

Sept. 22, 1970

J. H. BRENNAN

3,529,436

SYSTEM OF REFRIGERATION

Filed Oct. 8, 1968

4 Sheets-Sheet 1

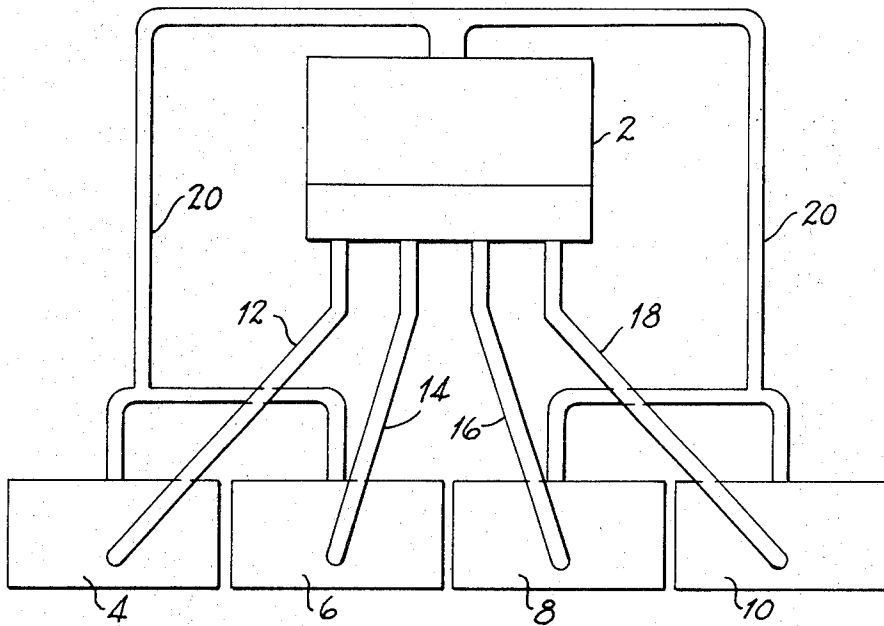


Fig-1-

INVENTOR.
JAMES H. BRENNAN
BY *Sperry and Zoda*
Attorneys.

