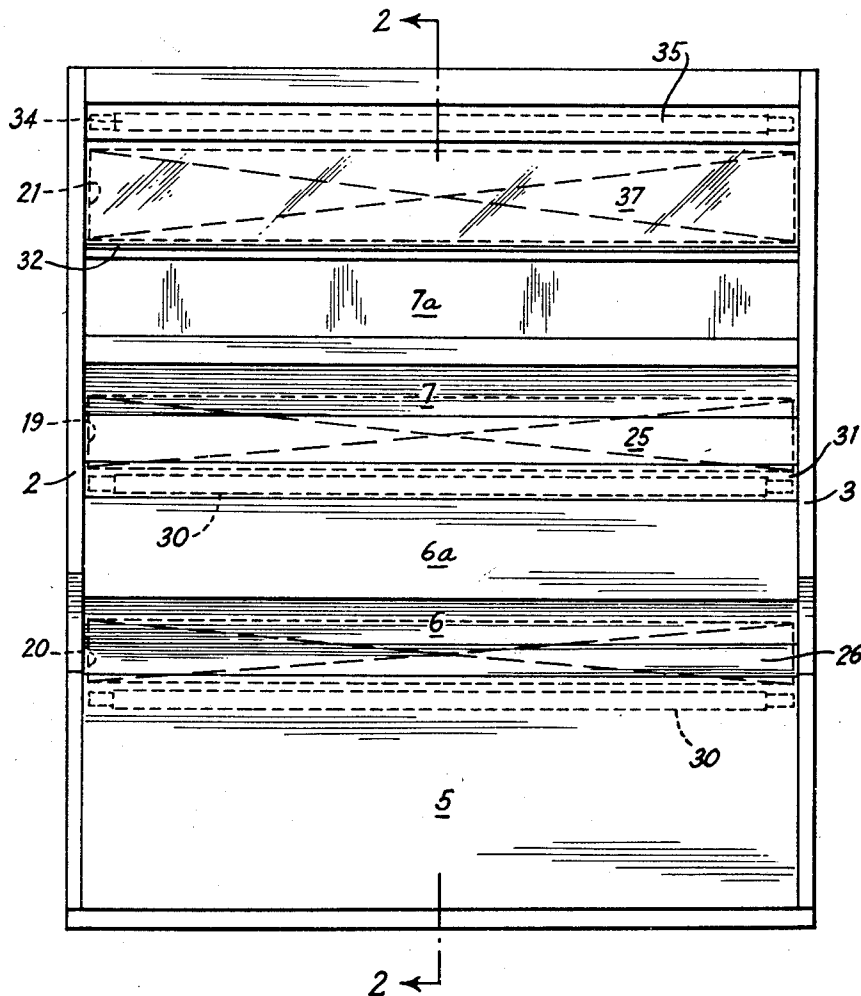


Fig. 1

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3 Sheets-Sheet 2

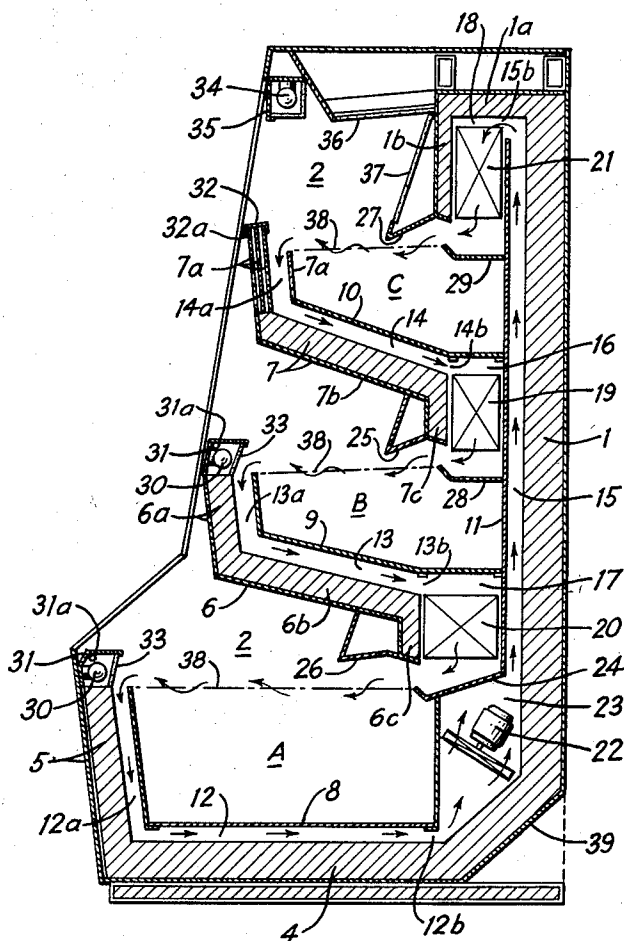


Fig. 2

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3 Sheets-Sheet 3

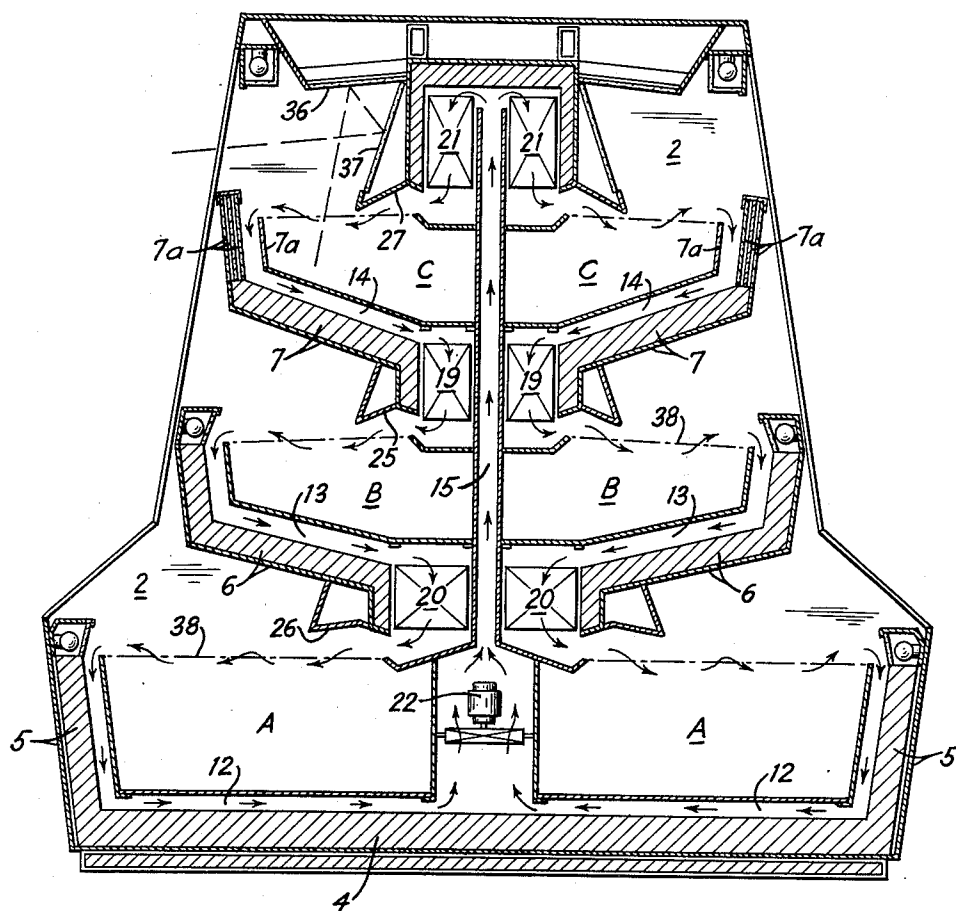


Fig. 3

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MULTI-TIERED OPEN BIN REFRIGERATED SHOWCASES AND IN METHOD OF REFRIGERATING PERTAINING THERETO

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12 Claims. (Cl. 62-89)

This invention relates to improvements in self-service refrigerated showcases of the type in which frozen merchandise is displayed in a plurality of open bins arranged one above another.

