Aug. 7, 1962 J. W. JACOBS 3,048,024

REFRIGERATING APPARATUS

Filed July 6, 1959 5 Sheets-Sheet 1

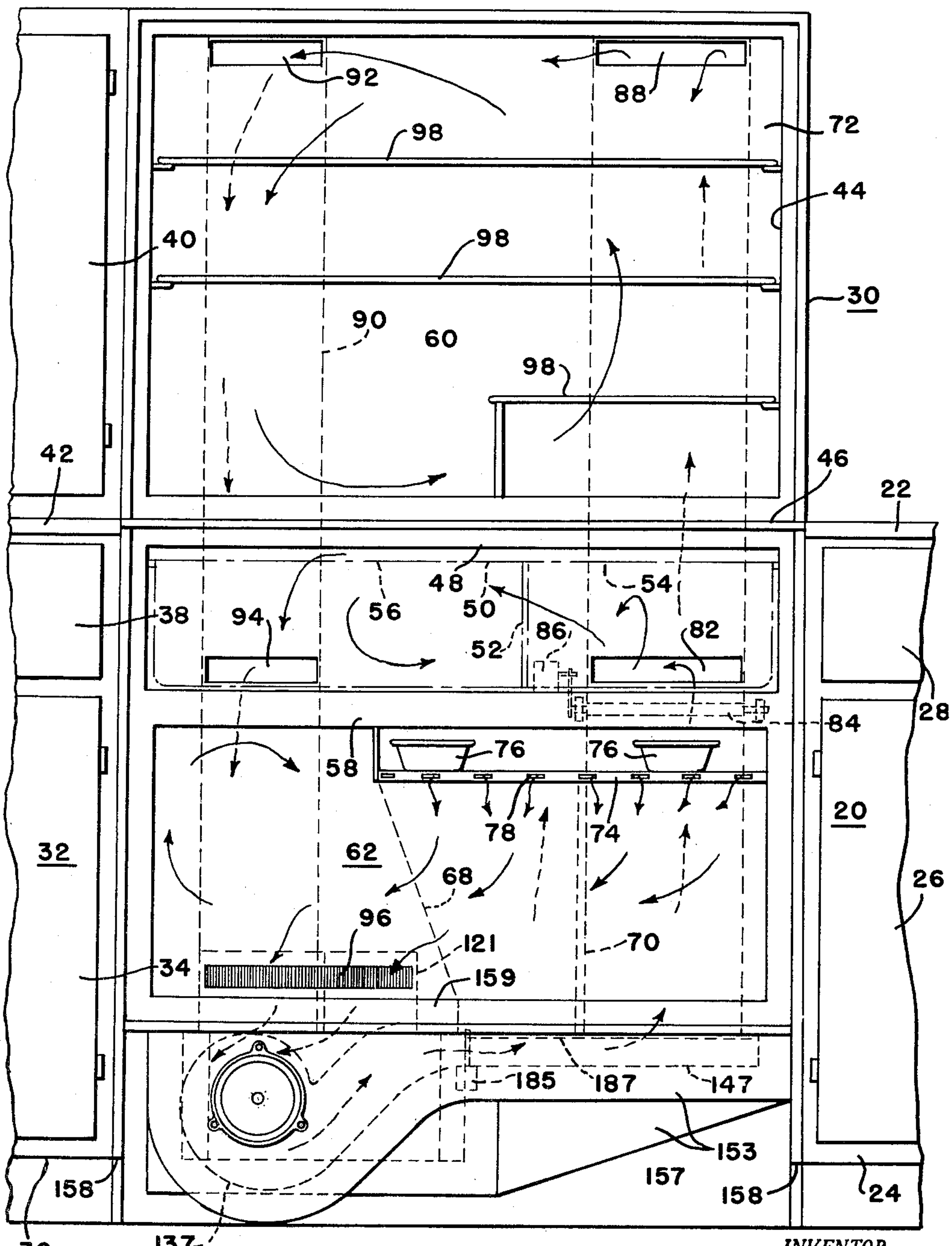

Fig. 1