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J. H. BRENNAN

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4 Sheets-Sheet 2

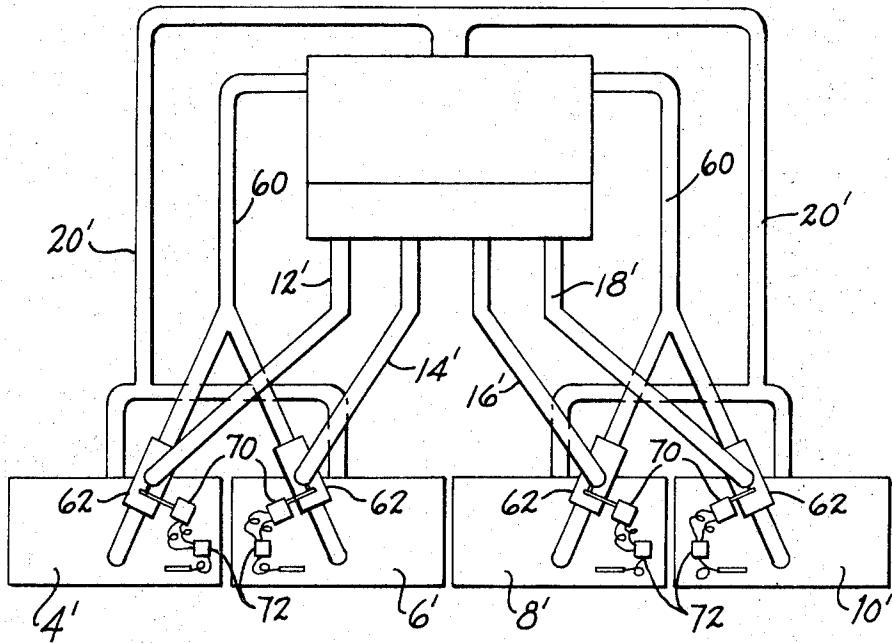


Fig-5

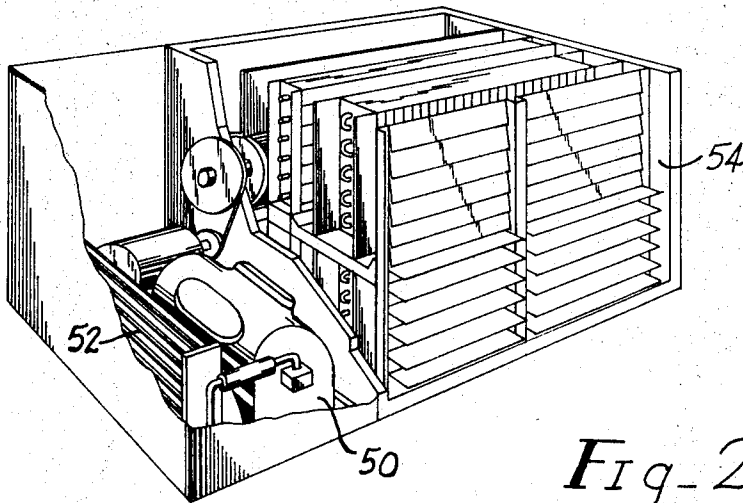


Fig-2

INVENTOR
JAMES H. BRENNAN
BY *Sperry and Zoda*
Attorneys

Sept. 22, 1970

J. H. BRENNAN

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4 Sheets-Sheet 3

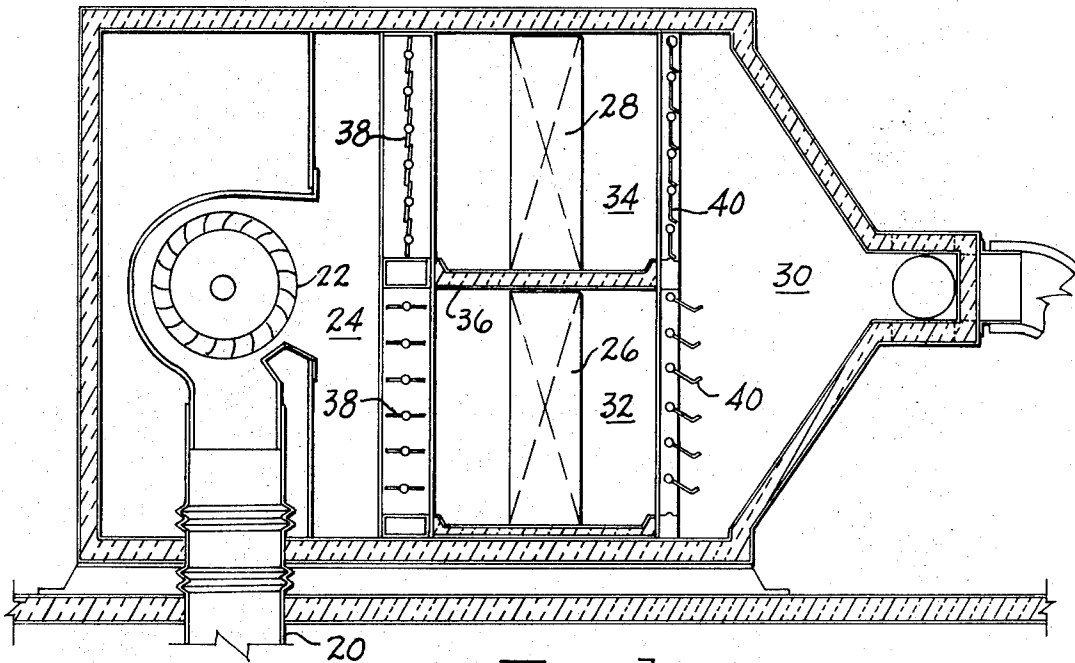


Fig. 3

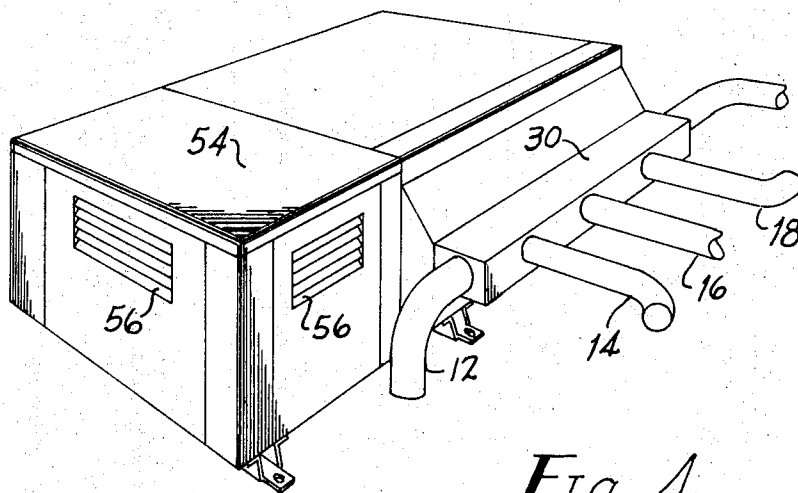


Fig. 4

INVENTOR
JAMES H. BRENNAN
BY *Sperry and Zoda*
Attorneys

Sept. 22, 1970

J. H. BRENNAN

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4 Sheets-Sheet 4

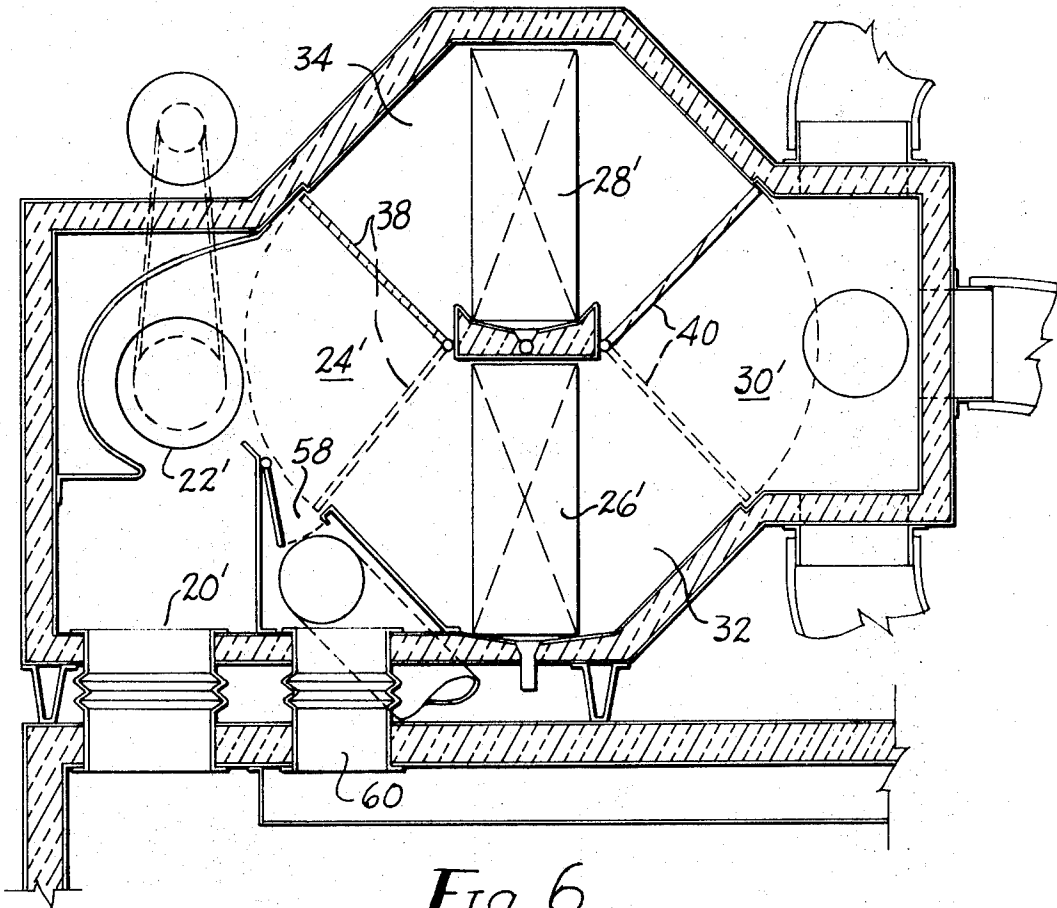


Fig. 6

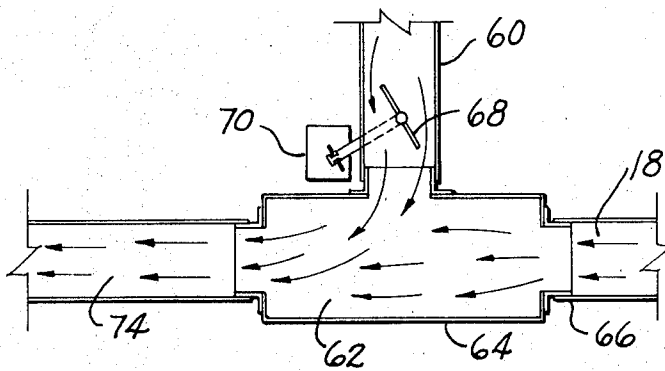


Fig. 7

INVENTOR
JAMES H. BRENNAN
BY *Sperry and Zoda*
Attorneys

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3,529,436

SYSTEM OF REFRIGERATION

James H. Brennan, Trenton, N.J., assignor to Emhart Corporation, Bloomfield, Conn., a corporation of Connecticut

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9 Claims

ABSTRACT OF THE DISCLOSURE

A refrigerating system for continuously maintaining the temperature within one or more refrigerated storage and display cases substantially constant at all times while providing for effective defrosting of evaporator units employed in the system. The system embodies refrigerating means located exteriorly of the cases to be refrigerated and provided with duct means for supplying refrigerated air to the cases. The refrigerating means includes two evaporators each of which is alternately refrigerated and defrosted whereas air is circulated continuously