It is known to maintain the contents of open display bins at temperatures below the freezing point of water by passing refrigerated air over the bins. Refrigerated air, due to its higher density with respect to air of room temperature, settles in the bins and, in the absence of agitation, remains therein until warmed or displaced by still colder, denser air.

In order to maintain below-freezing temperatures in the bins, it is necessary continuously to feed refrigerated air into them in a circulatory system in which air from the bins is refrigerated and then returned to the bins.

In this condition it is known to supply each of a plurality of bins arranged one above another with refrigerated air from a common vertical duct. The refrigerated air drops from air outlets of the duct into the respective downwardly forwardly inclined bins and spills over the front edge of the bins in cascade fashion into the next lower bin which protrudes somewhat with respect to the bin above. All the spilt air is finally caught in the bottom bin, is re-refrigerated and returned to the vertical duct.

This arrangement is economically wasteful as the cascading air spilling over the front edges of the bins picks up heat as well as moisture from the surrounding atmospheric air through which it passes. The power consumption of the known arrangement is correspondingly high and frequent defrosting is necessary.

In a similar known arrangement which lacks a common vertical supply duct, individual evaporators are provided for the bins and air passes solely by reason of changes in density first from the atmosphere past the evaporator of an elevated bin whence it drops into the bin, spills over the front edge, cascades down into the space above the next bin, moves past the evaporator of the next bin, and so forth. The air spilling over the front edge of the bottom bin passes into the atmosphere, more particularly on the floor on which the showcase rests, and is wasted.

In still another two-level arrangement a common blower supplies the two bins through parallel ducts. The refrigerated air passes across the bins and is withdrawn at the front edge of the bins into separate parallel return ducts leading to a common evaporator and the blower.

This arrangement suffers from an inherent structural limitation. While a full-width feed duct is provided for the upper bin, its return duct is of limited width due to the presence of the parallel supply duct for the lower bin. Since only one blower is provided, more refrigerated air is supplied to the upper bin than can be withdrawn, leading to a loss of circulated air which must be made up from atmospheric air. This in turn, involves the introduction of atmospheric moisture into the circuit and

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necessitates frequent defrosting. The inherent structural complications and limitations would, of course, be aggravated if three bins are to be refrigerated by the parallel branch flow principle of the known arrangement.

The invention avoids a parallel flow arrangement and permits the use of any number of bins without structural complications or limitations. The bins are traversed, in series, by the circulated air. Air passing from one bin to the next is confined in ducts, is repeatedly re-refrigerated and use is made of the syphoning principle for transporting air from one bin to the next, thus eliminating the need for inter-bin blowers.

The inter-bin evaporators serve the double purpose of firstly refrigerating the air and secondly, transporting it by increasing the air density at the outflow end of a syphon duct, whereby suction is maintained at the inflow end of the same duct. Unlike ordinary syphons for transporting liquid, the air syphon employed by the invention never loses its prime.

Intermixing of refrigerated air with atmospheric air of higher relative humidity is avoided, aside from the unavoidable effect of air turbulence caused by loading the bins with merchandise or the removal of packages therefrom.

As a result a remarkable degree of energy economy (electric power in relation to refrigerated cubic content) is achieved, in addition to the economic advantage and operational convenience resulting from the adequacy of infrequent periods of defrosting.

The invention involves method aspects capable of being incorporated in structurally different embodiments, the principal aspect being that the volumes of air discharged into, and withdrawn from, all the bins are maintained substantially equal.

The various objects, features, and advantages of this invention will appear more fully from the detailed description which follows accompanied by drawings showing, for the purpose of illustration, preferred embodiments of the invention. The invention also resides in certain new and original features of construction and combination of elements as well as steps and sequences of steps hereinafter set forth and claimed.

Although the characteristic features of this invention which are believed to be novel will be particularly pointed out in the claims appended hereto, the invention itself, its objects and advantages, and the manner in which it may be carried out, may be better understood by referring to the following description taken in connection with the accompanying drawings forming a part of it in which:

FIG. 1 is an elevational front view of a showcase incorporating the invention and comprising three vertically spaced bins;

FIG. 2 is an elevational side view, in section, the section being taken on line II-II in FIG. 1; and

FIG. 3 is an elevational side view, in section, of a double-faced showcase composed of two three-tiered units having certain structural elements in common.