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REFRIGERATING APPARATUS

Filed July 6, 1959 5 Sheets-Sheet 2

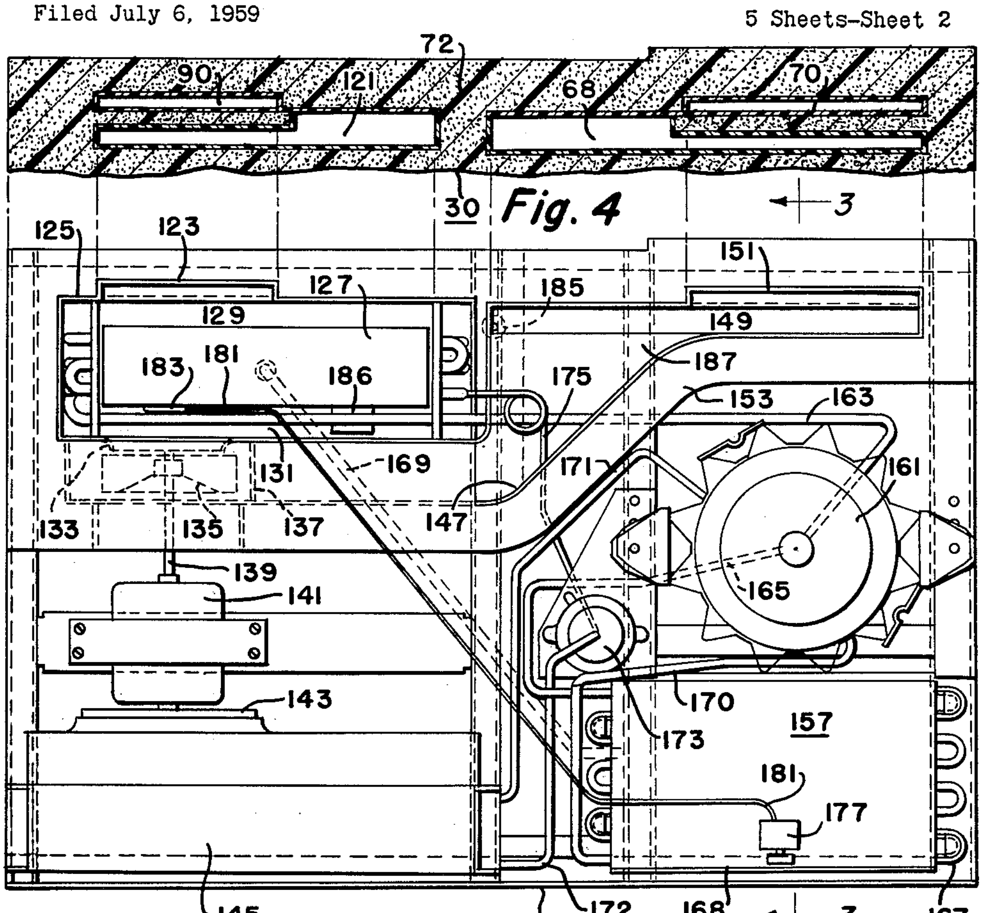

Fig. 4

