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REFRIGERATED CABINET AND DEFROSTING MEANS

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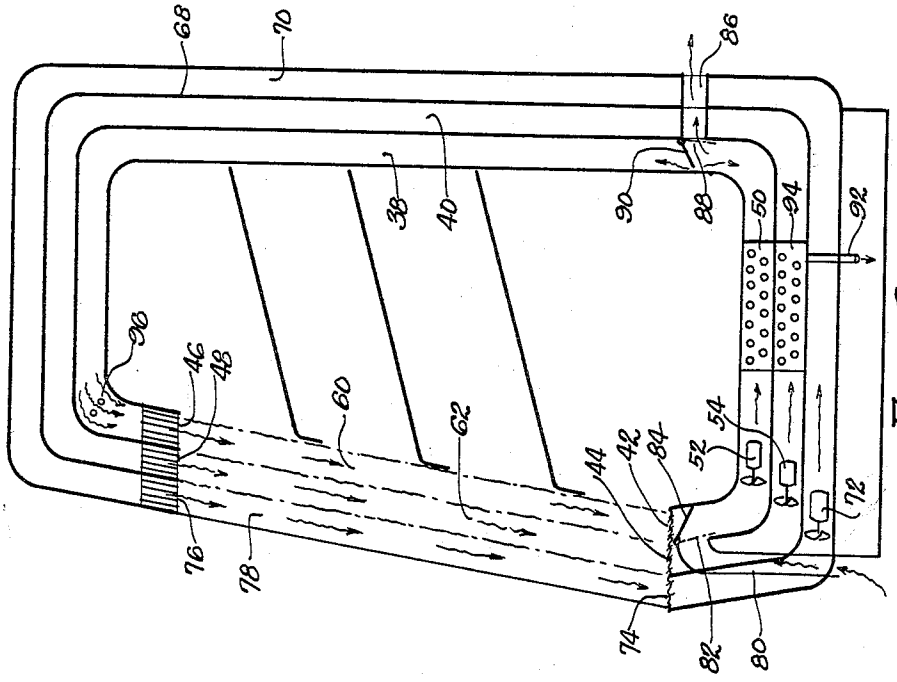


FIG. 2

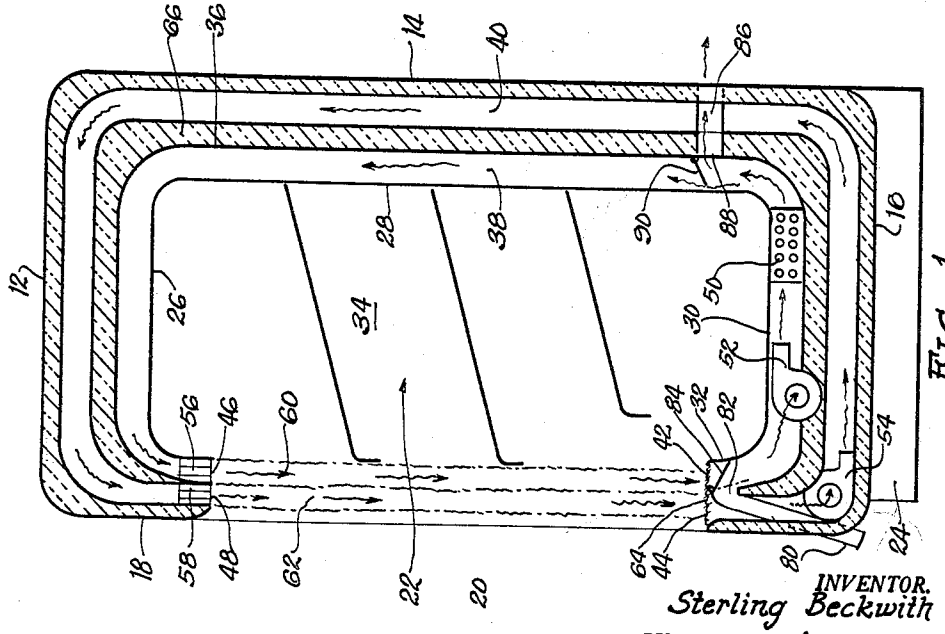


FIG. 1

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REFRIGERATED CABINET AND DEFROSTING MEANS

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This invention relates to the conditioning of an enclosed space having an open side for communication of the enclosed space with the atmosphere and it relates more particularly to maintaining a refrigerated state within the enclosed space having an open side and which is used for the storage of food products and the like.