In the following description and in the claims various details will be identified by specific names for convenience. The names, however, are intended to be generic in their application. Corresponding reference characters refer to corresponding parts in the several figures of the drawings.

The drawings accompanying, and forming part of, this

specification disclose certain specific details of construction for the purpose of explanation of broader aspects of the invention, but it should be understood that structural details may be modified in various respects without departure from the principles of the invention and that the invention may be incorporated in other structural forms than shown.

The showcase illustrated in FIGS. 1 and 2 comprises a back wall 1, side walls 2 and 3 and a bottom 4 constructed of any suitable material of low heat conductivity such as fibreglass. A front wall 5 for the lowest bin A as well as partition walls 6 and 7 forming the intermediate B and the upper bin C extend from side wall 2 to side wall 3 and also consist of heat insulating material.

The partition wall 6 comprises a steeply inclined front portion 6a, a slightly rearwardly inclined bottom portion and a rear portion 6c which extends downwardly at a distance from the rear wall 1 and terminates at approximately the top edge or rim of the bin A immediately below.

The partition wall 7 of the top bin C is constructed similar to the partition wall 6 and could, like the latter, be of one-piece construction and be composed of the same heat insulating material. Preferably, however, for reasons explained further below, the front portion 7a is constructed of transparent material. It is composed of three spaced panels of glass or transparent sheet plastic resulting, by reason of the air layers therebetween, in good heat insulating properties of portion 7a.

The rear wall extends above the level of the top bin C and comprises a forwardly extending horizontal portion 1a integral with a downwardly extending lip or flange 1b. The latter terminates approximately at the level of the top edge or rim of the top bin C. The portions 1a and 1b, like the partition walls, extend the full width of the bins from side wall 2 to side wall 3.

The lower, central, and upper compartments A, B and C comprise internal panels 8, 9 and 10 extending the full width from side wall 2 to side wall 3. The panels 8, 9 and 10 are bent or angled to extend parallel to the walls and wall portions 4, 5; 6a, 6b; 7a, 7b, respectively. Appropriate spacers and terminal mountings at the sides 2, 3 are provided for this purpose which, however, are omitted from the drawings for the sake of clarity and ease of illustration of air ducts and passages 12, 13 and 14 formed by these panels and described below in greater detail. The panels 8, 9 and 10 are preferably insulated at the bottom sides by insulating plastic foam material bonded thereto.

Preferably that front portion of the panel 10 of the top bin C which extends parallel to the wall portion 7a is formed of transparent material.

The panels 8, 9 and 10 represent inner bottom walls in the compartments A, B and C and define the usable space of the latter.

At the front of the vertical compartments the internal panels terminate at a level somewhat lower than the top edge of the respective outer front wall, whereas the rear portion of the panels abuts an inner back panel 11 extending the full width from side 2 to side 3 and at a certain distance from the rear wall 1 to form an air duct 15.

The spaces between the panels 8, 9 and 10 on one hand and partition walls 4, 5; 6a, 6b; 7a, 7b, respectively, represent rearwardly downwardly inclined air ducts 12, 13, 14 extending from intake ports 12a, 13a and 14a, respectively, at the front to full width discharge ports 13b and 14b in the rear extending from side 2 to side 3.

A full width vertical air duct on riser 15 is formed between the inner back panel 11 and the back wall 1.

The lower ends 13b and 14b of ducts 13 and 14 discharge air into the spaces or chambers 16, 17 between the inner back wall 11 and the vertical wall portions 6c and 7c, respectively.

The air duct 12 discharges air through a full-width discharge port 12b into the vertical air duct 15 whose

full-width discharge port 15b discharges air into the space or chamber 18 defined between the vertical wall portion 1b and the inner back wall in depth and side walls 2 and 3 in width.

