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AIR DISTRIBUTION SYSTEM FOR COMBINATION FREEZER-REFRIGERATOR

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FIG 1

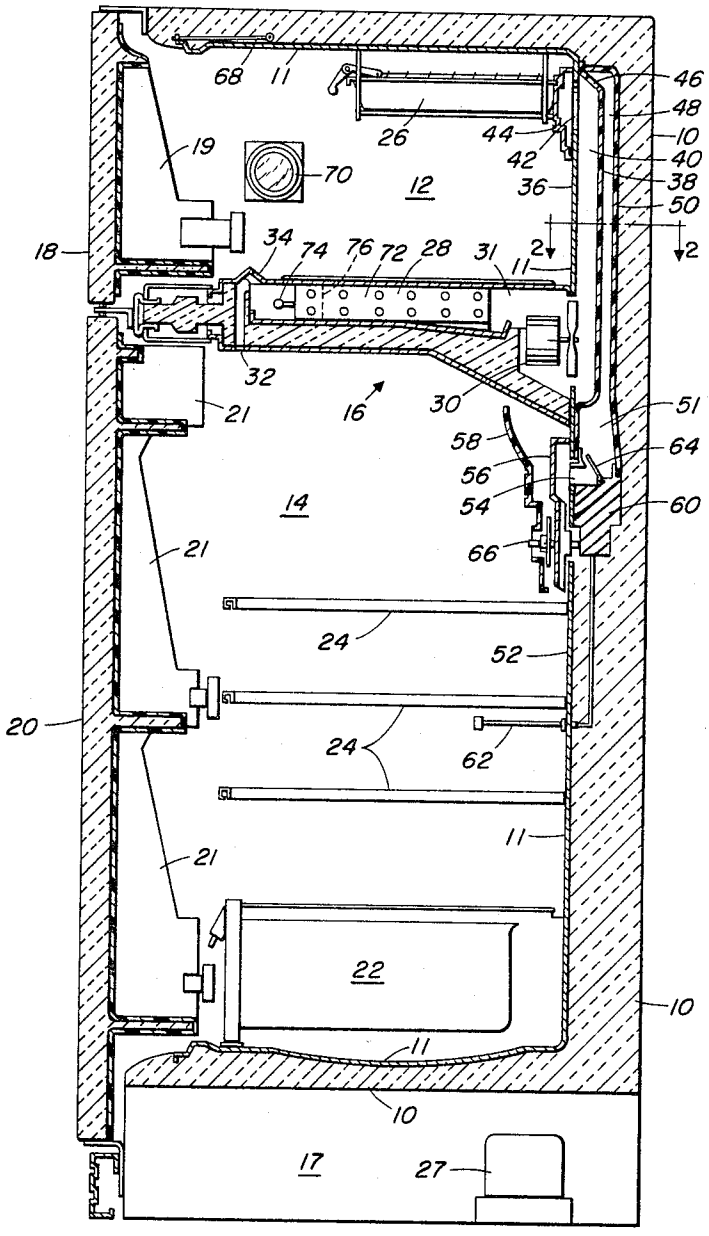
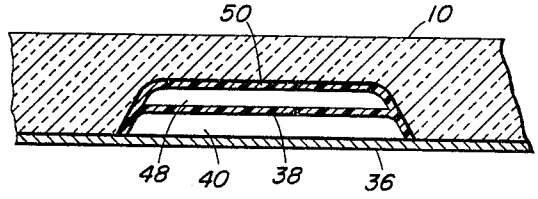


FIG 2



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AIR DISTRIBUTION SYSTEM FOR COMBINATION FREEZER-REFRIGERATOR

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This invention relates to refrigeration and more particularly to an air distribution system for a combination freezer-refrigerator unit of the household type.

The combination freezer-refrigerator is now found in many households instead of the type of refrigerator having only a small freezing compartment within a much larger refrigerator compartment. As the name implies, the freezer-refrigerator combination has separate sections which are maintained at different temperatures, the freezer section usually being maintained at approximately 0° F., while the refrigeration section is usually maintained at about 35–40° F. In some combination units the freezer section is located above while in others it is located below the refrigerator section. The air distribution system of this invention is applicable to any freezer-refrigerator combination regardless of the relative location of the two sections.

