Feb. 21, 1967 J. H. BRENNAN ETAL 3,304,736

REFRIGERATED DISPLAY CASE

Filed Aug. 6, 1965 3 Sheets-Sheet 1

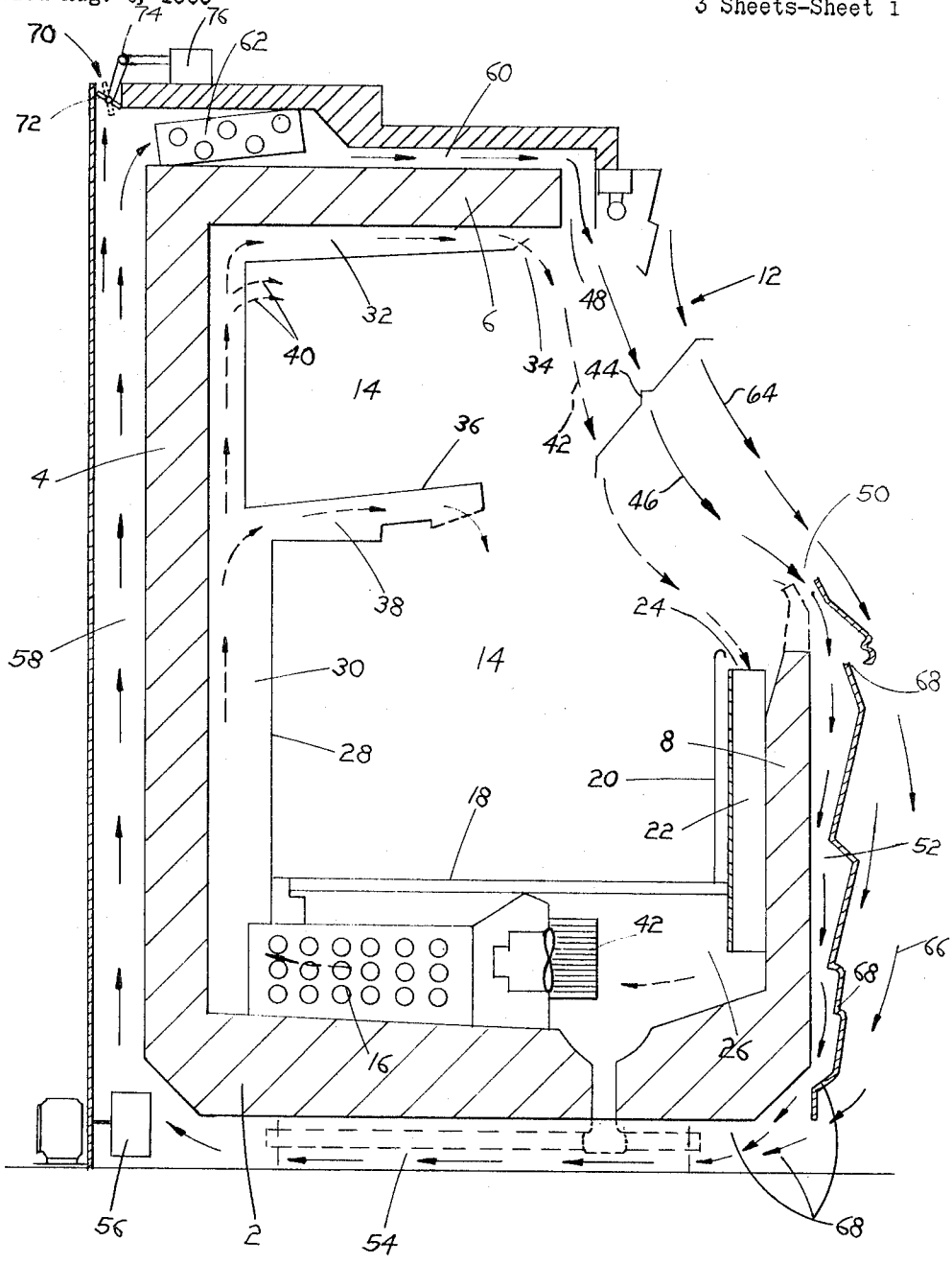

FIG. 1

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Filed Aug. 6, 1965 3 Sheets-Sheet 2