Evaporators 19, 20 and 21 are mounted in the spaces 16, 17 and 18, respectively. Their length is equal substantially to the width of the bins measured between side walls 2 and 3. The evaporators extend downwardly approximately to the level of the top edge of the front wall 6a, 5 7a of the compartment immediately below.

The evaporators are supplied with a flow of refrigerant from an otherwise conventional refrigerating unit which may be built into the showcase or may be located elsewhere and is thermostatically controlled in a manner well known in the art.

The duct 15 accommodates a blower 22 within its lower portion. The blower 22 imparts mechanical kinetic energy to air arriving from port 12a through duct 12 to transport the air upwardly through the riser duct 15.

In order to provide adequate space 23 for the blower 22, the lower portion of the inner back wall 11 is forwardly offset. A full-width inner wall 24 extending from side 2 to side 3 completes the air duct at the offset.

Air discharged from the riser duct at 15b passes the evaporator 21 which withdraws heat energy from the air and causes the air to assume a higher density than the surrounding atmospheric air. The cooled air passes into the top bin C as a full-width air blanket and displaces from the bin C any warmer air which may be therein.

As the discharge port through which air enters the top bin C lies at about the same level as the top edge of the front wall 7a, there is no tendency of the refrigerated air in the bin C to mix with the lighter atmospheric air above the bin.

Air displaced from the top bin C by newly supplied refrigerated air is syphoned off at the front of the bin at the intake port 14a, passes through the rearwardly downwardly sloping duct 14 and reaches the evaporator 19 which re-refrigerates the withdrawn air, making it denser and causes it to flow off downwardly into the bin B, thereby producing a syphoning effect within the duct 14 and at the intake port 14a.

As the discharge port through which air enters the bin B lies at about the same level as the top edge of the front panel 6a there is no tendency of the refrigerated air in the intermediate bin B to mix with the lighter atmospheric air about it.

Air displaced from the intermediate bin B by newly supplied re-refrigerated air is syphoned off at the intake port 13a and passes through the duct 13 to the evaporator 19 which re-refrigerates the air and produces the above described suction-by-syphoning effect in the duct 13.

The re-refrigerated air enters the bottom bin A after moving past the evaporator 20.

Air displaced from the bottom bin A is drawn off at the intake port 12a by the blower 22 which produces suction in the duct 12 and transports the withdrawn air to the top evaporator 21 through the riser duct 15.

It is thus seen that the refrigerating air circulates through the bins and ducts of the showcase in a continuous closed circuit in which the bins are traversed in series. The air is re-refrigerated between the bins and never cascades through atmospheric air from which it would pick up heat as well as moisture.

Once a state of equilibrium is reached after the cabinet is put in operation, the equilibrium condition being characterized by maintenance of a set low temperature in the bins, the refrigerated air in the bins remains below the top level or edge of the bins and the atmospheric air remains separate therefrom, at a higher level.

A certain degree of loss of cold occurs due to heat radiation and turbulence caused by the placing of contents into, and removal of contents from, the bins. But whatever temperature rise occurs in the refrigerating air by reason of these causes, the heat is immediately extracted

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from the circulating air before it passes into the next bin in its circuit or cycle.

The air transport from bin to bin in a downward direction is accomplished entirely by syphoning. In this connection advantage is taken of the fact that air after refrigeration has a higher specific weight than before refrigeration. The change in air density is utilized to produce the above described syphoning effect which is aided by the downward slant of the syphoning ducts from intake to outlet.

The only mechanical pumping means required in the illustrated arrangement is the blower 22. One centrally disposed blower suffices for relatively narrow showcases. Two or more laterally spaced blowers may be used in wide installations.

While the evaporators may be installed at any location within the air ducts the location of the evaporators at the end of the ducts is preferred because of its structural simplicity, the ease of defrosting and the ease of disposal of the water during defrosting.

The location of the evaporator 21 at the top of the riser duct has the advantage that the blower 22 need feed only warmer lighter air and is assisted in its function by the syphoning effect of the evaporator 21 which tends to draw air out of the top of the duct 15.