to the duct means and cases from only that evaporator which is being refrigerated. As a result a continuous supply of air for refrigerating the cases is assured while the temperature of the air supplied to the storage and display cases is maintained constant at all times, and does not undergo a rise in temperature by reason of the defrosting of the evaporators.

BACKGROUND OF INVENTION

Refrigerated fixtures, such as display cases, walk-in coolers and storage chambers, used in food markets and elsewhere are generally provided with evaporator coils to which liquid refrigerant from a compressor and condenser is supplied and in which the refrigerant is expanded to absorb heat from air circulated through the equipment. Such evaporator coils occupy considerable space within a refrigerated fixture which could otherwise be used for the storage and display of products. It is also known that moisture from the air condensing on the coils and fins of the evaporator builds up as frost or ice which interfere with the flow of air over the evaporator and decrease the efficiency of heat exchange. As a result it is necessary to defrost the evaporator from time to time to remove the frost and ice therefrom and restore the efficiency of operation. Such defrosting is usually effected by providing heating elements which serve to raise the temperature of the coils and fins or the temperature of the air circulated over the same. In the alternative hot refrigerant gas may be supplied to the coils to melt the ice and frost.

In any event when the evaporator is defrosted the refrigerating operation is terminated and the temperature of the evaporator is increased sufficiently to melt the ice and frost on the coils and fins. The temperature of the air adjacent the evaporator is then increased and if it is circulated to or through the refrigerated equipment, as is frequently the case, the articles being stored or displayed will be subjected to an increase in temperature which may amount to as much as 20° F. or more depending upon the type of equipment. On the other hand, if the refrigerated equipment is of the open self-service type provided with an air curtain for preventing the entry of ambient air into the case, the termination of air flow to the equipment would tend to permit warm ambient air to enter the case causing a further increase in temperature.

Such variations in the temperature at which meats are stored and displayed is particularly objectionable since it has been found that a change of as little as 5° F. promotes the growth of bacteria and causes darkening or discoloration of the meat. As a result, meats, even when

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wrapped in cellophane or other moisture proof material, are often found to undergo an objectionable change in color within a day or two by reason of the fact that the temperature at which they have been maintained varies by about 5° or 10° F. or more. Fluctuations in temperature of the air circulated about articles on display or in storage is also objectionable for the reason that such changes in the air temperature give rise to the condensation of moisture on the products so that they become wet or soggy and when refrigeration is renewed they tend to freeze together or become coated with objectionable layers of ice and frost.