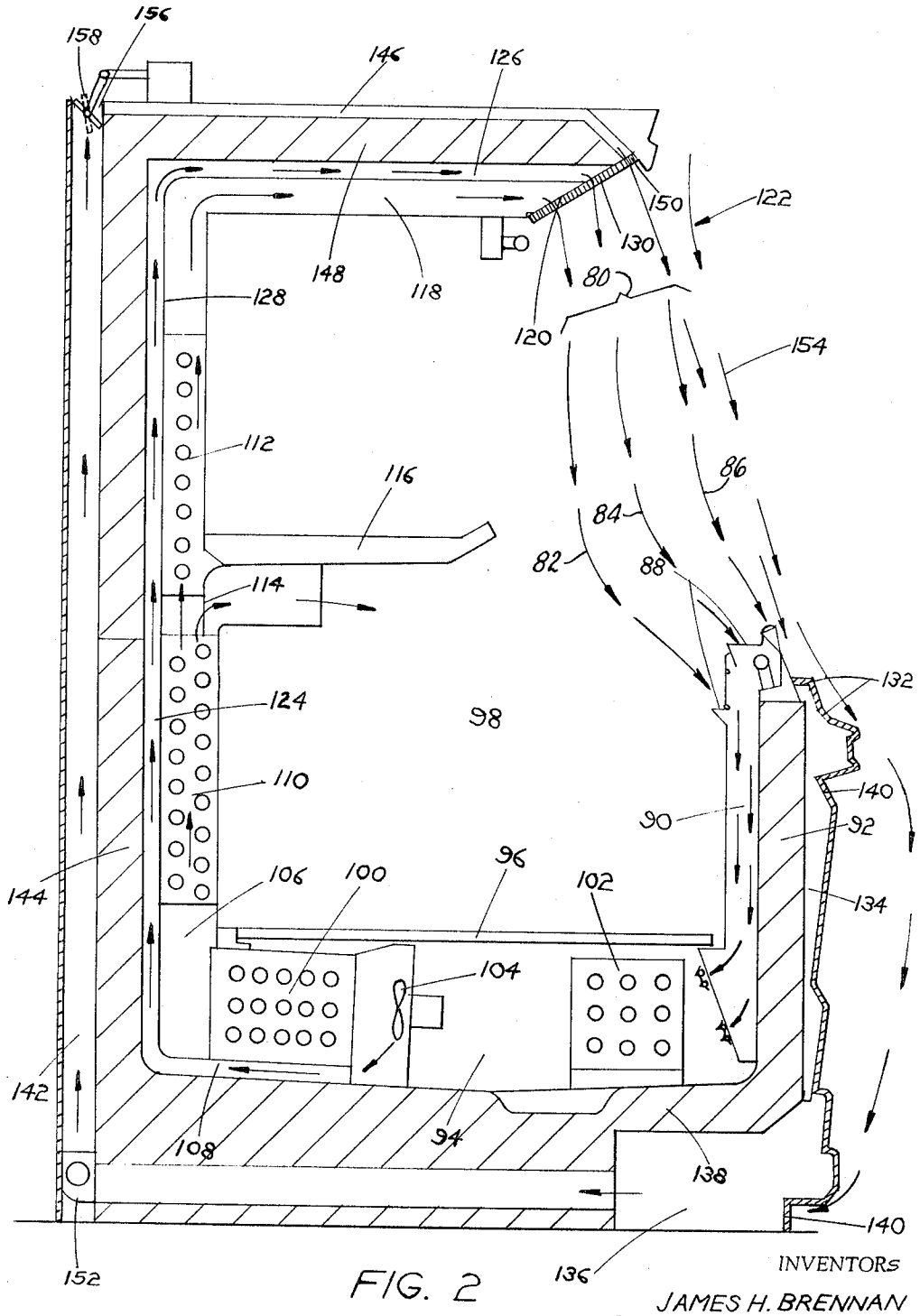

FIG. 2

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Filed Aug. 6, 1965 3 Sheets-Sheet 3