The separation of the refrigerated air from the atmospheric surrounding air is assisted by the provision of deflectors 25, 26 and 27. These deflectors guide the re-refrigerated air to, or to a point slightly below, the border level between cold air and warm air.

This border level is very pronounced and is comparable to the level of a pool of water dammed up by the top edge of the panels 8, 9 and 10 representing a dam for the pool. In the bins this level is indicated by dash-dot lines 38.

As shown in FIG. 2, pans 28 and 29 are arranged below the evaporators for catching and removing condensate during defrosting through suitable drain lines (not shown). These drip pans also catch condensate flowing along the vertical wall portion 1b and out of the duct 14 via the vertical portion 7c of the partition wall. Removal of water by dripping is facilitated by the sloping ends of wall portions 1b and 7c.

The drip pan for the lowest evaporator is formed by a forward extension of the panel 24 which protrudes beyond the lower portion of the inner back panel 11 and is provided with a raised front rim.

Defrosting is preferably effected by heating elements (not shown) which are associated with the evaporators and heat them while the refrigerating unit or compressor is turned off. Heating of the evaporators causes air to be heated also. This warm air flows off in an upward direction through ducts 13 and 14 and is discharged through the ports 13a, 14a. In order to prevent heating of the contents of the bins the inner panels 9 and 10 are insulated at the bottom side by polystyrene foam sheets or other suitable material.

As shown in FIG. 2, fluorescent light tubes 30 are mounted above the upper edge of the front wall 5 and above the partition wall 6a. These tubes are covered and protected along the front and top by guards 31 preferably of heat conductive material. These guards form a top rail for the fronts of the partitions and also protect customers from contact with refrigerated elements of the showcase. In the event the fluorescent lights are turned off, or in the event supplemental heat is required, supplemental heaters 31a are provided. A similar heater 32a is provided for the rail 32 of the top compartment. Sheets 33 of transparent or translucent material enclose the fluorescent tubes on the inside. A fluorescent tube 34 for the top bin is enclosed in an elongated housing 35.

In order to facilitate inspection of the top bin by short persons, a pair of mirrors 36, 37 are provided which show the contents correctly, rather than inverted

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as would be the case if only one mirror were used.

Mirror 36 above the bin produces a first image which, in turn, is reflected horizontally by the second mirror 37 towards a person standing in front of the showcase.

Inspection of the top bin is further facilitated by the transparent front wall 7a. Inspection of the bottom bin is facilitated by its forwardly advanced location which, at the same time, provides the required space for the blower or fan 22.

The rear bottom portion between the back wall 1 and the bottom 4 is preferably slanted at 38 to provide space for ducts for refrigerant, drain lines, electric cables, and the like.

A particularly advantageous utilization of space in relation to showcase capacity is realized by the double-faced arrangement shown in FIG. 3 in which, in a sense, two showcase units are placed back to back, but with a common riser duct 15. An insulating back wall corresponding to wall 1 of FIG. 2 is not needed. Corresponding reference numerals are applied to the two units to obviate the need for a separate description. A common blower 22 serves both units.

Any portions of the showcases which tend to collect condensate, such as the undersides of the partitions 6, 7, the mirror 37, the fronts of panels 25, 26 and 27 and the side walls 2 and 3 above the cold air level may be heated slightly, sufficient to prevent condensation.

What is claimed is:

1. In the method of refrigerating by recirculation of air the contents of open bins of a showcase in which bins are arranged one above another, the steps of syphoning air at a certain volumetric rate from one elevated bin into the next lower bin by increasing the density of the air being syphoned by refrigeration at a point between the levels of the bins; withdrawing at substantially the same rate air from the lower bin and elevating such withdrawn air by imparting mechanical kinetic energy thereto; refrigerating the air at a zone above the level of the lowest bin; and then discharging the last refrigerated air into an elevated bin at said certain rate.

2. The method of refrigerating by recirculation of air the contents of three open bins of a showcase in which the bins are arranged one above another, the method comprising, syphoning air at a certain volumetric rate from the highest into the intermediate bin, and syphoning air at substantially the same volumetric rate from the intermediate into the lowest bin by increasing the density of the air being syphoned by refrigeration at a point between the levels of the respective two bins, withdrawing air at substantially the same volumetric rate from the lowest bin and elevating such withdrawn air by imparting mechanical kinetic energy thereto to lift the air to a discharge point above the highest bin; refrigerating the elevated air at a point above the highest bin; and then discharging the refrigerated air into the highest bin at said certain rate.