In accordance with the present invention a system is provided wherein refrigerated display and storage equipment may be supplied with air refrigerated to a constant low temperature even during the periods when evaporators in the system are being defrosted. This result is attained by providing refrigerating means embodying two separate evaporating units over which the air supplied to the cases is alternately circulated during the refrigeration cycle only of each evaporator. The evaporator being defrosted is then closed off from the air circuit and may be defrosted in any manner desired and for a relatively longer period of time without raising the temperature of the air being supplied to the refrigerated equipment and without interruption in the supply of refrigerated air thereto. Furthermore, the refrigerating means are located at a point exterior to the cases being refrigerated whereby the available space in which articles may be displayed or stored is increased and the articles are maintained at a uniform desired low temperature. The accumulation of frost or ice within the case is substantially reduced and it has been found in practice to be possible to preserve meats in a prime condition for much longer periods of time. Moreover, the preservation of meats at such uniform temperatures can be effected even when employing open self-service display cases utilizing an air curtain as a barrier to the entry of ambient air into the case.

THE DRAWINGS

FIG. 1 is a diagrammatic illustration of a typical system embodying the present invention and including a plurality of refrigerated cases,

FIG. 2 is a perspective illustrating typical refrigerating means used in the system of FIG. 1 with part of the enclosure therefor broken away;

FIG. 3 is a vertical sectional view through the refrigerating means shown in FIG. 2;

FIG. 4 is a perspective illustrating the exterior of the construction shown in FIGS. 2 and 3, and

FIG. 5 is a diagrammatic illustration of a modified construction embodying the present invention;

FIG. 6 is a vertical sectional view through the refrigerating means employed in the system of FIG. 5, and

FIG. 7 is a diagrammatical illustration of control means which may be used in the practice of the invention illustrated in FIG. 5.

PREFERRED EMBODIMENTS OF THE INVENTION

In that form of the invention chosen for purposes of illustration in the FIGS. 1 to 4 of the drawing, the equipment embodies refrigerating means indicated generally at 2 which may be located at any convenient and remote point on a roof, in a basement or engine room, as desired. The refrigerating means 2 is operable to refrigerate air and direct the same to a plurality of refrigerated cases indicated at 4, 6, 8 and 10 through thermally insulated ducts indicated at 12, 14, 16 and 18 respectively. The refrigerated cases 4, 6, 8 and 10 may be of any suitable or preferred type. Thus, for example, the case 4 may be of the type shown and described in applicant's copending ap-

plication, S.N. 693,200; the case 6 may be a walk-in cooler; the case 8 may be a frozen food display case and the case 10 may be a dairy case or the like. The cases 4, 6, 8 and 10 are each connected to a return air duct 20 by which the air supplied to the cases through the refrigerated air ducts 12, 14, 16 and 18 may be returned to the refrigerating means 2.

As shown in FIGS. 2 and 3, the return air duct 20 communicates with a blower 22 which serves to force air through a return air plenum chamber 24 to one or the other or both of the two evaporators 26 and 28. The air refrigerated by the evaporators 26 and 28 flows to a refrigerated air plenum chamber 30 communicating with the refrigerated air ducts 12, 14, 16 and 18. The evaporators 26 and 28 are located in compartments 32 and 34 which are separated by a thermally insulated wall 36. Each of the compartments 32 and 34 is provided with closure members or dampers 38 and 40 respectively at the inlet and outlet ends of the compartments 32 and 34 in which the evaporators are located. As shown in FIG. 3, the dampers or closure members 38 and 40 associated with the compartment 32 and the evaporator 26 are open to permit free flow of air from the return air plenum chamber 24 through the compartment 32 and over the evaporator 26 to refrigerate the air being discharged to the refrigerated air plenum chamber 30 and the refrigerated air ducts 12, 14, 16, 18, etc. On the other hand, the dampers or closure members 38 and 40 associated with the chamber 34 and the evaporator 28 are closed so as to prevent air circulated by the blower 22 from coming into contact with the evaporator 28. With this construction the evaporator 28 may be defrosted while the evaporator 26 is on a refrigerating cycle whereby air may be refrigerated to a predetermined low temperature for supply to the refrigerated air ducts and various display and storage cases without danger of having the temperature of the refrigerated air raised by reason of the operation of defrosting of the evaporator 28. Thereafter, when the evaporator 26 becomes frosted or clogged with ice by reason of the condensation of moisture, the dampers 38 and 40 are moved to close off the compartment 32 and evaporator 26 and permit return air from the duct 20 to be passed over the evaporator 28 to refrigerate the air supplied to the refrigerated air plenum chamber 30 and the refrigerated air ducts 12, 14, 16 and 18.