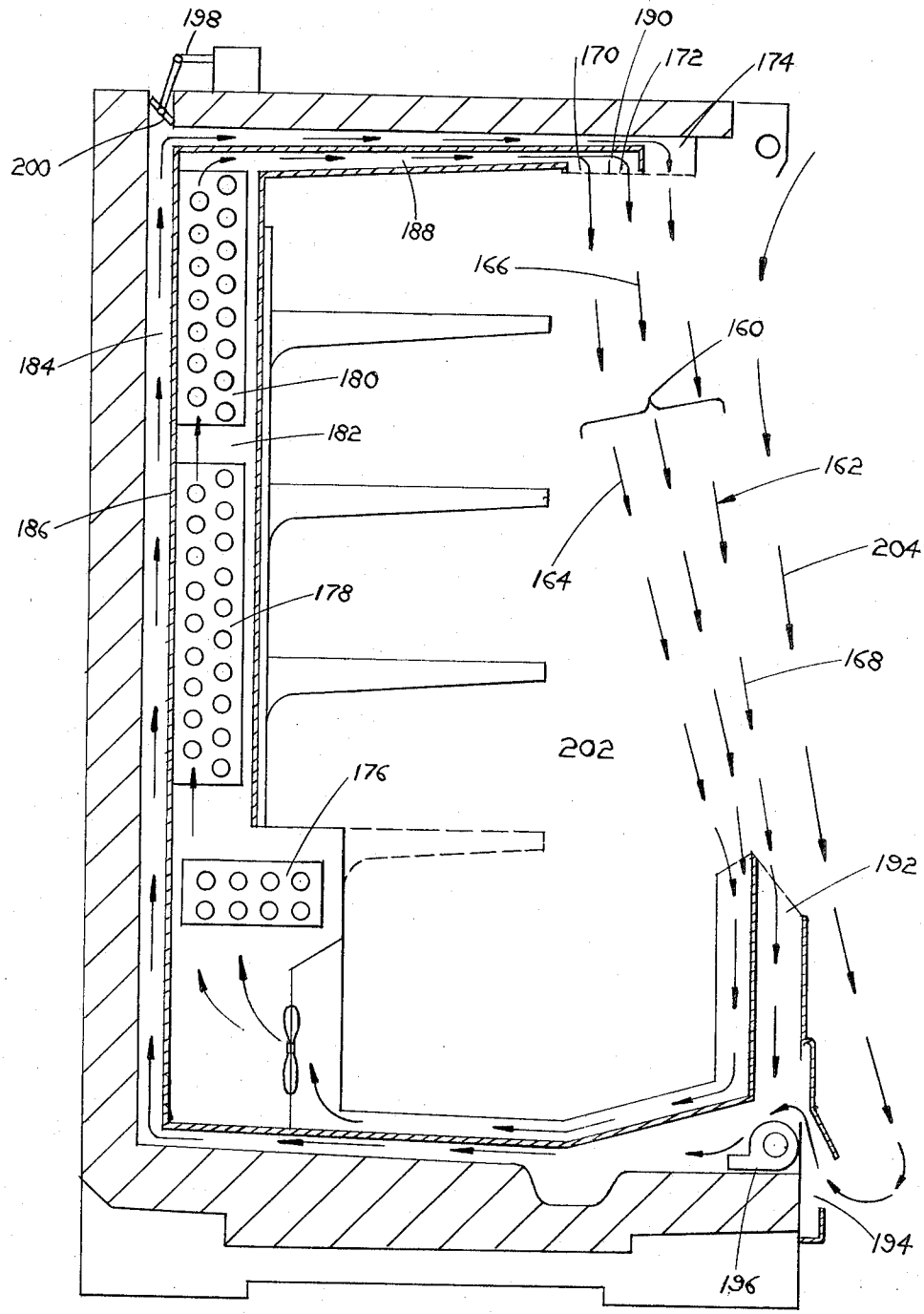

FIG. 3

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3,304,736

REFRIGERATED DISPLAY CASE

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12 Claims. (Cl. 62—176)

This invention relates to refrigerated display cases of the type wherein there is a storage space provided with an access opening and means are employed for establishing an air curtain flowing across the access opening to shield the storage space from ambient air.

The use of air curtains to prevent or reduce the entry of ambient air into a display space is common practice today and various means have been employed for reducing the adverse effects of ambient air entrained by refrigerated air utilized in producing the air curtain. For this purpose, multiple streams of air are sometimes provided and are caused to flow across an access opening in laminar relation with the colder layer of air being located adjacent the storage space and air at higher temperature forming the outermost layer of the air curtain.