Since both sections are preferably, for reason of cost, cooled by a single evaporator, the combination freezer-refrigerator presents many problems due to the wide difference in the temperature which must be maintained in each of the two sections. Some units employ separate thermostatic controls which govern the relative distribution of refrigerated air between the two sections. Thus, design of the air distribution system, especially of the forced circulation type, for such a combination freezer-refrigerator becomes quite important, and improvements in prior art designs are needed. For example, since the refrigerated air must obviously be cooled to a temperature sufficiently low to maintain the freezer at the desired low temperature, and since the same air or a portion thereof is distributed into the refrigerator, there can result a wide variation in the temperature throughout the refrigerator section because such air must be introduced into the latter section at a relatively low velocity and in a relatively small amount. Also, introduction of the extremely cold air into the refrigerator section presents problems of "sweating" due to condensation of moisture from the air in the vicinity of the refrigerator air inlet. The moisture thus condensed on surfaces near this inlet sometimes may freeze and thus present defrosting problems in addition to those normally encountered in freezer-refrigerator combinations.

It is therefore an object of the inevntion to provide an improved freezer-refrigerator combination which has an air distribution system that overcomes the above mentioned shortcomings of prior art units of this type.

It is another object of the invention to provide an improved air distribution system for a freezer-refrigerator combination, which can be used regardless of the relative location of the refrigerator and freezer sections.

It is a further object of the invention to provide an improved freezer-refrigerator combination in which the air distribution in the refrigerator is improved and the temperature more uniform throughout the refrigerator section.

It is a still further object of the invention to provide an improved freezer-refrigerator combination in which the distribution of the cooling air is more efficient.

It is another object of the invention to provide an improved air distribution system of the forced draft type for a freezer-refrigerator combination, the system having two adjacent distribution ducts which circulate the air from

a single evaporator coil located between the refrigerator and freezer sections, the double duct minimizing losses in the system and temperature variation in the refrigeration section.

These and other objects of the invention will be readily apparent from a consideration of the following description of the preferred form thereof taken in connection with the accompanying drawings in which:

FIGURE 1 is a vertical sectional view through a combination freezer-refrigerator unit of the type in which the freezer section is located above the refrigerator section; and

FIGURE 2 is a sectional view taken on the line 2—2 of FIGURE 1 and showing further details of the double-duct air distribution system.

Referring now to the drawings, there is illustrated a freezer-refrigerator combination of the "top mount" type having insulated walls 10 and an inner, one-piece liner 11 forming a cabinet which is divided by an insulated, metal walled horizontal partition, indicated generally by the reference numeral 16, to define a freezer section 12 located above a refrigerator section 14. Below the refrigerator section 14 is a machinery compartment 17. Access to the freezer section 12 is through an insulated storage door 18, which may carry storage shelves 19 on its inner face, and similarly an insulated storage door 20 is provided on the front of the refrigerator section 14 which may also be equipped with suitable storage shelves 21 on its inner face. Refrigerator section 14 is also preferably provided with meat and vegetable storage drawers 22 and with shelves 24. The freezer section 12 may contain a separate area set aside for storage of ice cube trays 26 or other ice producing and storage means.

The air supplied to the freezer section 12 and to the refrigerator section 14 can be cooled by any suitable well known refrigeration system such as a compression type, some or all of whose liquifying components may be housed in machinery compartment 17. All of the components of this system have not been shown or illustrated since such systems are well known to those skilled in the art and do not form a part of the invention herein. As is well known to those skilled in the art, the commonly used compression system basically includes a compressor, indicated at 27 in machinery component 17, supplying the compressed refrigerant to a condenser where it is liquified, the liquid refrigerant being thereafter expanded through an expansion device and passed immediately through an evaporator, indicated at 28, from where the gaseous refrigerant is returned to the suction side of the compressor. The air supplied to the freezer and refrigerator sections is cooled by being passed over the evaporator, the warmer air from these sections being recirculated back to the evaporator for cooling.