Fig. 2

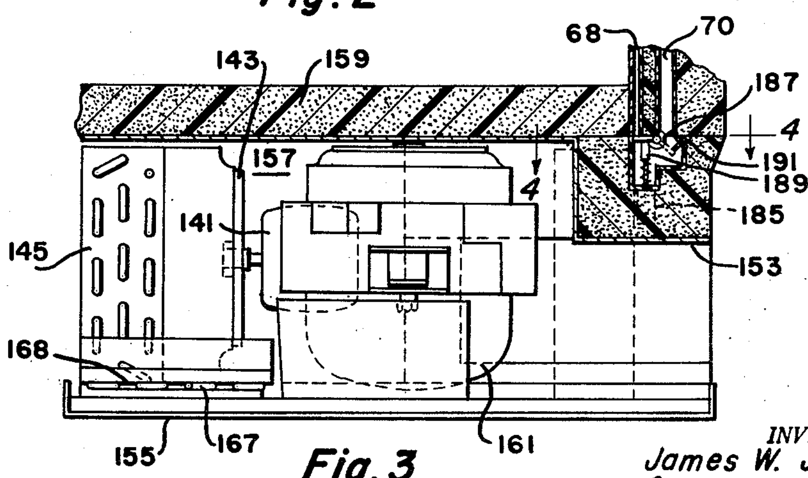

Fig. 3

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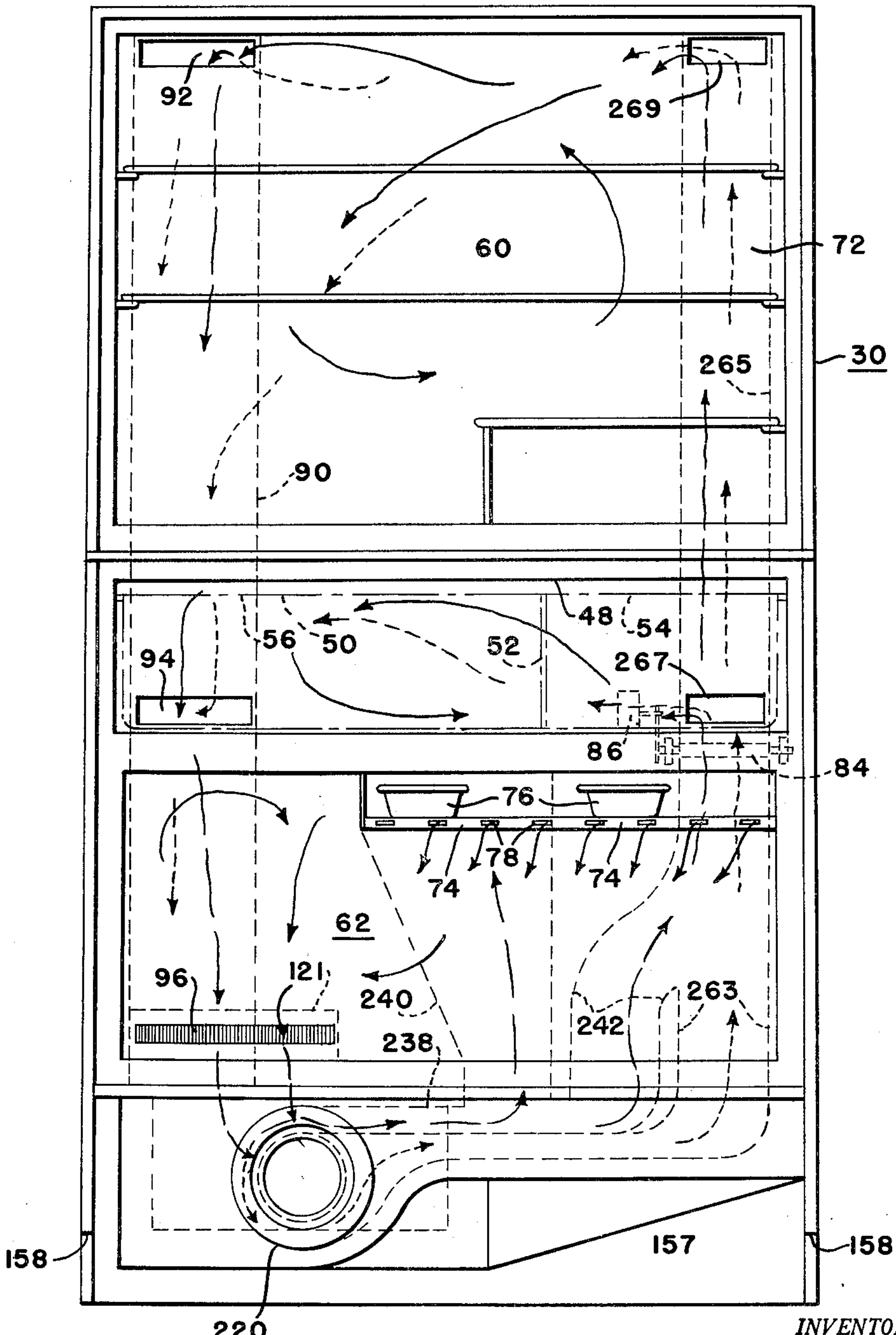