While such arrangements have significant advantages, the outermost layer of air inevitably entrains some additional ambient air as it flows across the access opening and the volume of the air approaching the air inlet is, therefore, substantially increased beyond the volume of the air issuing from the air outlet and flowing through the ducts employed in establishing the outermost or protective layer of air in the air curtain. As a result, the excess air in the outermost layer spills over the front of the case into the aisle or space in front of the case. Since such spill air is generally chilled by admixture with adjacent refrigerated layers of air, the spill air chills the aisle and renders it uncomfortable for patrons or children passing up and down the aisle.

This adverse effect can be overcome by removing the chilled spill air or raising its temperature as described in the patent to Ural, No. 3,125,864, and the cooling effect of the spill air may be utilized to increase the efficiency of the refrigerating system as disclosed in said patent and in the copending application of Balk et al. Serial No. 293,205. However, in such constructions, the spill air is not recirculated to form a protective layer or part of the air curtain and no means are provided for controlling or varying the velocity of flow of that portion of the air curtain in contact with the ambient air so as to assure the most effective protection of the storage space by the air curtain.

In accordance with the present invention, these objections and limitations of refrigerated display cases of the prior art are reduced or overcome and constructions are provided which not only prevent undesired chilling of the aisle adjacent the case but also improve the protective action of the air curtain provided.

These results are preferably attained by providing refrigerated display cases with an air curtain for an access opening which embodies a plurality of adjacent layers of air differing progressively in temperature from a colder innermost layer to an outer protective layer of air which may be but little, if any, lower in temperature than the ambient air. At the same time, spill air which might chill the aisle is removed and at least a portion thereof is recirculated while the excess air resulting from entrainment of ambient air by the outer protective layer of air, and not required in producing the protective layer, is vented or expelled from the case. Moreover, means may be provided for controlling the velocity and or the temperature of the air circulated and utilized in forming the protective layer of air whereby it is possible to attain the most effective protection therefrom.

Accordingly, the principal objects of the present invention are to prevent or reduce the spillage of air from an air curtain in a display case; to remove both the outer protective layer and entrained ambient air from an air curtain used in protecting a display space while venting excess air not required for producing the protective layer in a manner to avoid chilling of the aisle or space adjacent the case; and to control the velocity and temperature of air forming an outer protective layer of an air curtain so as to attain the most effective protection of the display space thereby.

These and other objects and features of the present invention will appear from the following description thereof wherein reference is made to the figures of the accompanying drawings.

FIG. 1 is a diagrammatic vertical sectional view through a typical form of refrigerated display case embodying the present invention; and

FIGS. 2 and 3 are similar sectional views of alternative embodiments of the present invention.

In that form of the invention chosen for purposes of illustration in FIG. 1, the display case is of the self service type having an insulated base portion 2, an insulated vertical rear wall 4 and an insulated top 6. The lower portion of the case is provided with a front wall 8 having an upper edge 10 which is spaced from the top 6 of the case to provide an access opening 12 in the front of the case through which articles in the refrigerated storage space 14 may be removed by customers as desired.

The storage space is refrigerated by suitable refrigerating means including an evaporator 16 which preferably is located in the lower portion of the case above the insulated base portion 2 and beneath a bottom plate 18 upon which articles to be refrigerated may be located. A front panel 20 projects upward from the bottom plate 18 and is spaced from the inner surface of the insulated front wall 8 to provide an air passage 22 having an inlet opening 24 located adjacent the upper edge of the front wall 8. The passage 22 communicates at its lower end with a space 26 between the base 2 and bottom plate 18 wherein the evaporator 16 is located.

A vertically extending inner back panel 28 is spaced from the insulated rear wall 4 and cooperates therewith to form a vertically extending air duct 30 which communicates at its lower end with the space 26 beneath the bottom plate 18 of the storage space. The upper end of the duct 30 communicates with an air passage 32 located beneath the insulated top 6 of the case and provided with an outlet opening or nozzle 34 located near the front edge of the top of the case and adjacent the upper edge of the access opening 12 to the storage space 14.

The rear panel 28 may also serve to support one or more shelves 36 which can each be provided with an air passage 38 communicating with the vertical air duct 30, and if desired various air outlet openings 40 may be provided for the circulation of refrigerated air from the duct 30 through the storage space 14 of the case.

