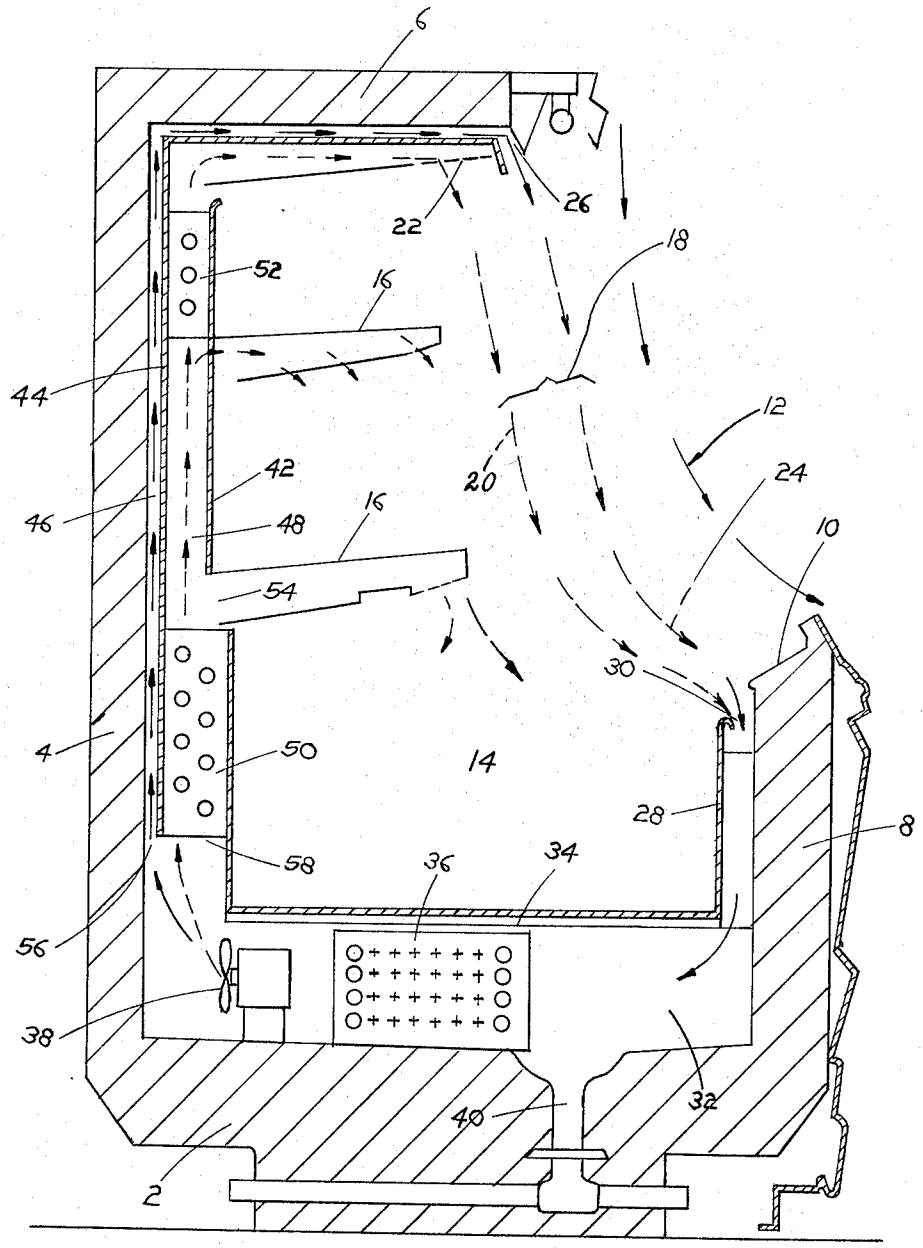
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DISPLAY CASE

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DISPLAY CASE

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This invention relates to refrigerated display cases of the type wherein there is a storage space having an access opening, and an air curtain embodying a plurality of layers of air is directed across the access opening to shield the storage space from ambient air.