In the illustrated embodiment, the evaporator 28 employed is of the finned coil type having its fins running fore and aft of the cabinet and horizontally located within the partition 16 between the freezer section 12 and refrigerator section 14. A fan 30 is located to the rear of the evaporator 28 within an enlarged compartment 31 in the rear of the partition 16 communicating with the downstream end of evaporator 28. Fan 30 serves to draw the air from the refrigerator and freezer sections through the evaporator 28 from front to rear and then recirculate the cooled air back to the refrigerator and freezer. Openings 32 are provided in the lower wall of partition 16 communicating with the upstream end of evaporator 28 to permit the air within the refrigerator section 14 to be withdrawn and passed through the evaporator 28, and similar openings 34 are provided in the upper wall of the partition 16 to permit the air to be withdrawn from the freezer section 12.

The warmer air sucked by fan 30 from both the refrigerator section 14 and freezer section 12, the air from each section commingling at the upstream end of evaporator 28, is cooled by the latter and then distributed to the respective sections by means of a duct arrangement located in the rear wall 10 of the apparatus. The inner rear wall 36 of the freezer portion of liner 11 and a vertically extending channel 38 spaced from and to the rear of the wall 36 define an inner duct 40 whose lower end is connected to compartment 31 downstream of fan 30 and into which the latter discharges all of the air cooled by evaporator 28. The upper end of duct 40 is provided with an opening 42 through the rear wall 36 into the freezer section 12 to allow for discharge of cold air at the top rear of the freezer section 12. An air diffuser or distributor 44 may be located over the opening 42 to direct the air both upwardly and downwardly and thereby provide efficient distribution. The upper end of the inner duct 40 is closed by convergence of the channel 38 toward the rear wall 36. However, an opening 46 is provided in the outer rear wall of channel 38 at the upper end of duct 40 through which some of the cold air can be discharged into an outer duct 48 that is defined by the outer rear face of the channel 38 and the inner face of an additional channel 50 formed on the rear wall of channel 38 and surrounded by the insulated wall 10. Preferably ducts 40 and 48 are molded integrally from suitable plastic material. The outer duct 48 is closed at its upper end except for opening 46, and extends downwardly to a point below the horizontal partition 16 and the lower end of duct 40, terminating in an enlarged chamber 51, open at its lower end, at the rear of the upper portion of the refrigerator section 14. The inner rear wall 52 of the refrigerator portion of liner 11 just below chamber 51 is provided with a discharge opening 54 through which air flowing down the outer duct 48 is discharged into the refrigerator section 14 at the upper rearmost portion thereof. An air deflector 56 is provided over opening 54 to direct the air therefrom downwardly in order to provide efficient air circulation throughout the refrigerator section 14. Deflector 56 may be hidden behind a translucent lens 58 spaced forwardly thereof to provide a compartment to house a lamp for illumination of refrigerator section 14 when its door 20 is opened.

The lower end of chamber 51 is closed by a thermostatically operated air valve assembly 60, which is responsive to a temperature sensor 62 centrally located inwardly of the rear of the refrigerator section 14. The air valve assembly 60 operates a damper 64 at the lower end of outer duct 48 adjacent opening 54 which controls the amount of air discharged from the outer duct 48 into the refrigerator section 14. The operation of damper 64 is adjusted by a manual control knob 66 to produce the desired temperature in the refrigerator section 14 as determined by sensor 62. A further sensor or bulb 68 of a conventional thermostat governing the operation of compressor 27 and fan 30 is located outside freezer section 12 on the top wall of liner 11, operation of the thermostat being controlled by means of a knob 70 to adjust the temperature in freezer section 12.