Fig. 5

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REFRIGERATING APPARATUS

Filed July 6, 1959 5 Sheets-Sheet 4

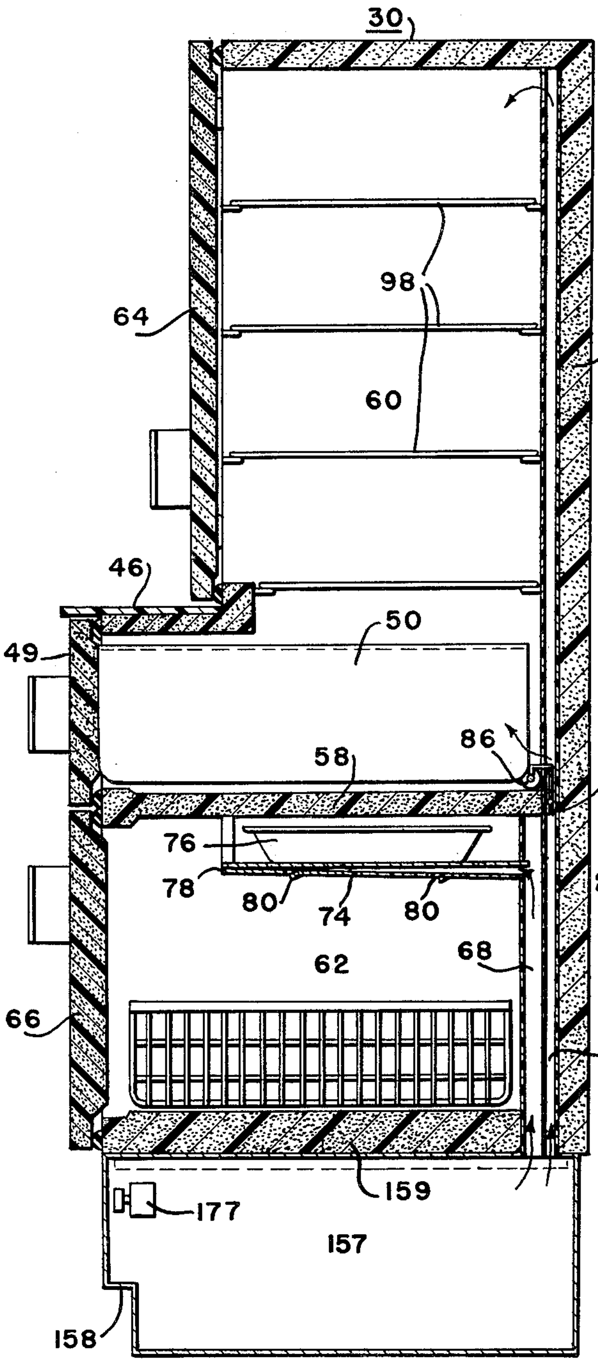

Fig. 6

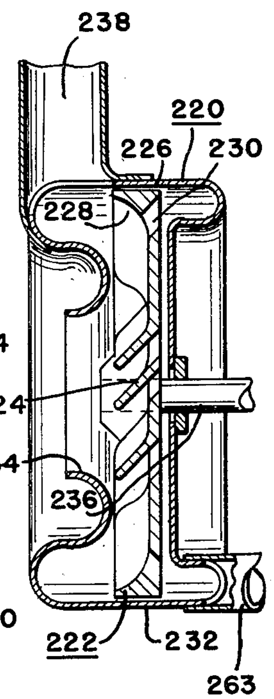

Fig. 7

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Aug. 7, 1962 J. W. JACOBS 3,048,024

