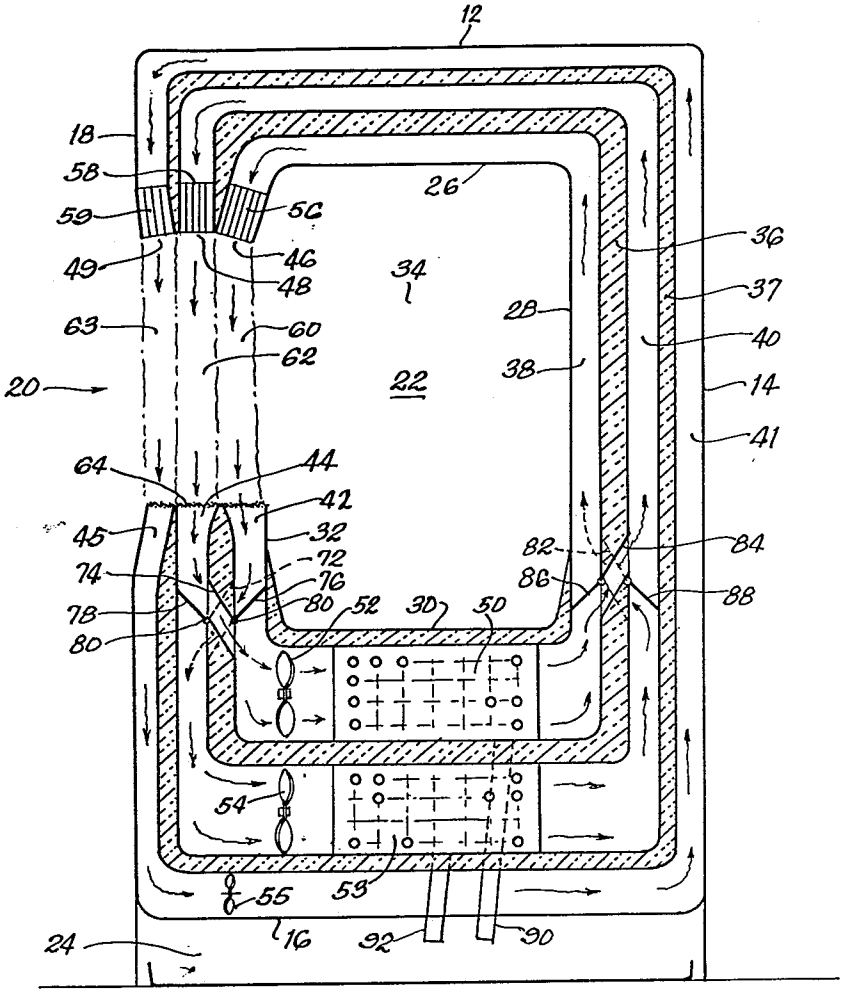
June 25, 1963 S. BECKWITH 3,094,851

REFRIGERATION CABINET AND DEFROST

Filed May 1, 1961 2 Sheets-Sheet 1

Fig. 1



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REFRIGERATION CABINET AND DEFROST