A blower 42 is provided for circulating air through the air passages and ducts 22, 26, 30 and 32 and preferably is located in the space 26 adjacent the evaporator 16. The blower thus operates to draw air into duct 22 through inlet opening 24 so as to force it over the evaporator to refrigerate the air and cause it to flow upward through the vertical duct 30 and forward through passage 32 to outlet nozzle 34. At the same time, a portion of the refrigerated air may flow through the passage 38 in shelf 36 and through openings 40 to circulate within the storage space 14.

Since the air outlet opening or nozzle 34 is located adjacent one edge of the access opening 12 of storage space

14, and the inlet opening 24 of the passage 22 is located adjacent the opposite edge of the access opening, the construction serves to establish a refrigerated air circuit including a layer of refrigerated air 42 forming the inner portion of a laminar type air curtain 44 directed across the access opening 12 to shield the storage space 14 from ambient air in front of the access opening.

In order to reduce heat transfer between the ambient air and the air circulated in the refrigerated air circuit and the air curtain, an outer protective layer of air 46 is also caused to flow downward across the access opening parallel to and adjacent the layer of refrigerated air 42 as a part of the multilayer air curtain 44. The protective layer of air 46 is caused to issue from the downwardly directed air outlet nozzle 48 adjacent the upper edge of the access opening 12 and in front of the air outlet 34 of the refrigerated air circuit. It flows across the access opening toward the lower side thereof so as to enter the inlet opening 50 of an air passage 52 located on the exterior of the lower front wall 8 of the display case. The air then is drawn through a passage 54 beneath the base portion 2 of the case by means of a blower 56 and is directed upwardly through duct 58 at the rear of the case to a forwardly extending air passage 60 terminating in the outlet opening or nozzle 48. If desired, an additional evaporator element or temperature control means 62 may be located in the passage 60 to chill the air forming the protective outer layer 46 of the air curtain and to reduce the temperature differential between the inner and outer layers of air in the air curtain 44.

In any event, when an air curtain is utilized as described to reduce or eliminate the entry of ambient air into the display space, the outermost layer or portion of the air curtain which is flowing across the access opening is in contact wtih ambient air, and, therefore, tends to pick up or entrain a portion of the ambient air and to create an induced flow of ambient air parallel to the outermost layer of the air curtain. Thus as shown at 64 in FIG. 1, an induced flow of ambient air is developed and flows downward toward the lower front wall of the case and toward the inlet opening 50 in the upper portion of the air passage 52. The volume of the air approaching the inlet opening 50, therefore, exceeds the volume of the air issuing from the air outlet nozzle 48 and forming the outer protective layer 46 of the air curtain 44. As a result, the excess air approaching air inlet 50, over the volume of air utilized in producing the protective layer of air 46, tends to spill over the front wall 8 of the case as indicated at 66. This excess or spill air, which has heretofore tended to chill the space adjacent the case, is withdrawn from the aisle in accordance with the present invention through openings or supplemental air inlets 68 which communicate with the air passage 52 or the passage 54 beneath the base portion 2 of the case.

The location and size of the air inlets 50 and 68, and the size or capacity of the passages 52, 54 and 58, as well as the capacity of the blower 56 are, therefore, designed to be capable of receiving and handling an amount of air substantially exceeding that required for producing the outer protective layer of air 46 which forms a part of the air curtain 44. However, in order to vent the excess air from the protective air circuit thus established, an air vent 70 is located at a suitable point remote from the front of the case and preferably at the top and rear portion of the case. In the event a supplemental evaporator or temperature control means 62 is provided, the vent 70 is located between the blower 56 and the evaporator 62 so that the vented excess air is not passed over the evaporator before being vented from the case.

Further in order to aid in controlling the air curtain to effect the desired protection of the storage space by the protective layer of air 46 issuing from the air outlet or nozzle 48, the vent 70 is preferably variable or adjustable to control the amount and velocity of the air utilized in producing the protective layer of air 46. Thus, when the vent 70 is opened to permit a relatively large amount of air to be exhausted or vented from the protective air circuit, the velocity of flow of the protective layer of air 46 may be somewhat less than the velocity of the refrigerated layer of air 42 embodied in the air curtain and located adjacent the storage space 14. Conversely, by restricting the vent 70, the velocity of the air circulated across the access opening as the outer protective layer may be increased to provide a more rapidly flowing outer layer of air 46 separating the layer of refrigerated air 42 from the ambient air.