REFRIGERATING APPARATUS

Filed July 6, 1959 5 Sheets-Sheet 5

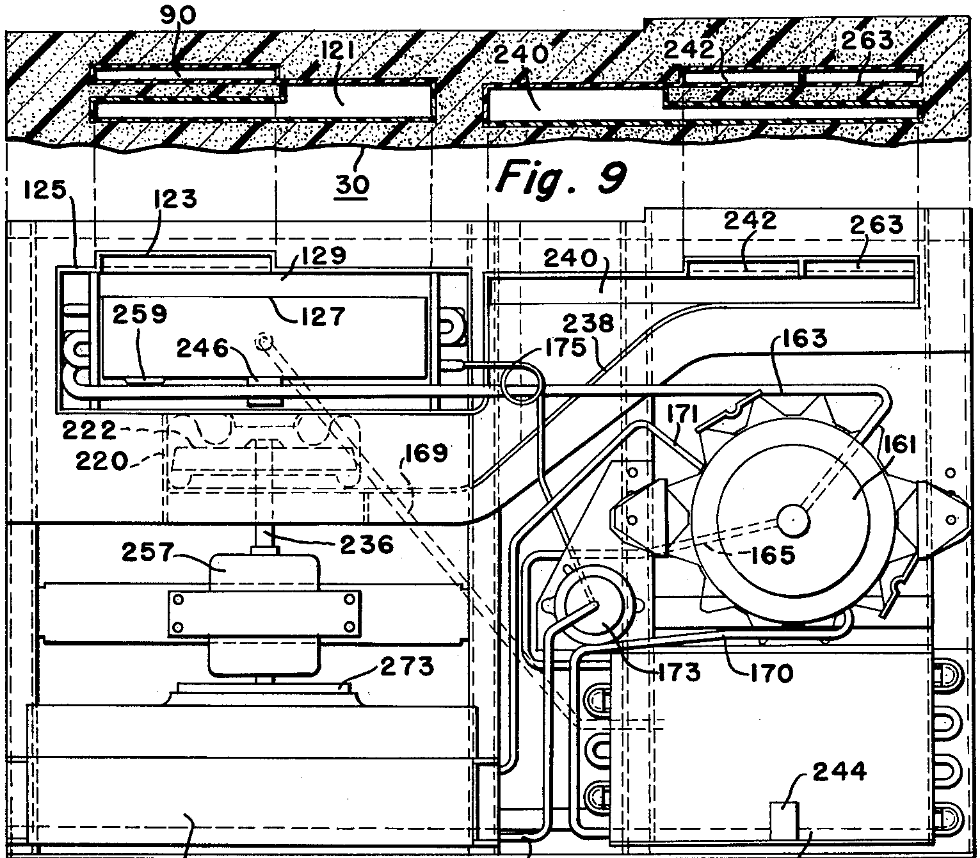

Fig. 9

Fig. 8

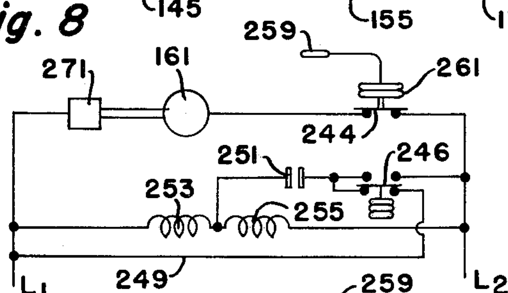

Fig. 10

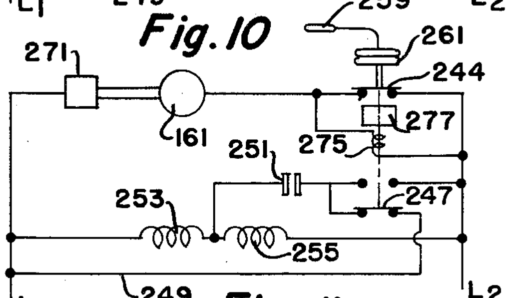

Fig. 11

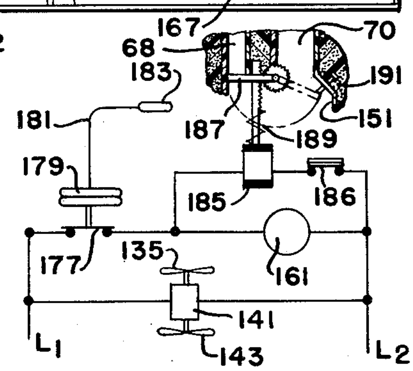

Fig. 12

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REFRIGERATING APPARATUS

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Filed July 6, 1959, Ser. No. 825,132
6 Claims. (Cl. 62—156)

This invention relates to refrigerating apparatus and more particularly to a modern household refrigerator which harmonizes with other facilities in a modern kitchen and in which the food storage compartments will not accumulate frost.