In the copending application of Hagen et al., Ser. No. 54,077, filed September 6, 1960, and entitled "Refrigerated Display Case," and in the issued Simons Patent No. 2,862,369, description is made of a refrigerated display cabinet of the type described. Loss of heat from the refrigerated storage space through the open side is substantially obviated by the use of an air curtain which is advanced continuously across the open side from one edge of the opening to the opposite edge in a manner to blanket the entire opening.

The air curtain is adapted to be formed of adjacent panels of air with the inner panel comprising a refrigerated cold air panel and one or more outer panels having temperatures more closely approaching the ambient temperature from the inside out. For most efficient practice, it has been found to be desirable to recirculate at least the inner cold air panel and as many of the adjacent guard panels as possible thereby to conserve on the investment in the refrigeration required to maintain the otherwise enclosed space in the desired refrigerated state.

For example, in the Simons patent, use is made of an air curtain formed of but two panels comprising an inner cold air panel which is refrigerated and continuously recirculated and an outer ambient air panel which is cut off from the cold air panel at the opposite side of the access opening for return to the atmosphere. In the aforementioned copending application of Hagen et al., illustration is made of a modified arrangement which makes use of an inner cold air panel and an outer panel both of which are recirculated through separate systems in the cabinet whereby the outer panel acquires a temperature intermediate the cold air panel and ambient temperature to function as a guard panel which minimizes heat loss while, at the same time, enhancing laminar flow of the air panels making up the air curtain. Also disclosed in the aforementioned copending application of Hagen et al. is an arrangement wherein the curtain is formed of three recirculating panels in side-by-side relationship thereby further to increase the efficiency of operation from the standpoint of laminar flow characteristics and heat loss from the conditioned space.

In the aforementioned constructions, description is made of an arrangement wherein the nozzles extend across the bottom edge of the access opening to direct the air panels upwardly across the opening towards inlets similarly extending across the top side of the access opening. Description is also made of an arrangement wherein the nozzles are located across the upper edge of the opening for projecting the air panels downwardly across the opening to inlets arranged across the bottom side of the opening. It will be understood that the air nozzles can also be located across one of the lateral edges of the opening for directing the corresponding air panels across the opening towards inlets in the opposite edge. Because of the more desirable effect of gravity on the higher density cold air, it is preferred to flow the air curtain downwardly from nozzles across the top to inlets across

the bottom and the invention will hereinafter be described with reference thereto, but it will be understood that the concepts hereinafter described will also be applicable to other directions of flow.

It is an object of this invention to provide a method and means for improving the operational characteristics as well as the flow characteristics of the refrigerated cabinet and it is a related object to provide a method and means for the removal of frost separated out upon surfaces with which the cold air stream comes in contact and which, if not removed, might interfere with the desired flow characteristics for most efficient operation of the device.

These and other objects and advantages of this invention will hereinafter appear and for purposes of illustration, but not of limitation, an embodiment of the invention is shown in the accompanying drawing, in which—

FIG. 1 is a schematic sectional elevational view of a refrigerated cabinet embodying the features of this invention, and

FIG. 2 is a schematic sectional elevational view similar to that of FIG. 1 illustrating a further modification in the cabinet construction.

Before entering into a discussion of the concepts of this invention, a brief description will be given of the cabinet and modifications thereof.

Referring now to FIG. 1 of the drawing, the conditioning cabinet is provided in the form of an enclosure having a top wall **12**, a back wall **14**, a bottom wall **16**, side walls (not shown) and a front wall **18**. The front wall is provided with an access opening **20** of substantial dimension for communicating the enclosed space **22** within the interior of the cabinet with the outside atmosphere. The cabinet rests upon a suitable base **24**.

Spaced inwardly from the outer walls of the housing and in substantially parallel relationship therewith are inner walls including a top wall **26**, back wall **28**, bottom wall **30**, front wall **32** and side walls **34**, all of which define the storage space **22** therebetween. The space between the inner walls and the outer walls of the cabinet is subdivided in FIG. 1 by a partitioning wall **36** to define two separated passages **38** and **40** which extend substantially continuously about the storage space **22** from the inlet openings **42** and **44** across one edge of the opening **20** to outlet openings **46** and **48** across the opposite edge of the opening.