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Fig. 2

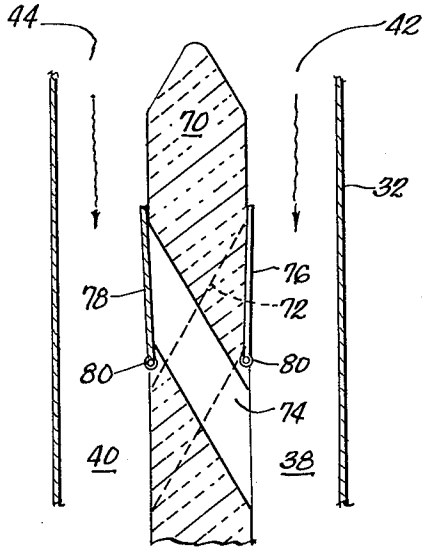


Fig. 3

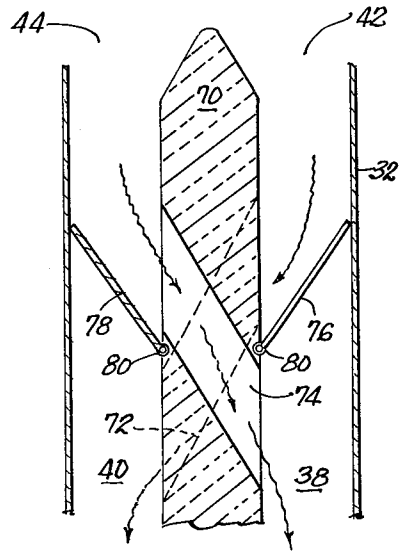


Fig. 4

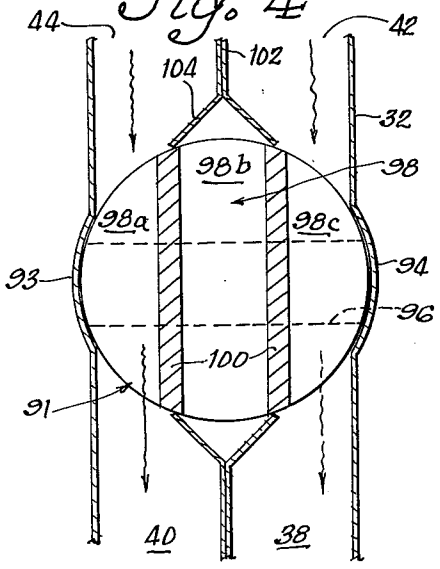
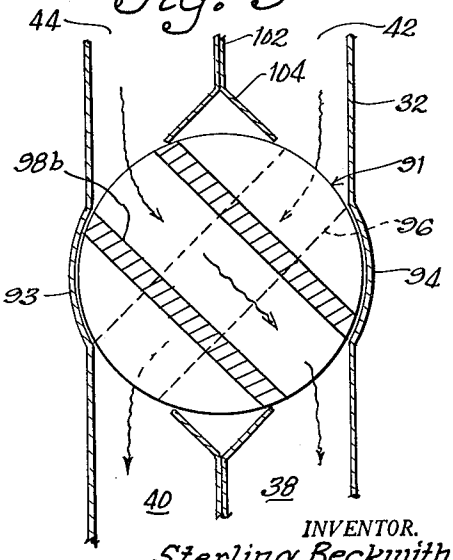


Fig. 5



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3,094,851

REFRIGERATION CABINET AND DEFROST

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Filed May 1, 1961, Ser. No. 106,805
9 Claims. (Cl. 62—256)

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 construction, 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 produce a refrigerated cabinet of the type described embodying simple and efficient means for defrosting the refrigeration coils without interruption of the normal pattern of the air curtain which is caused to flow across the access opening of the refrigerated space thereby to provide for continuous and efficient operation of the refrigeration 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 drawings, in which—

FIG. 1 is a schematic sectional elevational view of one modification of a refrigerated cabinet embodying the features of this invention;

FIG. 2 is an enlarged sectional elevational view showing the arrangement of elements in normal operation;

FIG. 3 is a sectional elevational view similar to that of FIG. 2 showing the arrangement of elements for the defrost cycle;

FIG. 4 is a schematic diagram of a valve system embodying the features of this invention in normal position; and

FIG. 5 is a schematic diagram similar to that of FIG. 4 showing the valve in cross-over position.

Before entering into a discussion of this invention, a brief description will be made of the basic construction of the refrigeration cabinet embodying the features of this invention. The cabinet is in the form of a housing 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 communication of the enclosed space **22** within the interior of the housing with the outside atmosphere. The cabinet may rest 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 by spaced partitioning walls **36** and **37** to define three separated passages **38**, **40** and **41** which extend continuously about the storage space **22** from the inlet openings **42**, **44** and **45** extending continuously across the bottom edge of the access opening **22** to outlet openings **46**, **48** and **49** extending continuously across the opposite or top edge of the access 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 the refrigeration means **50** is illustrated as being located in the bottom run of the passage **38**, adjacent the inlet, it will be understood that the refrigeration means can be disposed in other parts of the passage. 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 or blower **52** which operates to introduce 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 the recirculation of the cold air stream.

Similarly located within the passage **40** is an auxiliary set of refrigeration coils **53** through which refrigerant is adapted to be circulated, as will hereinafter be pointed out, and the passage **40** is also provided with an air cir-

culating 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 what will hereinafter be referred to as the guard jet.