Modern kitchens are provided with working surfaces of convenient height, such as thirty-six inches. The conventional household refrigerator with straight vertical lines from top to bottom provides an undesirable break in such surfaces in the kitchen. Frostless refrigerators employing circulating cold air are now being manufactured partially insulated by organic foam insulation. Such refrigerators may be built into a kitchen in which event it is necessary to provide a convenient means for access and removal of the refrigerating system for service and repair.

It is an object of this invention to provide a simple inexpensive convenient refrigerator provided with a convenient working surface which will connect with and align with other working surfaces in the kitchen and yet provide satisfactory refrigerated storage.

It is another object of this invention to provide a refrigerator which may be permanently built into the kitchen in which the cabinet is separately formed with foam insulation and the entire refrigerating system is inserted into and removable from the front of the cabinet as a unit and in which refrigeration is supplied to the cabinet from the unit entirely by air circulation.

It is another object of this invention to provide a frostless refrigerator in which the air circulation is changed during each off cycle to provide simple rapid defrosting together with continued cooling of the above freezing compartment.

The terms "above" and "below freezing" and "frost" as used in the specification and claims pertain to water and water vapor and ice.

These and other objects are attained in the forms of the invention shown in the drawings in which a refrigerator cabinet which may be formed of cast foam insulation is provided with a working surface of the same height as the remaining work surfaces in the kitchen. The portion immediately beneath the work surface is provided with a drawer having an insulated front which may be divided into a cold meat storage compartment and a high humidity vegetable storage compartment. Beneath this portion is an insulated wall separating the upper above freezing compartment from the lower below freezing compartment. The below freezing compartment has a hollow shelf communicating at the rear with an upwardly extending air duct.

The entire refrigerating system slides into the cabinet through an opening at the front below the below freezing compartment and includes a blower which draws air downwardly from both compartments during the running cycle through the evaporator coil and discharges some of the air upwardly through the duct at the back of the below freezing compartment into the hollow shelf from which it escapes at the front edge and other distributed points into the below freezing compartment. The hollow shelf supports ice trays for fast ice freezing. A separate upwardly extending duct connects with the discharge from the blower and extends to the upper above freezing compartment discharging a portion of its air directly adjacent the meat receptacle and the remainder in the upper portion. The upper portion above the work surface and

the drawer receptacle is reduced in depth to provide convenient access to the entire surface of the upper shelves therein.

The refrigerating system operates upon a defrosting cycle according to the temperature of the evaporator. During the off cycle, air is circulated only from the above freezing compartment through the evaporator and returned by the blower to the above freezing compartment. This continues the refrigeration of the above freezing compartment during the off period and hastens the defrosting of the evaporators. This change in air circulation is accomplished in one form by a damper operable coincidentally to the operation of the thermostatic control switch providing the defrost cycle. In a second form, a novel reversing blower operates in one direction to deliver air to both the above and below freezing compartments while the air is below a selected temperature zone; when the air temperature is above the selected temperature zone, it operates in the opposite direction to circulate air only between the above freezing compartment and the evaporator.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing wherein preferred embodiments of the invention are clearly shown.