Preferably the freezer-refrigerator is also provided with means to defrost evaporator 28. Suitable means may employ an electric heater embedded in evaporator 28 and energized by a timer providing two defrost periods of fixed duration every 24 hours during which operation of compressor 27 and fan 30 is suspended. In order to prevent unnecessary temperature rise should defrosting of evaporator 28 be completed before the fixed defrost period expires, the upstream end of one of the header plates 72 of evaporator 28 is equipped with a bracket mounted thermostatic defrost limit switch 74 which de-energizes the evaporator heater upon the rise of header plate 72 to a predetermined temperature. In order to avoid the tendency of frost to clog the spaces between the upstream ends of the fins of evaporator 28, the upstream portion of every other fin is shortened, as indicated at 76, thus providing much wider spacing of the fins in the area of principal frost collection. Defrost systems are well known to those skilled in the art and since such a system forms no part of the invention herein it is not disclosed in any further detail.

During operation, as previously indicated, the refrigeration system is controlled only by sensor or bulb 68 responsive to the temperature in the freezer section 12. When the latter rises above that set by knob 70, the refrigeration system, including compressor 27 and fan 30, will be started. Fan 30 withdraws the air from the freezer section 12, cools it, and recirculates it through the inner duct 40 and opening 42 into the freezer section 12. The recirculation and cooling of the air will continue until the temperature in the freezer section 12 is lowered to the point set by knob 70 at which time the refrigeration system will be shut off. The temperature in the refrigerator section 14 is controlled by the air valve assembly 60 which determines the position of the damper 64. The design of the inner and outer ducts 40 and 48 and openings 42 and 46 is such that with the damper 64 wide open, about 15 percent of the air discharged by fan 30 will be passed through the outer duct 48 into the refrigerator section 14. Obviously, with the damper 64 closed completely, all of the air from fan 30 will be discharged into the freezer section 12. This will be the case when the temperature in the refrigerator section 14 is below the point set by knob 66 but the temperature of the freezer section 12 is above the point set by knob 70. However, if the refrigerator temperature is also above the point set by knob 66, each time the refrigeration system is operated by reason of a rise in temperature in the freezer section 12, a percentage of the cooled air, up to the aforesaid maximum, will be circulated into the refrigerator section 14. This will continue until either the refrigeration system is shut down or the set temperature in the refrigerator section 14 is attained, at which time the damper 64 will be closed. Obviously, regardless of the position of the damper 64, the outer duct 48 will always be filled with cold air whenever the fan 30 is operating. This serves to provide additional insulation between the inner duct 40 and the exterior of the freezer section 12. The outer duct 48 thus blankets the air flowing through the inner duct 40 thereby minimizing heat transfer and thus refrigeration losses from the cold air in inner duct 40.

The double ducts 40 and 48 also serve several other purposes. Obviously, the air flowing into the refrigerator section 14 from the fan 30 must travel over twice as far as the air flowing directly into the freezer section 12. Thus, the air in outer duct 48 will be somewhat warmed due to the losses through the wall 10. This warming of the air supplied to the refrigerator section 14 is desirable because extremely cold air discharged into the refrigerator section 14 would tend to freeze the foods located near the discharge opening 54. Also, the temperature sensor 62 in the refrigerator section 14 would be subjected to cooler air than the remainder of the compartment thus causing premature closing of the damper 64 which would decrease both the velocity and quantity of air supplied to the refrigerator section 14 and result in poor air distribution and circulation throughout the refrigerator section 14. Indeed, in the many designs employing a single evaporator to cool both compartments where the cold air is in fact discharged by the fan directly into the refrigerator, not only do the foods near the discharge opening tend to freeze, but since such air must necessarily be discharged into the refrigerator in very small quantities and velocities, air circulation therein and thus temperature uniformity tends to be poor. In other words, the damper 64 should be kept open as far and as long as possible until the desired temperature in the refrigerator section 14 is reached in order to provide maximum air circulation and uniformity in temperature throughout the refrigerator section 14. Consequently, the air entering

the refrigerator must be warmed as much as possible, as provided in the case of the two ducts of the present invention.