Constructions of this type are widely used and generally are arranged so that the innermost layer of air in the air curtain is refrigerated and maintained at a lower temperature than the outermost layer of air adjacent the ambient air. Nevertheless, as the display case is used, moisture penetrates the air curtain as persons reach into the storage space and disturb the air curtain and additional moisture tends to migrate or be drawn into the air curtain by entrainment from the ambient air. Thereafter as the air used in producing the air curtain is recirculated and passed through ducts or passages and an evaporator to refrigerate the same, the moisture deposits on the coils, fins and surfaces of the evaporator and air ducts. As a result, snow, frost or ice which builds up progressively on such surfaces not only reduces the heat transfer from the air to the evaporator but seriously restricts the passages and reduces the velocity of the air flowing through the ducts and forming the air curtain. The temperature of the air in the air curtain and the migration or penetration of moisture into the air curtain is then increased so that the accumulation of ice, frost and snow on the refrigerated coils and surfaces is increased and the development of undesired conditions are progressively accelerated. This situation is particularly aggrevated when the display case is operated at low temperatures, as when frozen foods, ice cream and the like are on display; since the humidity of the refrigerated air is then very low, the migration of moisture into the air curtain is increased, and the deposition of moisture on the coils and fins takes place rapidly and in localized areas where it first contacts low temperature surfaces. Defrosting of the evaporator must then take place frequently and the temperature of the air in the air curtain and storage space fluctuates considerably.

In accordance with the present invention, these objections and limitations of prior refrigerated display cases utilizing an air curtain are reduced or overcome and a simplified construction provided which serves to operate automatically to compensate for variations in the air curtain resulting from accumulation of snow, ice or frost on the evaporator and surfaces used for reducing the temperature of the air in the air curtain.

These results are preferably attained by constructing and arranging the ducts through which the air forming the air curtain is passed with a common passage or plenum chamber to which the moisture containing return air from the air curtain is directed and by providing a condenser by-pass for the air utilized in producing the outer or protective layer of air in the air curtain. In this way, less return air is caused to pass over the condenser when the evaporator and its surfaces become restricted by accumulations of frost or snow thereon, whereas the velocity of the air in the outer protective layer of the air curtain is increased and the protective action thereof is rendered more effective.

Accordingly, the principal objects of the present invention are to improve the operation and simplify the construction of refrigerated display cases utilizing an air curtain to shield a storage space therein from ambient air; to automatically vary the action of the elements employed in producing an air curtain embodying multiple layers of air; to adjust the amount and velocity of air circulated through ducts or passages to produce a multi-layer air curtain in response to the accumulation of snow, frost or ice on surfaces over which such air is passed; and to decrease the frequency and duration of the defrosting cycle required to assure proper operation of display cases.

A specific object of the present invention is to provide a refrigerated display case utilizing a multi-layer air curtain with means for automatically causing the air used in producing an outer protective layer of air, to by-pass the evaporator and to vary the amount of air thus by-passed as the accumulation of frost, snow and ice on the surfaces of the evaporator increases.

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 drawing.

The drawing is a vertical sectional view of a typical form of refrigerated display case embodying the present invention.

In that form of the invention chosen for purposes of illustration in the drawing, the display case has an insulated base **2**, an insulated rear wall **4**, an insulated top **6** extending forwardly from the rear wall **4** and an insulated front wall **8** extending upward from the base **2**. The upper edge **10** of the front wall **8** is spaced from the top **6** of the case to provide an access opening **12** in the front of the case through which persons may reach into the storage space **14** to place articles in or remove articles from the storage space and shelves **16** therein.

In order to shield the storage space from ambient air, an air curtain **18** is established for directing air across the access opening **12**. The air curtain comprises at least two parallel layers of air which flow in the same direction and, as shown, includes an inner layer of refrigerated air **20** which is directly downwardly across the access opening from an outlet or nozzle **22**, and an outer or protective layer of air **24** which is directed downwardly adjacent to the inner layer **20** from an air outlet or nozzle **26**.

Both, or all, of the layers of air embodied in the air curtain **18** are recirculated in establishing and maintaining the air curtain. For this purpose, the case is provided with a return air passage **28** located adjacent the inner side of the lower front wall **8** of the case and has an air inlet opening **30** positioned near the upper edge **10** of the front wall to receive air from the air curtain. The lower end of the return air passage **28** communicated with a plenum chamber **32** located above the insulated base **2** of the case and beneath the bottom **34** of the storage chamber **14**. An evaporator section or drying coil **36** is located in the plenum chamber and the layers of air from the air curtain are drawn downward into the return air passage **28** and into the plenum chamber **32** so as to pass over the coil **36** by means of a blower or fan **38**. In this way, the return air from the air curtain is caused to flow through a common return passage and the common plenum chamber where they may mingle and give up moisture which has penetrated or been entrained by either, both or all of the layers of air embodied in the air curtain. While the coil **36** preferably is refrigerated to a sufficient extent to cool the air passing thereover and cause moisture to condense on tubes and fins of the coil without causing the moisture to freeze or to produce a build-up of snow, frost or ice thereon, the moisture thus condensed may drip from the coil to a drain outlet **40** whereas the air passing to the blower and returning to maintain the air curtain is relatively dry.