Control of the velocity, and, therefore, the volume of air circulated in a unit period of time, may also be utilized to preclude or reduce the migration or inter-mingling of moisture from the ambient air into the storage space of the display case, or into the circulating layer or layers of refrigerated air such as the layer 42 of the air curtain. Moreover, the vent 70 may be adjusted to vary the amount of air drawn into the protective air circuit through the air inlets 50 and 68 by controlling the back pressure of the air in the air duct 58 and on the outlet side of the blower 56. In this way, it is possible to control the amount and effect of the spill air 66 which overflows from the front of the display case and into the space adjacent thereto. Vent means 70, therefore, can, in fact, be employed to control not only the temperature, velocity and humidity of the protective layer of air embodied in the air curtain but may also serve to control the amount and temperature of any air spilling from the case and the disposition thereof.

Vent 70 may be controlled by any suitable means but, as shown, it may be provided with a simple damper or butterfly valve 72 operable by means such as an arm 74. The arm and valve in turn may be actuated manually or by automatic means, indicated generally at 76, and including a thermostat, humidistat, time clock or the like, if desired. In this way, accurate control of the protective layer of air forming a part of the air curtain can be attained to assure the desired protection of the display space from the effects of the ambient air adjacent the access opening of the display case.

In some refrigerated display cases embodying the present invention, it is desirable to establish an air curtain embodying two or more layers of refrigerated air which vary progressively in temperature from an innermost and coldest layer of air adjacent the storage space to an intermediate layer of air which is refrigerated to a lesser extent and may be directly adjacent an outermost protective layer of air in contact with the ambient air. Thus as shown in FIG. 2, the air curtain 80 embodies an innermost layer of air 82, an intermediate layer of air 84 and an outermost protective layer of air 86. The innermost and intermediate layers of air from the air curtain are drawn into a common air inlet 88 to an air passage 90 located on the inner side of the lower front wall 92 of the display case. The lower end of air passage 90 communicates with a plenum chamber 94 beneath the bottom 96 of the storage space 98 and an evaporator 100 is located in the plenum chamber 94 for refrigerating the air. Further if desired, a dehumidifying coil or evaporator element 102 may be located in the plenum chamber between the air passage 90 and the refrigerating evaporator 100.

A blower 104 is located in the plenum chamber between the evaporator and the dehumidifying coil 102 and serves to force air over the evaporator 100 to a refrigerated air duct 106 and to force additional air to a secondary air duct 108. The refrigerated air duct 106 preferably has additional evaporator or air refrigerating elements 110 and 112 therein and may be provided with an intermediate air outlet 114 for directing refrigerated air to a shelf 116 and to the interior of the storage space 98. The upper end of the refrigerated air duct 106 extends forwardly at 118 adjacent the top of the storage space and is provided at its front end with one or more air outlet openings

or nozzles 120 located near the upper edge of the access opening 122 and on the inner side thereof. The nozzle or nozzles 120 thus cooperate with the air inlet 88 to establish the innermost layer or layers of refrigerated air 82 embodied in the air curtain 80.

The blower 104 also serves to force air through the secondary air duct 108 so as to bypass the evaporator 100. However, the secondary air duct 108 is arranged to extend upwardly at 124 and forwardly at 126 parallel and in heat exchanging relation with the refrigerated air duct 106. For this purpose, the portions 124 and 126 of the secondary air duct 108 may be separated from the refrigerated air duct 106 by a metal or other heat transmitting wall 128.

The front or outer end of the portion 126 of the secondary air duct 108 is provided with a downwardly directed secondary air outlet or nozzle 130 which is positioned adjacent and in front of the air outlet 120 so as to create the intermediate layer 84 of the air curtain 80. The air forming the intermediate layer 84 is thus refrigerated or cooled to a lesser extent than the innermost layer 82 of the air curtain whereby the temperature gradient between the adjacent layers of air may be limited and the resultant heat transmission therebetween is reduced.

In order to produce the outermost protective air layer 86 of the air curtain 80, the display case is further provided with means establishing a protective air circuit which may be the same or similar to that described above in connection with that form of the invention illustrated in FIG. 1. Thus, one or more air inlets 132 are located adjacent the lower edge of the access opening 122 and communicates with an air duct 134 on the outer side of the insulated lower front wall 92 of the display case. The lower end of air duct 134 communicates with a lower air passage 136 which extends beneath the insulated bottom portion 138 of the case and is provided supplemental air inlets 140 near the bottom of the front wall for drawing spill or ambient air into the lower passage from in front of the case. The lower air passage 136 communicates with a vertical air duct 142 positioned at the rear of the insulated rear wall 144 of the case and having a horizontally extending portion 146 located above the insulated top 148 of the case.