The passage **38** is provided with refrigeration coils **50** through which a suitable refrigerant is circulated for passage in indirect heat exchange relationship with the air traveling through the passage **38** for the refrigeration thereof. While refrigeration means **50** is illustrated as being located in the bottom run, adjacent the inlet to the passage, it will be understood that the refrigeration means may be disposed in other parts of the passage but preferably in the direction towards the inlet.

Located in advance of the refrigeration means **50** and preferably between the refrigeration means and the inlet **42** is an air circulating means such as a fan **52** or blower which operates to induce the flow of a stream of air through the passage **38** from the inlet **42** to the outlet **46** and, in accordance with the concepts of this invention, from the outlet **46** across the access opening **20** to the inlet **42** for recirculation of the cold air stream.

Similarly located within the outer passage **40** is another air circulating means **54**, such as a fan or blower, for inducing the flow of air through the passage **40** from the inlet **44** to the outlet **48** and then, in accordance with the concepts of this invention, from the outlet **48** across the access opening to the inlet **44** for recirculation of the guard jet.

The outlets **46** and **48** are provided with nozzle members **56** and **58** adapted directionally to channel the air streams issued therefrom for laminar flow across the

open space from the outlets to the inlets as previously described. For this purpose, it is desirable to make use of nozzles of a vane construction, such as a honeycomb section preferably having an effective length greater than about 1 inch and up to about 5 or 6 inches. The streams of air issuing from the outlets 46 and 48 form continuous inner and outer air panels 60 and 62 which extend across the access opening 20 from the outlets to the inlets with the inner panel 60 representing the refrigerated or cold air panel which is adapted to maintain the storage space in a desired refrigerated state. Both of the inlets can be provided with screening members 64 to prevent the entrainment of solid materials, insects and the like into the passages.

From the foregoing brief description of the basic construction of the refrigerated cabinet, it will be apparent that there is provided an inner cold air panel 60 and an outer air panel 62 which will acquire a temperature intermediate the temperature of the cold air panel and the ambient atmosphere. The guard panel 62 operates to guard the cold air from the heat of the atmosphere and to minimize the loss of cold air into the atmosphere since air entrained from the guard panel into the cold air panel will be at considerably lower temperature than the air from the atmosphere which otherwise would be admixed. Further to minimize heat loss into the cold air recirculated through the passage 38, it is desirable, though not essential, that the partitioning walls 36 and the outer wall 14 be provided with suitable insulation, as designated by the numeral 66, and it is also preferred that the passage 38 be separated from the storage space by an inner wall 26, 28 and 30 having relatively good heat conductivity so that the cold air traveling through the passage 38 will be effective to refrigerate the space.

By way of still further modification, instead of making use of a single guard jet, additional guard jets may be provided whereby the air panels extending across the access opening 20 will correspond to the number of such jets. In the modification illustrated in FIG. 2, an additional partition 68 is provided in the cabinet to make available a third passage 70 which is provided with a fan or blower 72 for the recirculation of an outer air stream through the passage 70 from an inlet 74 to an outlet 76 and, in accordance with the concepts of this invention, from the outlet 76 across the open space to the inlet 74. Thus the air curtain is formed with a third air panel 78 which is located outwardly adjacent the panels 60 and 62, For best practice in maintaining desirable laminar flow characteristics between the panels, it is desirable to provide for air velocities within the range of about 50 to 1,000 feet per minute and preferably within the range of 100 to 400 feet per minute.

Because of the marked reduction that takes place in the temperature of the air as it shifts gradually from the ambient atmosphere into the outer air panel and from the outer air panel to the guard panel and from the guard panel to the cold air panel, it will be apparent that the relative humidity of the air will be increased with corresponding reduction in temperature to the extent that the air making up the guard jet and most likely the cold air panel will reach a state of complete saturation whereby frost formation will occur. Such a frost will usually separate out onto surfaces engaged by the air stream and more preferably the cold surfaces, such as the evaporator plates.

Such portions of frost or excess moisture as are not removed by the refrigeration coils will usually subsequently separate out on surfaces encountered by the moving stream of cold air, the most likely surface being the ingoing side of the vaned or honeycomb sections forming the nozzles from which the air streams are projected across the access opening of the container.