The air from the blower 38 is directed to and through two separate ducts or passages which, as shown, extend vertically between the rear wall 4 of the case and the back wall 42 of the storage space 14, and forwardly beneath the top 6 of the case to the air outlets or nozzles 22 and 26 at the upper edge of the access opening 12. For this purpose, a metal or other thermally conducting divider 44 is provided which cooperates with the rear wall 4 and top 6 to form a protective air duct 46. At the same time, the divider 44 cooperates with the back wall 42 of the storage chamber to form a refrigerated air duct 48. Two or more evaporators or evaporator sections 50 and 52 are located in the refrigerated air duct 48 and air discharge openings 54 may be formed in the back wall 42 to permit refrigerated air from the duct 48 to flow forward into the storage space 14 and beneath or over the shelves 16 therein. On the other hand, the protective air duct 46 is preferably free and unobstructed throughout its length although the air passing therethrough is cooled or refrigerated to some extent by heat exchange from the evaporators and refrigerated air in the duct 48 through the thermally conducting divider 44.

The lower inlet opening 56 of the protective air duct 46 and the lower inlet opening 58 of the refrigerated air duct 48 are both located beyond the drying coil 36 and blower 38 and communicate with the common plenum chamber 32 so that both ducts are supplied with return air from the air curtain under the same pressure and conditions of temperature and humidity. Thereafter, the air which is to form the outer protective layer of air 24 in the air curtain 18 flows freely through the protective air duct 46 to the outlet opening 26 so as to be directed downwardly across the access opening 12 toward the inlet opening 30 of the return air passage 28. In a similar way, the air which is to form the inner refrigerated layer or layers of air 20 of the air curtain 18 is caused to flow upward through the refrigerated air duct 48 and over the refrigerating coils 50 and 52 to the inner air outlet or nozzle 22. From the air outlet 22, the refrigerated layer of air 20 is directed downwardly across the access opening 12 between the protective layer of air 24 and the storage space 14 to the return air inlet 30 at the upper end of the return air passage 28.

With this construction, the amount of air and the velocity of flow thereof through the protective and refrigerated air ducts 46 and 48 will depend primarily upon the cross sectional area of the ducts and their inlet openings 56 and 58 respectively and the amount of obstruction or restriction to air flow imposed by the coils and fins of the evaporators 50 and 52 in the refrigerated air duct 48, as well as the size or power of the blower 32. Since these elements are fixed or may be established by the design and construction of the case and by control of the blower 32, the amount and velocity of the air discharged from the air outlets or nozzles 22 and 26 and forming the layers of air which make up the air curtain 18 can be predetermined to assure the desired operation of the case.

Thereafter, as operation continues, the air flowing through the refrigerated air duct 48 and over the evaporators 50 and 52 will be materially reduced in temperature so as to deposit additional moisture in the form of snow, frost or ice on the coils and fins of the evaporators and, in some instances, on the walls or other surfaces of the refrigerated air duct 48. However, little if any such accumulations will take place within the protective air duct 46. As a result, the restriction to flow of air through the refrigerated air duct will increase as the frost accumulations build up, and such accumulations and restriction will take place more rapidly as the humidity of the ambient air and the migration and entrainment of moisture in the returned and recirculated air from the air curtain increases.

The amount and velocity of the air flowing through the ducts 46 and 48 and forming the layers of air 20 and 24 of the air curtain 18 will therefore be automatically

and progressively proportioned or varied as the resistance to flow of air through the refrigerated air duct 48 is varied. Moreover, as the velocity of the air flowing through the refrigerated air duct 48 decreases, its temperature will be reduced while the velocity of the protective air flowing through duct 46 will increase and its temperature will be decreased to a lesser degree. Nevertheless, the higher velocity of the protective layer of air 24 resulting from such conditions serves to increase the protective action thereof by decreasing the possibility of heat exchange therethrough between the ambient air and the refrigerated air in the storage space and forming the inner layer 20 of the air curtain.