3. A multiple-bin refrigerated showcase comprising, in combination, a plurality of open display bins arranged one above another, each bin comprising a front wall and a rear wall; air duct means extending from each elevated bin to the bin immediately below the respective elevated bin, said duct means comprising an intake below the level of the top of the respective front wall and an outlet above the bin immediately below, and adjacent the rear wall of the latter; an evaporator in said duct means between the respective intake and outlet; air passage means extending from the lowest bin to a point above the highest bin, said passage means comprising an intake adjacent, and below the level of, the top of the front wall of the lowest bin, and an outlet above, and adjacent the rear wall of, the highest bin; a blower in said passage means for elevating the air in said passage toward the passage outlet; and a further evaporator in said passage means at a point upstream of the outlet of the passage means.

4. A multiple-bin refrigerated showcase comprising, in

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combination, a plurality of open display bins arranged one above another, each bin comprising a front, an inner front wall, a bottom, and a rear wall; air duct means extending from each elevated bin to the respective bin immediately below said elevated bin, said duct means having an intake below the level of the top of the respective inner front wall and an outlet above the bin immediately below, and adjacent the rear wall of the latter; an evaporator in said duct means adjacent its outlet; air passage means extending from the lowest bin to a point above the highest bin, said passage means comprising an intake below the level of the top of the inner front wall of the lowest bin and an outlet above, and adjacent the rear wall of, the highest bin; a blower in said passage means for elevating the air in said passage toward the passage outlet; and a further evaporator in said passage means in advance of said passage outlet.

5. A multiple-bin refrigerated showcase comprising, in combination, a plurality of open display bins arranged one above another, each bin comprising a main front wall, an inner front wall terminating at a level below the main front wall, a main bottom, an inner bottom spaced from and above said main bottom, and a rear wall, the space between said main front wall and the inner front wall of an elevated bin and the space between the main bottom and the inner bottom of said elevated bin constituting a continuous air duct having an outlet above the bin immediately below, and adjacent the rear wall of the latter; an evaporator in said air duct adjacent its outlet, the space between the main front wall and the inner front wall of the lowest bin and the space between the main bottom and the inner bottom of said lowest bin constituting a continuous air duct underneath said lowest bin; a blower for withdrawing air through said air duct; a riser duct adjacent the rear walls of said bins leading from said blower to a point above the highest bin, said riser duct having a discharge port adjacent the rear wall of the highest bin; and a further evaporator adjacent said discharge port.

6. A multiple-bin refrigerated showcase as defined in claim 5 in which said inlets and outlets extend over substantially the entire width of the respective bins to produce a full-width refrigerated air blanket over the bins.

7. A multiple-bin refrigerated showcase comprising, in combination, a plurality of open display bins arranged one above another; each bin comprising a front wall and a rear wall; air duct means extending from each elevated bin to the bin immediately below the respective elevated bin, said duct means comprising an intake below the level of the top of the respective front wall and an outlet above the bin immediately below, and adjacent the rear wall of the latter; an evaporator in said outlet; air passage means extending from the lowest bin to a level above the highest bin, said passage means comprising an intake adjacent, and below the level of the top of, the front wall of the lowest bin and an outlet above, and adjacent the rear wall of, the highest bin; a blower in said passage means for elevating the air in said passage toward the passage outlet; and a further evaporator in said passage outlet, said outlets being at a vertical level below the top of the front wall of the respective front wall of the bin into which the outlet and its associated evaporator discharges air.