The construction thus provided serves to assure a continuous supply of air refrigerated to a desired and constant low temperature to each of the refrigerated cases 4, 6, 8 and 10 without interruption in the air flow or an increase in temperature of the air being circulated by reason of the fact that one or the other of the evaporators 26 or 28 is being defrosted. The evaporators therefore operate at their maximum efficiency at all times, whereas the temperature of the air issuing from the evaporators to the refrigerated air plenum chamber 30 and the various refrigerated air ducts may be maintained uniform at all times. Such uniformity in the temperature of the air circulated to the various cases 4, 6, 8 and 10, is of particular importance when any one or more of such cases is used for the preservation, display or storage of meats. As pointed out above, variations in temperature at which meats are stored or displayed tends to give rise to the growth of bacteria and discoloration of the meats in a relatively short period of time. However, by reason of the fact that the air being circulated in accordance with the present invention is always refrigerated to known temperature, even during the defrosting of the evaporator unit which is not being employed, it is possible to maintain the temperature of the air within any one or more of the refrigerated cases substantially uniform and within the limits of 2° to 5° F.

As shown in FIGS. 2 and 4, the refrigerating means employed in the practice of the present invention may

be located on the top of an enclosure for the case 4, 6, 8 and 10, such as the roof of a building or the refrigerating means may be located in a cellar or a rear machine room or elsewhere as desired. The refrigerating means includes a compressor 50 and a condenser 52 and may be located in a ventilated housing 54 having vents 56 or the like. The condenser may be water cooled if desired, and the entire assembly of the compressor, condenser, evaporators, etc. may be of any suitable or preferred type and design.

In some instances, one or more of the various refrigerated fixtures to which refrigerated air is supplied may be designed to operate at a higher or lower temperature than other fixtures in the assembly. For this purpose a system such as that shown in FIGS. 5, 6 and 7 may be employed. As there illustrated any one or more of the fixtures 4', 6', 8' or 10' may be provided with a source of supplemental air to be mixed or blended with the refrigerated air received from the refrigerated air plenum chamber 30' and supplied to the ducts 12', 14', 16' or 18'. Thus, as shown in FIG. 5, a portion of the air received from the return air duct 20' may be directed through an opening 58 to each of the by-pass air ducts 60 so that such by-pass air will not come into contact with either of the evaporators 26' or 28'. The by-pass ducts 60 then serves to direct such return air to one or more of the ducts 12', 14', 16' or 18' in an amount required for mixing with the refrigerated air supplied from plenum chamber 30' to produce the modified air temperature desired in any one or more of the cases 4', 6', 8' or 10'.

Since the return air received from the ducts 20' by the blower 22' will be air which was previously refrigerated and circulated to the fixtures 4', 6', 8' and 10', such return air will be at a temperature lower than atmospheric temperature but at a temperature higher than that of the air delivered to ducts 12', 14', 16' and 18'. Such by-pass air and the refrigerated air can be blended together by a mixing device indicated at 62 in FIGS. 5 and 7 and located adjacent to the fixture which is to receive air at a modified temperature.

The mixing device 62 employed may be of any preferred type but as shown in FIG. 7, embodies a chamber 64 connected at one end to refrigerated air duct 12' by which refrigerated air from plenum chamber 30' is supplied to the display case 4'. The by-pass duct 60 also communicates with the chamber 64 and is controlled by a valve or damper 68 responsive to actuating means 70. The actuating means 70 is in turn controlled by a thermocouple or other temperature responsive means 72 in the display case 4' so as to cause the valve 68 to open and close as required to permit the relatively high temperature return air from by-pass duct 60 to enter and mingle with the refrigerated air flowing through the chamber 64. The resulting mixed or tempered air flows from the mixing device 62 through the outlet duct 74 to the fixture 4' so as to maintain this fixture at a predetermined temperature required for the proper preservation of articles therein.