The front end of the horizontally extending portion 148 of the protective air circuit terminates in a downwardly directed air outlet or nozzle 150 located in front of the secondary air outlet 130 and adjacent the upper edge of the access opening 122. A blower 152 in the protective air circuit serves to provide the protective outer layer of air 86 of the air curtain 80 and serves to draw air from layer 86 and entrained ambient air as indicated at 154, into inlet 132 and to draw spill air through supplemental air inlets 140 from the space in front of the display case An excess air vent 156 located near the top and rear of the case serves to vent from the protective air circuit air drawn into the circuit and in excess of that required to produce the protective outer layer of air 84 of the air curtain. Adjustable control means, indicated generally at 158, serve to permit the desired variations in the amount of air and the velocity thereof utilized in establishing the protective layer of air 86 between the intermediate layer 84 and the ambient air.

In the further alternative form of the invention illustrated in FIG. 3, the air curtain 160, which is directed across the access opening 162 of the case, embodies an innermost layer 164, an intermediate layer 166 and an outer layer 168, all of which are refrigerated to at least some extent. The innermost layer issues from an inner air outlet or nozzle 170, the intermediate layer issues from an adjacent or intermediate nozzle 172 and the outer layer 168 is discharged from an outermost nozzle 174. Both the innermost layer of air 164 and the intermediate layer of air 166 are refrigerated by the evaporators or evaporator sections 176, 178 and 180 located in a common air duct

182 whereas the outer layer of air 168 is refrigerated by heat exchange between the common air duct 182 and protective air duct 184 through a heat transmitting common wall 186.

In order to produce the two adjacent refrigerated layers of air 164 and 166 from the air flowing through the common air duct 182, the upper horizontal portion 188 thereof is provided with a restrictor 190 located between the air outlet openings or nozzles 170 and 172. The restrictor 190 serves to direct air from the horizontal portion 188 of the refrigerated air circuit through inner nozzle 170 and is so arranged that the velocity of the innermost layer 164 of the air curtain will be somewhat less than the velocity of the air passing beyond the restrictor to the intermediate nozzle 172 by which the intermediate layer 166 of the air curtain is produced.

The outer layer of air 168 in the air curtain 160 includes recirculated ambient and spill air drawn into the protective air circuit through the air inlet 192 and supplemental inlet 194. Therefore, even though it is cooled by heat exchange between the common air duct 182 and the protective air duct 184, its temperature will be higher than that of the air flowing through the intermediate layer 166 while being lower than that of the ambient air. The protective air circuit, as in the other forms of the invention described, is provided with a blower 196 and an excess air vent 198. Moreover, control means 200 are provided to regulate the volume and velocity of air discharged through the outermost nozzle 174 to produce the outer protective air layer 168 of the air curtain.

In certain applications of the invention, the blower 196 and vent 198 or control means 200 are arranged to cause the velocity of the air in the outer protective layer 168 to exceed that of the intermediate layer 166. Under such circumstances, the display case may be operated so that both the temperature and the velocity of flow of the air in the various layers of the air curtain 160 increase progressively from the innermost layer of air adjacent the storage space 202 to the outermost or protective layer of air 168 which shields the storage space from the ambient air 204 adjacent the access opening 162. In a typical construction designed for low temperature operation, the innermost layer of air 164 may have a temperature of about −10° F. and a velocity of about 400 feet per minute; the intermediate layer of air 166 may have a temperature varying from about −10° F. to +10° F. and a velocity of about 450 feet per minute, whereas the outer protective layer 168 of the air curtain 160 may have a temperature of about 25 to 30° F. and a velocity of about 475 to 500 feet per minute. Of course, these temperatures and velocities may be varied in any particular case and for use in maintaining any desired temperatures within the storage space of the case. Therefore, the particular temperatures and velocities cited are merely examplary.