The passage 41 is merely provided with a fan or blower 55 for inducing the flow of air from the inlet 45 through the passage 41 to the outlet 49 and then, in accordance with the concepts of this invention, across the access opening 20 to the inlet 45 for recirculation as a second guard jet. It will be understood that the refrigerated cabinet can be effectively operated without the passage 41 and its corresponding inlet 45 and outlet 49 and that, by way of still further modification, the cabinet may be constructed with still further passages and corresponding inlets and outlets to increase the number of guard jets, where practical, with the corresponding improvement in laminar flow characteristics of the air curtain traveling from the outlets to the inlets across the access opening and with corresponding improvement also in the reduction of heat loss from the interior of the cabinet to the ambient atmosphere.

The outlets 46, 48 and 49 are provided with nozzle members 56, 58 and 59 constructed directionally to channel the air stream issuing therefrom for laminar flow across the access opening from the outlets to the inlets as previously described. For this purpose, the nozzles may be constructed of vaned sections, 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, 48 and 49 form continuous inner and outer air panels 60, 62 and 63 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 the desired refrigerated state. The inlets can be provided with a screening member 64 to block entrainment or entrance of foreign material, 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 outer guard panels 62 and 63. The guard panel 62 will acquire a temperature intermediate the temperature of the cold air panel 60 and the temperature of the guard panel 63 while the guard panel 63 will acquire a temperature intermediate the temperature of the guard panel 62 and the ambient atmosphere by reason of the small amount of intermixing that normally occurs between the panels flowing next to each other in a combined curtain. Refrigeration of the space 22 is also achieved by the flow of the cold air stream through the passage 38 in substantially heat exchange relationship with the storage space. 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 37 be provided with suitable insulation, as indicated by the numeral 66.

Because of the marked reduction that takes place in the temperature of the air as it shifts gradually from the ambient atmosphere through the outer air panels and the guard panels to the cold air panel, it will be apparent that the relative humidity of the air will be increased to the extent that the air making up the cold air panel will reach a state of relative humidity whereby frost formation will occur, especially on the cold surfaces of the refrigeration coils.

An important concept of this invention resides in a new and novel means for defrosting the refrigeration coils in the described refrigeration system without interruption of the continuous flow of the air curtain across the access opening 20 and without material change in the temperature of the air panels within the air curtain.

In accordance with the practice of this invention, defrost of the refrigeration coils 50 in the cold air passage 38 is achieved by interchange of the cold air stream and the air stream making up the adjacent guard panel whereby the warmer air from the adjacent guard panel is detoured for flow through the passage 38 in heat exchange relationship with the frosted refrigeration coils 50 to effect defrost while the cold air panel is detoured into the vacated portion of the passage 40 for flow in heat exchange relationship with the auxiliary refrigeration coil 53 through which refrigerant is circulated during the defrost cycle. The described interchange is followed by a return interchange after passage through the coils to return the cold air stream from the passage 40 to its normal passage 38 and for return of the guard stream from the passage 38 to its normal passage 40 by reaching the outlet nozzles 46 and 48 so that the cold air stream will continue to issue as the inner cold air panel in the air curtain with the guard air panel still located outwardly thereof, as in the normal pattern. Once defrost has been completed of the main refrigeration coils 50, the detour is removed for return of the air streams to normal flow through their respective passages accompanied by a return of the flow of the refrigerant to the refrigeration coil 50.

Having briefly described the concepts of this invention, reference will now be made to a means by which the concepts can be carried out in a cabinet of the type described. For this purpose, in the wall section 70 of substantial thickness between the passages 38 and 40 but beyond the inlets 42 and 44 and before the fans 52 and 54, there is provided a plurality of laterally spaced apart cross-over passages which are divided into two groups 72 and 74. One group 72 of such passages extends angularly through the wall 70 with the upper inlet end terminating in the wall defining the passage 38 while the lower end terminates in the wall defining the guard air passage 40. The other group of passages 74 are similarly angularly disposed, but in the opposite direction, so that the upper end communicates with the passage 40 while the lower end communicates with the passage 38.