The double ducts **40** and **48** also serve usefully even when the damper **64** is completely closed and no air is being circulated into the refrigerator section **14**. With the damper **64** completely closed, a dead air space will be formed in the outer duct **48** including chamber **51** above the damper **64**. This dead air pocket not only insulates the freezer section **12**, but also insulates the refrigerator section **14** from the extremely cold air that is being circulated through the inner duct **40** into the freezer section **12**. "Sweating" of the liner **11** at and around the discharge opening **54**, which otherwise might occur if the cold air were circulated directly from the fan **30** to the refrigerator section **14**, is thereby minimized.

Thus, in addition to reducing refrigeration losses, the use of a dual duct system as disclosed herein provides for improved air circulation and distribution throughout both the freezer section **12** and refrigerator section **14**. The novel air distribution system also minimizes the likelihood of freezing of foods located near the air discharge opening **54** in the refrigerator section **14** and prevents undesirable sweating of the liner at and around this opening. It is obvious that that principles of the dual duct arrangement can be utilized not only with the so-called "top mount" freezer-refrigerator combination as illustrated herein but can be utilized regardless of the relative position between the refrigerator and freezer sections. It is also evident that principles of the system can be used regardless of the type of refrigeration system or the type of defrost system employed. The invention therefore has broad application to any type of freezer-refrigerator combination. Accordingly, modifications and revisions in the illustrated embodiment can be made by those skilled in the art without departing from the scope of the invention, and the intention is that such revisions and modifications be included within the scope of the following claims.

We claim:

1. An air distribution system for a combination freezer-refrigerator unit having a refrigerator section located below and separated by a partition from a freezer section to each of which sections air cooled to below freezing temperature by a refrigeration system is circulated by a fan located in said partition, said air distribution system comprising an inner duct extending upwardly along the rear wall of said freezer section from the discharge side of said fan and terminating in a discharge opening in the top rear wall of said freezer section, an outer duct formed integrally on the rear wall of said inner duct extending downwardly between said inner duct and the outer rear wall of said unit and terminating at a discharge opening near the top rear wall of said refrigerator section, the upper end of said outer duct communicating with the upper end of said inner duct through a port of fixed size in the common wall between said ducts and restricting the flow of air from said inner duct to said outer duct, a variable position damper in the lower end of said outer duct controlling the flow of air from said outer duct through the discharge opening into said refrigerator section, first temperature responsive means in said refrigerator section controlling the position of said damper, and second temperature responsive means for said freezer section controlling the operation of the refrigeration system and said fan, the restriction of said port reducing the volume of air admitted to said outer duct when said damper is in its fully open position to less than twenty percent of the total volume of air delivered through said inner duct by said fan.

2. A combination freezer-refrigerator unit comprising a cabinet defining a compartment, a partition in said cabinet dividing said compartment into separate freezer and refrigerator sections, a compression type refrigeration system for said unit, said system including a compressor and having an evaporator and a fan located within said partition for cooling air circulated across said evaporator by said fan to below freezing temperature, said partition having openings therein which provide for withdrawal of air from said freezer and refrigerator section and discharge of air by said fan after cooling by said evaporator, an inner duct behind a wall of said freezer section communicating with the discharge opening in said partition and terminating in a discharge opening in said freezer section, an outer duct contiguous to said inner duct and communicating at its upstream end with said inner duct immediately adjacent said freezer section discharge opening, said communication between said inner and outer duct being through an opening of fixed size effective to admit a volume of air into said outer duct of less than half the total volume of air discharged by said fan through said outer duct, said outer duct terminating in a discharge opening in said refrigerator section, means adjacent the discharge end of said outer duct effective to control the amount of air delivered to said refrigerator section, said means including a damper movable between open and closed positions, means in said refrigerator section responsive to the air temperature therein controlling the position of said damper, and means responsive to the temperature in said freezer section controlling operation of said compressor and fan.

References Cited by the Examiner

UNITED STATES PATENTS

2,907,180	10/1959	Mann	62—187
3,004,401	10/1961	Mann	62—187
3,126,716	3/1964	De Witte	62—187
3,126,717	3/1964	Schumacher	62—187
3,164,970	1/1965	Hubacker	62—156

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