It is an important concept of this invention to provide a simple and efficient means for rapid defrosting of the refrigerating coils without the necessity completely to

shut down the refrigeration of the cabinet and it is a further concept of this invention to effect snow or frost removal from the vanes of the cold air nozzle and preferably to achieve such snow or frost removal from the vanes in combination with the defrost of the refrigerating coils thereby rapidly to recondition the cabinet for normal operation.

For this purpose, the cabinet is formed with one and preferably a number of laterally spaced apart passages 80 communicating the ambient atmosphere with ports 82 in the walls of the passage 38 beyond the inlet 42 but before the circulating fan 52 and the refrigeration coils 50. The passage 38 is provided with a shutter plate 84 pivoted on the outer wall above the ports 82 for rocking movement between a raised position to span the passage 38 for blocking the movement of air therethrough while freeing the ports 82 to a lowered position wherein the passage 38 is free for normal circulation of the cold air stream therethrough while the ports 82 are blocked. For this purpose, the shutter plate 84 is dimensioned to have a length corresponding to the length of the passage and a width at least as great as the width of the passage or the distance between the pivot and the far end of the ports 82.

Another similar group of passages 86 communicate the ambient atmosphere with ports 88 in the walls of the passage 38 beyond the refrigeration coils and preferably closely adjacent thereto. Another shutter plate 90 is pivotally mounted on the wall of the passage 38 above the ports 88 for rocking movement between a raised position to extend across the passage 38 for blocking the movement of air therethrough and freeing the ports 88 to a lowered position for freeing the passage 38 for the flow of refrigerated air therethrough while blocking the ports 88. For this purpose, the shutter plate 90 is dimensioned to have a length corresponding to the length of the passage 38 and a width at least as great as the width of the passage 38 or the distance between the pivot and the far end of the ports 88. The gates 84 and 90 are adapted to be operated together whereby the gates are both shifted to raised position together so that the circulating fan 52 causes ambient air to be drawn into the passage 38 from the passage 80 and to be returned to the atmosphere through the ports 88 and the passage 86 until the warm ambient air has been effective to achieve defrosting of the refrigeration coils 50, either by melting or by evaporation. The passage 38 is provided with a drain 92 for venting the water that is produced upon defrosting of the coils.

Upon removal of the frost from the surfaces of the refrigeration coils 50, the shutter plates 84 and 90 can be returned together to normal, lowered position whereby the cold air panel is reformed for recirculation from the nozzles 46 across the access opening 20 to the inlets 42 to the passage 38 through which it is again recirculated past the defrosted refrigeration coils.

For rapid defrost, it is desirable to shut off the circulation of refrigerant to the evaporator coils 50. It is preferred, however, to shift the cold air channel from the inner panel to the adjacent panel during the defrost cycle thereby to minimize the amount of temperature rise that is permitted to take place in the refrigerated space. However, it is desirable to achieve this objective without interference with the defrost cycle and without delay in the return of the elements to normal operation. For this purpose, the guard passage 40 is provided with an auxiliary refrigerating coil 94 through which the refrigerant is bypassed when shut off from the main refrigerating coils 50 in the passage 38 during the defrost cycle. Thus the guard panel is able temporarily to function as the cold air panel without stopping operation of the device. Any frost collected on the evaporator coils in the guard passage 40 will eventually be removed when the guard passage is returned to normal operation for the recirculation of air therethrough since the air in the

guard panel is usually at a temperature below ambient but above freezing temperature.

The period of defrost of the refrigeration means in the cold air passage affords an opportunity for removal of snow or frost separated or otherwise collected on the vanes of the cold air nozzle 56 and particularly on the ingoing side. For this purpose, the shutter plate 90 is constructed to permit the passage of a slight flow of air beyond the plate for continued flow through the passage 38 to the nozzles on the out-going side thereof. Immediately in advance of the nozzles the passage is provided with a heating element 96 of relatively small capacity, such as small resistance wires or heaters which are sufficient to raise the temperature of the small amount of air which is permitted by the raised plate to continue to flow through the passage 38 but which would be relatively ineffective when confronted by the large volume of cold air normally circulated through the passage when the shutter plate is lowered. Thus the heat is taken up by the slight flow of air for carriage of heat to the vanes where the heat is effective to melt the snow or frost and provide for substantially complete removal thereof.