Each passage 38 and 40 is provided with a shutter plate 76 and 78 respectively pivotally mounted at their lower ends 80 onto the wall portion immediately below the inlet openings to the cross-over passages 72 and 74. The shutter plates are adapted to be rocked between a normal position, shown in FIG. 2, wherein the shutter plate extends vertically alongside the walls of the passages to cover the inlets to the cross-over passages 72 and 74 and a lowered or blocking position, illustrated in FIG. 3, wherein the shutter plates 76 and 78 extend crosswise across the passages 38 and 40 to block the passages 38 and 40 and free the cross-over passages 72 and 74 for the flow of the air streams therethrough. For this purpose, the shutter plates 76 and 78 should be dimensioned to have a length corresponding to the length of the passages and a width as great as the width of the passages or the distance between the pivot and the far end of the inlets to the cross-over passages.

A similar set of cross-over passages 82 and 84 are provided in the corresponding wall between the passages 38 and 40 but beyond the refrigeration coil section 50 with the exception that the angular direction is reversed to position the inlet of the cross-over passages upstream of the air flow through the passages, as in the previously described set 72 and 74. More specifically, a plurality of angularly disposed cross-over passages are provided in laterally spaced apart relation in a wall portion with the passages divided into two groups 82 and 84. One group of passages 84, alternating with the passages of the other group, extend at an upward incline from an inlet in the wall defining the passage 38 to an outlet opening in the wall defining the passage 40. The cross-over passages in the other group 82 have their inlet opening upstream in the wall defining the passage 40 with the outlet downstream in the wall defining the passage 38.

In operation, the shutter plates are adapted to be operated together for movement between blocking and unblocking positions. Normally, the shutter plates will be in unblocking position alongside the walls to free the passages **38** and **40**, as illustrated in FIG. 2, thereby to block the cross-over passages **72**, **74**, **82** and **84** so that the cold air stream will maintain its normal flow from the outlet nozzles **46** across the access opening **20** to the inlet **42** and from the inlet **42** through the passage **38** across the refrigerated coils to the outlet **46**. Similarly, the guard jet will flow from the outlet nozzle **48** across the access opening **20** to the inlet **44** and from the inlet **44** through the passage **40** to the outlet **48**.

When it is desired to effect the periodic defrost of the refrigeration coil **50**, the only change that is made is to shift the shutter plates from unblocking to blocking position and to by-pass the refrigerant from the refrigeration coil **50** to the auxiliary refrigeration coils **53** in passage **40**. Thereupon, the cold air stream will flow from the outlet nozzles **46** across the access opening **20** to the inlet **42**, as before. From the inlet, the cold air stream will enter the passage **38** until it is blocked by the plate **76** whereupon it will cross over through the cross-over passage **72** into the passage **40** for continued flow through passage **40** through the refrigeration coils **53** to effect the desired cooling action. The cold air stream will continue through passage **40** until it is confronted with the plate **88** which will force cross-over through the cross-over passages **82** to return the cold air stream to the cold air passage **38** for continued flow to the cold air nozzle **46**. In the meantime, the guard air stream will flow from the outlet **48**, across the access opening **20** to the inlet **44**. From the inlet, it will enter the passage **40** until confronted by the plate **78**. Thus the guard stream will be forced to flow through the cross-over passage **74** into the portion of the passage **38** previously vacated by the cold air stream for passage of the guard air stream in heat exchange relationship with the frosted refrigeration coils **50**. Since the guard jet is at a temperature above freezing temperature, the guard stream of air will operate to defrost the coils. After passage beyond the coils, the guard jet will encounter plate **86** whereby it will be forced through the cross-over passages **84** for return to its normal passage **40** and continued flow to the outlet nozzle **48**.

When defrosting has been completed, the plates **76**, **78**, **86** and **88** are returned to normal position to free the passages **38** and **40** and block the cross-over passages **72**, **74**, **82** and **84** whereby the cold air stream flows continuously again through the cold air passage **38** and the guard air stream flows continuously through the guard passage **40**. The refrigerant is redirected from the coils **53** to the refrigeration coils **50** for refrigeration of the cold air stream. Return of the guard stream to the guard passage **40** will operate to remove any frost which might have formed on the auxiliary refrigeration coils.