While the air utilized for modifying the temperature of refrigerated air received from the refrigerated air plenum chamber may be return air flowing through the by-pass duct 60, a part or all of the tempering air used may be ambient air or may be derived from any other source desired.

When using the construction described, it is possible to operate each fixture at the desired temperature and to maintain the temperature of the air and the articles on display in any particular case at a constant and predetermined temperature. As a result, each particular fixture can be provided with refrigerated air at a desired and uniform temperature, whereas the temperature of the air circulated to and from any of the other fixtures in the system can be similarly controlled to maintain a different but predetermined and uniform temperature therein at all times. Furthermore, whereas the fixtures 4', 6', 8' and

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10' have been indicated diagrammatically as being separate fixtures, the fixture may instead be of substantially greater length than the single conventional fixture and may be supplied with refrigerated air at a known and constant temperature through more than one insulated duct. Thus, for example, the ducts 12' and 14' may communicate with different portions of a single refrigerated case to distribute the refrigerated air uniformly throughout the length of such a large case.

The manner in which the evaporators 26 and 28 are successively and alternately operated through refrigeration and defrosting cycles may be varied as desired. However, in a preferred embodiment of the present invention, the evaporator being defrosted may be utilized as described in copending application, S.N. 737,679 to reduce the temperature of liquid refrigerant being supplied to the evaporator which is being operated on the refrigerating cycle. In this way the thermal efficiency of the refrigerating means may be increased and the manner of controlling and maintaining uniform temperature in the refrigerated air being supplied to the refrigerated air plenum chamber 30 and to the insulated ducts leading to the various cases can be more effectively controlled.

I claim:

1. Refrigerated equipment comprising a refrigerated space, two refrigerating elements, a blower associated with each of said refrigerating elements, refrigerated air duct means directing refrigerated air from said elements to said refrigerated space, return air duct means conducting air from said refrigerated space back to said refrigerating elements, said refrigerating elements each being located within a separate compartment having an inlet end and an outlet end, a return air plenum chamber receiving air from said return air duct means and communicating with the inlet ends of both of said compartments, a refrigerated air plenum chamber communicating with the outlet ends of both of said compartments and with said refrigerated air duct means, means for sequentially defrosting said refrigerating elements, and means for terminating flow of air from the refrigerating elements being defrosted to said refrigerated air plenum chamber while the latter elements are being defrosted, said refrigerated air duct means being provided with a mixing device for introducing supplemental air into said refrigerated air duct means to modify the temperature of the air supplied to said refrigerated space.

2. Refrigerated equipment as defined in claim 1 wherein temperature responsive means in said refrigerated space are operable to control the amount of supplemental air introduced into said refrigerated air duct by said mixing device.

3. Equipment as defined in claim 1 wherein a plurality of refrigerated air ducts communicate with said refrig-

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erating elements and with a plurality of refrigerated cases and return air duct means extend from all of said refrigerated cases to said refrigerated elements for recirculation of air from said cases to said refrigerating elements and back to said cases.

4. Equipment as defined in claim 1 wherein means are provided for modifying the temperature of the refrigerated air supplied to at least one of said cases.

5. Refrigerated equipment as defined in claim 1 wherein said supplemental air is received from said return air duct means.

6. Refrigerated equipment as defined in claim 1 wherein a supplemental air duct communicates with said mixing device and return air is supplied to said supplemental air duct by the blower associated with said refrigerating elements.

7. In combination with a plurality of cases to be refrigerated, refrigerating means including two evaporators, means for alternately and successively refrigerating and defrosting said evaporators, refrigerated air duct means communicating with each of said cases, and means for alternately and successively providing communication between that one of said evaporators which is being refrigerated and said refrigerated air duct means and for simultaneously cutting off communication between said refrigerated air duct means and that one of said evaporators which is being defrosted.

8. Equipment as defined in claim 7 wherein means for admitting supplemental air to said refrigerated air duct means are located between said evaporators and at least one of said cases to supply refrigerated air at one temperature to said one case and refrigerated air at a different temperature to another of said cases.

9. Equipment as defined in claim 8 wherein return air duct means serve to conduct air from said cases back to said refrigerating elements and the supplemental air admitted to the refrigerated air duct means is received from said return air duct means.

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WILLIAM J. WYE, Primary Examiner

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