The same increased protective effect of the outer layer of protective air at increased velocity is attained upon increase in the humidity of the ambient air. At such times, the tendency for frost and snow to build up on the evaporators 50 and 52 increases upon an increase in humidity of the ambient air, whereby the protective effect of the unrestricted air flow through the duct 46 and in the outer layer of air 24 of the air curtain is increased.

In this way, an automatic and progressive variation in the operation of the display case is effected without resort to the use of mechanical elements or control means. As a result, the frequency of the defrosting cycles required for removing excessive frost, snow and ice from the evaporators 50 and 52 is decreased and the length of the refrigerating cycles increased. The refrigeration efficiency of the display case is thereby increased whereas the construction and operation thereof is simplified.

While the construction shown in the drawing and described above is designed to establish an air curtain embodying only two layers of air, the nozzles or outlet openings and the ducts provided for supplying air thereto may be increased in number as desired to provide an air curtain embodying any desired number of layers of air progressing in temperature from the refrigerated storage space outward to the ambient air. Furthermore, it is not always necessary or desirable to provide a drying or humidifying coil in the plenum chamber particularly when the case wil be employed in locations wherein the humidity is relatively low.

The present invention further may be used in combination with elements designed to recover any recirculate spill air and/or to vent excess recirculated air from the protective air circuit as disclosed in copending application Serial No. 477,730, filed Aug. 6, 1965.

It will thus be apparent that numerous changes in the form, construction, arrangement and combination of the elements employed in the practice of the present invention may be made. In view thereof, it should be understood that the particular embodiment of the invention shown in the drawing and described above is intended to be illustrative only and is not intended to limit the scope of the invention.

We claim:

1. A refrigerated display case having a storage space therein provided with an access opening in the front thereof and means for establishing an air curtain embodying a plurality of layers of air directed across said access opening between said storage space and ambient air, said means comprising an inner refrigerated air duct provided with an outlet opening located on one side of the access opening for directing a refrigerated layer of air across said access opening as one layer of said air curtain, an outer protective air duct provided with an outlet opening located adjacent said one side of the access opening and farther from said storage space than the outlet opening of the refrigerated air duct for producing an outer protective layer of air as a second layer of said air curtain, air inlet means located at the opposite side of said access opening in position to receive air from both said layers of air in the air curtain, a plenum chamber communicating with said air inlet means, said inner refrigerated air duct and said outer protective air duct each

communicating with said plenum chamber to receive air therefrom, blower means operable to circulate air from said air inlet means through said plenum chamber and both said inner refrigerated air duct and said outer protective air duct to their respective outlet openings, and an evaporator located in at least said refrigerated air duct and beyond said plenum chamber to refrigerate air passing through the refrigerated air duct, the cross sectional area of said refrigerated air duct and said protective air duct through which air flows to their respective outlet openings during operation of said display case being variable in response to accumulation of frost on the surfaces of said ducts and any refrigerating means therein, whereby the proportion of the air from said plenum chamber which flows through said refrigerated air duct and protective air duct to form the inner refrigerated layer of air and the outer protective layer of air in said air curtain will be variable and dependent in part at least upon the amount of frost accumulated on the surfaces and refrigerating means in said refrigerated and protective air ducts, respectively.

2. A refrigerated display case as defined in claim 1 wherein the protective air duct is located in heat exchanging relation with said refrigerated air duct.

3. A refrigerated display case as defined in claim 1 wherein a drying coil is located in said plenum chamber to decrease the humidity of air passing therethrough to said refrigerated and protective air ducts.

4. A refrigerated display case as defined in claim 1 wherein said plenum chamber is located below said storage space and the refrigerated air duct and protective air ducts extend vertically at the rear of the storage space and forwardly to outlet openings positioned adjacent the upper side of the access opening at the front of the case and the inlet opening for the common return air duct is located near the lower side of the access opening.

5. A refrigerated display case as defined in claim 1 wherein the velocity of the air forced through the outlet openings of said refrigerated air duct and said protective air duct and forming said layers of air in said air curtain is variable in response to the resistance to air flow through the refrigerated air duct resulting from accumulation of frozen moisture on said evaporator.

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