In each of the embodiments of the invention shown in the drawings and described above, the construction is designed to recirculate the protective layer of air on the outer side of the air curtain and at the same time to remove all or at least a portion of the spill air which includes entrained or downwardly flowing ambient air which would otherwise tend to chill the space adjacent the front of the case. On the other hand, the excess air from the protective air circuit which is not required for producing and maintaining the protective outer layer of air in the air curtain is vented from the protective air circuit in a manner to avoid undesired cooling of the area adjacent the front of the case. Moreover, such venting of excess air may be controlled so as to assure the most effective or desired action of the protective layer of air in preventing or reducing losses in refrigeration and the entry of moisture from the ambient air into the storage space to freeze or condense on articles

therein or on the evaporator and other surfaces within the refrigerated air circuit.

It will, thus, be apparent that the particular embodiments of the invention illustrated and described above are intended to be illustrative only and are not intended to limit the scope of the invention.

We claim:

1. A refrigerated display case having a storage space provided with an access opening, means for circulating air in the form of an air curtain across said access opening, an air outlet located at one side of said access opening formed to produce a protective layer of air directed across said access opening between said storage space and air ambient to the case on the side of the air curtain remote from the storage space, air inlet means on the opposite side of said access opening so located and of such capacity as to be capable of receiving both said protective layer of air and ambient air entrained with the protective layer of air during passage thereof across the access opening, a conduit extending from said air inlet means to said air outlet, a blower in said conduit, and means located between said air inlet means and said air outlet for venting from said conduit excess air not utilized in producing said protective layer of air.

2. A refrigerated display case as defined in claim 1 wherein means are located in said display case between said venting means and said air outlet for refrigerating the air passing to said outlet.

3. A refrigerated display case as defined in claim 1 wherein said venting means is variable to control the amount of air vented from said protective air circuit.

4. A refrigerated display case as defined in claim 1 wherein said venting means is located near the upper rear portion of the case and includes a valve member movable to control the amount of air vented from the protective air circuit.

5. A refrigerated display case as defined in claim 4 wherein temperature responsive means are connected to said valve member for actuating the same.

6. A refrigerated display case as defined in claim 4 wherein humidity responsive means are connected to said valve member for actuating the same.

7. A refrigerated display case having a storage space therein provided with an access opening in the front thereof, means forming a refrigerated air circuit having inlet and outlet openings located at opposite sides of said access opening in position to establish a curtain of refrigerated air flowing across said access opening between said storage space and ambient air adjacent the access opening, refrigerating means including an evaporator located in said refrigerated air circuit, a blower circulating air over said evaporator and through said refrigerated air circuit, means forming a protective air circuit having an air outlet positioned to direct a layer of air across said access opening parallel to and in the same direction as said curtain of refrigerated air and on the side thereof remote from said storage space, said protective air circuit having an air inlet located adjacent the front of the case together with a supplemental air inlet located in the front of the case below said access opening in position to receive air which spills over the front of the case, means for circulating air received from both said air inlet and said supplemental air inlet through said protective air circuit, and a vent in said protective air circuit spaced from the front of the case for venting from said protective air circuit excess air not required to produce said layer of protective air.

8. A refrigerated display case as defined in claim 7 wherein said supplemental air inlet means is located in position to receive spill and ambient air from areas adjacent an aisle in front of said case.

9. In a refrigerated display case having an access opening and means for circulating air in the form of an air curtain across said opening, means for directing a protective layer of air across said access opening to form the outermost layer of said air curtain including an air outlet located on one side of said access opening, air inlet means located on the opposite side of said access opening in position to receive both said protective layer of air and ambient air entrained therewith during passage of said protective layer of air across said access opening, a conduit extending from said air inlet means to said air outlet, a blower in said conduit, and means located between said air inlet means and said air outlet for venting from said conduit excess air not utilized in producing said protective layer of air.

10. A refrigerated display case as defined in claim 9 wherein said air inlet means includes an opening located near the lower portion of the case in position to receive spill and ambient air from an area near the floor of an aisle adjacent the case.

11. A refrigerated display case as defined in claim 1 wherein means are provided for reducing the temperature of the air forming said protective layer of air.

12. A refrigerated display case as defined in claim 1 wherein a refrigerated air duct having a blower and refrigerating means therein are provided for producing and directing a layer of refrigerated air across said access opening between said protective layer of air and said storage space, and means located in heat exchanging relation with said refrigerated air duct are positioned to be contacted by and reduce the temperature of the air directed to said air outlet to form said protective layer of air.

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WILLIAM J. WYE, *Primary Examiner.*