The cabinet is provided with suitable drain pans and vents **90** and **92** for draining off the condensate formed by melting the frost. In the modification illustrated in FIG. 1, use is made of a second guard jet recirculated through an outer passage **41** from an inlet **45** to an outlet **49**. The second guard jet does not enter into the described defrost operation and thus can, if desired, be eliminated from the system. Thus it will be understood that the invention can be practiced with a system which makes use of a cold air stream and a guard stream, with or without one or more additional guard jets positioned outwardly thereof.

Instead of making use of shutters mounted for rocking movement between normal and blocking positions within the cold air and guard air passages **38** and **40** respectively, use can be made of a rotary valve means, illustrated in FIGS. 4 and 5. The rotary valve means comprises an elongate cylindrical member **90** dimensioned to have a length corresponding to the length of the passages and a diameter corresponding to the spaced

relation between the outer wall of the guard passage and the inner wall of the cold air passage and preferably slightly greater than the spaced relationships therebetween to require curvilinear deformation in the respective walls, as indicated by the numerals **93** and **94** to receive the cylindrical member **90** in fitting relationship completely to fill the space between the passages and to provide a seat in which the cylindrical member can be rotated. The cylindrical valve is provided with passages arranged in side-by-side relationship throughout the length of the cylindrical member with the adjacent passages extending substantially perpendicularly one to the other so that one group of passages **96** extend crosswise while the other group of passages **98** extend vertically when in normal position. The one group **98** of vertical passages are subdivided into three laterally spaced apart segments 98^a, 98^b and 98^c by spaced separating walls **100** to define an intermediate passage 98^b between the walls and outer passages 98^a and 98^c between the separating walls **100** and the adjacent outer and inner walls respectively of the guard and cold air passages. The wall **102** separating the cold air passage **38** from the guard air passage **44** is flared out at **104** for a distance to engage the spaced walls **100** for effecting a sealing relationship therewith to close off the passages 98^b when the rotary valve is in normal position. Thus when the rotary valve is in normal position, the center passage 98^b is blocked off by the wall sections **104** and the cold air in the cold air passage is capable of flow continuously through the passage 98^c of the valve while the guard air continues to pass through the passage 98^a for continuous flow to the guard air passage **40** in the normal fashion.

When it is desired to cross over the guard air into the cold air passage and the cold air into the guard air passage, the valve is rotated from the normal position shown in FIG. 4 to the defrost or cross-over position shown in FIG. 5. This will bring the cross-over passages **96** into communication with the cold air passage **42** at the inlet end and the guard air passage at the outlet end to cross over the cold air into the guard air passage. In the meantime, the center passage 98^b will communicate with the guard air passage at the inlet end and the cold air passage at the outlet end to cross over the guard air into the cold air passage. The remainder of the cylindrical valve, including the dividing walls **100**, will block the cold air passage and the guard air passage at the valve sections to prevent the cold air from continuing through the cold air passage and the guard air from continuing through the guard air passage. It will be understood that a similar rotary valve construction may be employed in advance of the refrigeration coils to effect the cross-over as described and that a similar valve may be employed beyond the refrigeration coils to return the cold air to the cold air passage and the guard air to the guard air passage, as previously described.

It will be apparent from the foregoing that I have provided a simple and efficient means for defrost of the refrigeration coils in a refrigeration cabinet of the type described without interruption of the flow of the respective air streams or modification thereof or relocation thereof during passage, as desired, across the access opening.

It will be understood that numerous 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 enclosure having an access opening in one wall communicating the otherwise enclosed space with the ambient atmosphere, an inner cold air nozzle and an outer warmer air nozzle extending in side-by-side relationship across one edge of said access opening, an inner cold air inlet and an outer warmer air inlet extending in side-by-side relationship across the opposite edge of said access opening, an inner cold air passage

communicating the cold air inlet with the cold air nozzle, a warmer air passage adjacent the cold air passage and communicating the warmer air inlet with the warmer air nozzle, circulating means in each of said passages for causing air to flow from the inlets to the nozzles and then as adjacent inner cold air and outer warmer air panels across the access opening to the cold air inlet and warmer air inlet respectively for recirculation, a first refrigeration means in said cold air passage and a second refrigeration means in said warm air passage, and means for defrosting the refrigeration means comprising means for bypassing the cold air stream from the cold air passage into the warmer air passage in advance of the second refrigeration means and returning said cold air stream from said warmer air passage to said cold air passage beyond the second refrigeration means but before the cold air nozzle and for concurrently by-passing the warmer air stream from the warmer air passage to the vacated portion of the cold air passage in advance of the first refrigeration means and then returning the warmer air stream from the cold air passage to the warmer air passage beyond the first refrigeration means but before the warmer air nozzles for passage of the warmer air through the refrigeration means for defrosting.