It will be understood that the shutter plate construction for blocking and unblocking the passages can be of other conventional constructions, such as slide gates or drawers or combinations thereof. It will be further understood that the guard passage 40 need not be provided with auxiliary refrigeration means, especially when one or more other guard jets are employed in combination therewith since the defrost cycle can be reduced to a matter of a few minutes, especially when heaters are employed in advance of the fan 52 to increase the temperature of the ambient air used to defrost and/or when the refrigeration cycle is modified to circulate exhaust from the compressor through the refrigeration coils for more rapid defrost both internally by the exhaust and externally by the ambient air.

When a system is adopted to make use of the hot exhaust gases from the compressor of the refrigeration system for circulation of the hot gases through the evaporator coils 50 to accelerate defrost, the concept heretofore described of using a heating element in advance of the cold air nozzle for preheating the small amount of air allowed to circulate past the shutter plate can be eliminated. Instead, the residual heat in the coils, immediately following defrost, will be sufficient to introduce enough heat in the initial portions of the air stream continued to be passed therethrough to effect the desired defrost of the nozzle vanes after the shutter 90 is returned to normal position.

It will be understood that the outlet nozzles may be positioned to extend across any of the sides of the openings with the inlet members being positioned to extend across the opposite side for the passage of the air current crosswise therebetween.

It will also be understood that various changes may be made in the details of construction, arrangement and operation without departing from the spirit of the invention, especially as defined in the following claims.

I claim:

1. In a refrigerated cabinet having an enclosed storage space with an access opening in one wall communicating the interior of the storage space with the ambient atmosphere, adjacent inner and outer outlet nozzles extending continuously across one side of the access opening and corresponding inlet members extending continuously

across the opposite side of the access opening, inner and outer passages communicating with the inlet members and the inner and outer outlet nozzles respectively, means for causing streams of air to flow through said passages from the inlets to the outlet nozzles and from the outlet nozzles as air panels making up an air curtain flowing continuously across the access opening to the inlet members for recirculation through the passages, refrigeration means in the inner passage for refrigeration of the stream of air flowing therethrough whereby the inner air panel of the air curtain comprises a cold air panel, ports within said inner passage before and beyond said refrigeration means, means communicating said ports with the ambient atmosphere, and means shiftable in said inner passage and associated with each of said ports for movement between unblocking position to block said ports and free said passages to permit normal flow of the cold air stream continuously through said inner passage and blocking position for blocking said passage and freeing said ports for communication with the ambient atmosphere for flow of ambient air into said passage, through said refrigeration means, and then out of said passage for defrosting the refrigeration means.

2. A refrigerated cabinet as claimed in claim 1 in which the ports comprise one port located between the refrigeration means and the inlet member and another port located between the refrigeration means and the outlet nozzle.

3. A refrigerated cabinet as claimed in claim 2 in which the means for causing a stream of air to flow through the passage comprises a fan means located between the refrigeration means and the port beyond the inlet member.

4. A refrigerated cabinet as claimed in claim 1 which includes drainage means communicating with said refrigeration means for the removal of moisture upon melting the frost.

5. A refrigerated cabinet as claimed in claim 1 in which the outlet nozzles are arranged in adjacent side-by-side parallel relation.

6. A refrigerated cabinet as claimed in claim 5 in which the outlet nozzles are arranged in side-by-side relation across the top of the access opening and the inlet members are arranged in side-by-side relation across the bottom of the access opening.

7. A refrigerated cabinet as claimed in claim 1 in which the means shiftable between blocking and unblocking position comprises a gate pivoted on the wall of the inner passage and dimensioned to have a length at least as great as the distance from the pivot to the farthest end of the port.

8. A refrigerated cabinet as claimed in claim 1 which includes a second refrigerating means in the adjacent passage.

9. A refrigerated cabinet as claimed in claim 8 which includes means for supplying refrigerant to said refrigerating means in the cold air passage and means for shutting off refrigerant from said refrigeration means in the cold air passage and by-passing the refrigerant to the refrigeration means in the adjacent passage at about the same time that the blocking and unblocking means is shifted to blocking position and vice versa.

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