8. A multiple-bin refrigerated showcase comprising, in combination, a plurality of open display bins arranged one above another, each bin comprising a front wall and a rear wall; air duct means extending from each elevated bin to the bin immediately below the respective elevated bin, said duct means comprising an intake below the level of the top of the respective front wall and an outlet above the bin immediately below, and adjacent the rear wall of the latter, said air duct means having a downward slant throughout its extent from intake to outlet; an evaporator at the lowest portion of said air duct means; air passage means comprising an intake adjacent, and below the level of the top of, the front wall of the lowest bin and an out-

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let above, and adjacent the rear wall of, the highest bin; a blower in said passage means for elevating the air in said passage toward the passage outlet; and a further evaporator in said passage outlet, said outlets being at a vertical level below the top of the front wall of the respective front wall of the bin into which the outlet and its associated evaporator discharges air.

9. A multiple-bin refrigerated showcase comprising, in combination, a plurality of open display bins arranged one above another, each bin comprising a front wall and a rear wall; air duct means extending from each elevated bin to the bin immediately below the respective elevated bin, said duct means comprising an intake below the level of the top of the respective front wall and an outlet above the bin immediately below, and adjacent the rear wall of the latter; an evaporator in said outlet; air passage means extending from the lowest bin to a level above the highest bin, said passage means comprising an intake adjacent, and below the level of the top of, the front wall of the lowest bin and an outlet above, and adjacent the rear wall of, the highest bin; a blower in said passage means for elevating the air in said passage toward the passage outlet; a further evaporator in said passage outlet; a drip pan forwardly extending from the rear wall underneath each of said outlets; and a deflector forward of each of said outlets, said deflector extending downwardly to a level below the top of the respective front wall, said drip pan and said deflector defining between them a substantially rectangular discharge port through which refrigerated air enters the respective bin.

10. A double-faced multiple-bin refrigerated showcase comprising two units arranged back-to-back, each unit comprising a plurality of open display bins arranged one above another; each bin comprising a front wall and a rear wall; air duct means extending from each elevated bin to the bin immediately below the respective elevated bin, said duct means comprising an intake below the level of the top of the respective front wall and an outlet above the bin immediately below, and adjacent the rear wall of the latter; an evaporator in said duct means between the respective intake and outlet; air passage means extending from the lowest bin to a point above the highest bin, said passage means comprising an intake adjacent, and below the level of, the top of the front walls of the lowest bins, and a riser outlet above, and adjacent the rear wall of, each of the highest bins, the rear walls of one unit being spaced from the rear wall of the other unit forming a hollow central common wall structure, said air passage means comprising a riser duct within said common wall structure, said riser duct being common to both units to which riser duct said riser outlets are manifolded; blower means for withdrawing air through said air passage means from the lowest bins and feeding the withdrawn air upwardly through said riser duct; and further evaporator means in said riser duct adjacent the riser outlets into the highest bins.

11. In the method of refrigerating by recirculation of air the contents of open bins of a refrigerated showcase in which one bin is arranged above another, the steps of

- (a) passing refrigerated air through an elevated first bin at a certain rate;
- (b) withdrawing air at said certain rate from said first bin after passage therethrough;
- (c) refrigerating the withdrawn air at a level below said first bin and above a second bin hereinafter recited;
- (d) discharging the refrigerated air at said certain rate into a second bin positioned at a lower level than said first bin;
- (e) withdrawing air at said certain rate from said second bin after passage therethrough;
- (f) elevating the withdrawn air to a level above the first bin;
- (g) refrigerating the elevated air;
- (h) and discharging the refrigerated air into an el-

evated bin for passage therethrough towards said first bin.

12. In the method of refrigerating the contents of open bins of a refrigerated showcase in which one bin is arranged above another, the steps of

- (a) first discharging, in the course of a first cycle, refrigerated air at a certain volumetric rate into an elevated first bin;
- (b) withdrawing air at said certain rate from said first bin after passage therethrough;
- (c) then refrigerating the withdrawn air;
- (d) discharging the refrigerated air at said certain rate into a lower second bin;
- (e) withdrawing air at said certain rate from the second bin after passage therethrough;
- (f) elevating the air withdrawn from the second bin to a level above the first bin;
- (g) refrigerating the elevated air;

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(h) and, as a beginning of a second cycle, discharging the refrigerated air into an elevated bin at said certain rate for passage therethrough and towards said first bin.

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