2. A refrigerated enclosure as claimed in claim 1 in which the means bypassing the cold air stream from the cold air passage into the warmer air passage and return and for concurrently bypassing the warmer air stream from the warmer air passage to the cold air passage and return comprises spaced apart cross-over passages communicating the cold air passage with the warmer air passage in advance of the second refrigeration means and beyond the second refrigeration means and other spaced apart cross-over passages communicating the warmer air passage with the cold air passage in advance of and beyond the first refrigeration means, and blocking means shiftable between normal position blocking said cross-over passages to permit normal flow of the cold air stream continuously through the cold air passage and the warmer air stream continuously through the warmer air passage and blocking position to block said cold air passage and warmer air passage beyond said cross-over passages and to free said cross-over passages for deterring the cold air stream from the cold air passage into the warmer air passage before the second refrigeration means and then back from the warmer air passage into the cold air passage beyond the second refrigeration means and for concurrently deterring the warmer air stream from the warmer air passage into the cold air passage before said first refrigeration means and for circulating said warmer air from the cold air passage to the warmer air passage beyond said first refrigeration means.

3. A refrigerated enclosure as claimed in claim 1 in which the first and second refrigeration means comprises evaporator coils through which refrigerant is circulated.

4. A refrigerated enclosure as claimed in claim 2 in which the blocking means comprises shutters dimensioned to have a length greater than the width of the passages and in which the shutters are pivotally mounted on the walls communicating the cross-over passages for rocking movement between blocking and unblocking position.

5. A refrigerated enclosure as claimed in claim 2 in which the wall between the cold air passage and the warmer air passage is of substantial thickness and in which the cross-over passages have their inlets upstream in the passage containing the air stream to be detoured and the downstream in the other passage.

6. A refrigerated enclosure as claimed in claim 1 in which the cold air stream is at a temperature below freezing temperature and in which the warmer air stream is at a temperature above freezing temperature.

7. A refrigerated enclosure as claimed in claim 1 in which the means for by-passing the cold and warm air streams into adjacent passages comprises a valve member mounted for rotational movement between normal and cross-over positions and dimensioned to span the cold and warm air passages crosswise and lengthwise to block said passages, said rotatable valve member having ports extending therethrough with one group of ports communicating the cold air passage to one side of the valve member with the cold air passage on the other side of the valve member and another group of said ports communicating the warm air passage to one side of the valve with the warm air passage on the other side of the valve member when the valve member is in normal position for the continuous flow of warm and cold air through the warm air passage and cold air passage respectively, and other ports in the valve member with one group of said other ports having their inlets in communication with the warm air passage to one side of the valve member and the outlet end in communication with the cold air passage on the other side of the valve member and yet another group of said other ports having their inlet ends in communication with the cold air passage to one side of the valve member and their outlet ends in communication with the outlet passage on the other side of the valve member when in cross-over position for the cross-over of the air from the cold air passage to the warm air passage and from the warm air passage to the cold air passage when the valve member is rotated to cross-over position.

8. A refrigerated enclosure as claimed in claim 7 in which the ports extending through the valve member are axially spaced apart with one group of ports extending substantially perpendicularly to the other group of ports through the valve member.

9. A refrigerated enclosure as claimed in claim 7 in which alternate ones of the ports extend crosswise through the valve member in one direction and the ones in between extend through the valve member in the direction substaintially perpendicular to the alternate ones of said ports.

References Cited in the file of this patent

UNITED STATES PATENTS

983,877	Cummings	Feb. 14, 1911
2,836,039	Weber	May 27, 1958
2,855,762	Zehnder	Oct. 14, 1958