In the drawings:

FIGURE 1 is a portion of a modern kitchen provided with continuous work surfaces including a front view of a refrigerator embodying my invention with the doors and the refrigerated drawer and the ornamental front of the machinery compartment, the motor-compressor and the condenser removed;

FIGURE 2 is a plan view of the removable refrigerating unit for the refrigerator cabinet shown in FIGURE 1;

FIGURE 3 is a fragmentary vertical sectional view taken substantially along the line 3—3 of FIGURE 2;

FIGURE 4 is a fragmentary sectional view taken substantially along the line 4—4 of FIGURE 3 showing the bottom of the air duct connections of the cabinet with the refrigerating unit;

FIGURE 5 is a front view of a slightly modified refrigerator embodying my invention;

FIGURE 6 is a side vertical sectional view corresponding to the refrigerators shown in FIGURES 1 and 5 with the refrigerating unit corresponding to FIGURE 3 being omitted;

FIGURE 7 is a sectional view partly diagrammatic of the reversible blower for the modification shown in FIGURE 5;

FIGURE 8 is a plan view of a modified refrigerating unit provided for the cabinet shown in FIGURE 5 and containing the reversible blower shown in FIGURE 7;

FIGURE 9 is a fragmentary sectional view similar to FIGURE 4 modified to apply to the refrigerating unit as shown in FIGURE 8 and the cabinet shown in FIGURE 5;

FIGURE 10 is a wiring diagram for the refrigerating unit shown in FIGURE 8;

FIGURE 11 is a modified wiring diagram for the refrigerating unit shown in FIGURE 8 incorporating a time delay arrangement for delaying the reversal of the blower following the operation of the thermostatic switch responsive to evaporator temperature controlling the sealed motor compressor unit; and

FIGURE 12 is a wiring diagram for the refrigerating unit shown in FIGURE 2 incorporating an electrically operated damper to change the air circulation between the on and off cycles.

Referring now more particularly to FIGURE 1, there is shown a wall portion of a modern kitchen including a first storage cabinet **20** having a work table **22** at a convenient height, such as thirty-six inches, and a toe recess 24 beneath. The cabinet 20 may contain lower cupboard 26 and a drawer 28 above the cupboard 26 beneath the work surface 22. The refrigerator cabinet 30 is located between the cabinet 20 and a third cabinet 32 which includes a lower storage space 34 beneath which is a toe recess 36 similar to the recess 24 and above which is a drawer 38. Between the drawer 38 and the upper cabinet 40 is a work surface 42. The toe recesses, the lower cabinets, the drawers and the work surfaces are similar and the upper cabinet 42 harmonizes with the remainder.

The refrigerator cabinet 30 may be made of any suitable materials but preferably is made of some form of cast foam insulation and has an upper above freezing food storage cabinet 44 of the same height and harmonizing with the upper cabinet 40. The upper portion of the cabinet 30 is of the same depth as the upper cabinet 40, and a work surface 46 separates the upper portion of the cabinet 30 from the lower portion in a manner similar to and aligning with and connecting to the work surface 42 of the cabinet 32 and the work surface 22 of the cabinet 20. Beneath the work surface 46 is a drawer opening 48 having an insulated drawer front 49 harmonizing with the drawer fronts 28 and 38 to which is connected a drawer 50 divided by a partition 52 into a meat tender compartment 54 and a high humidity vegetable storage compartment or hydrator 56. A horizontal insulated wall 58 separates the upper above freezing compartment 60 from the lower below freezing compartment 62. The upper portion of the above freezing compartment 60 is closed by a single or double insulated doors 64 while the freezing compartment is closed by an insulated door 66.

Cold air is supplied to both compartments during the on cycle through the upwardly extending ducts 68 and 70 as shown in FIGURES 1 to 5. These ducts may be cast into the rear wall 72 of the cabinet, if desired. The duct 68 communicates with the rear of the hollow shelf 74 which may be made of metal provided with internal fins for supporting and rapidly removing heat from an ice tray 76 to freeze ice cubes and other edibles. The hollow shelf 74 has front discharge openings 78 as well as additional openings 80 in the bottom wall to provide a uniform distribution of air within the below freezing compartment 62. The air is circulated through the below freezing compartment 62 substantially only during the running cycle at temperatures far below freezing, such as 0° F. While it provides adequate refrigeration at 0° F., and the circulation of cold dry air prevents the formation and accumulation of frost within the below freezing compartment 62.

The second upwardly extending air duct 70 has a first discharge opening 82 directly behind the bottom of the meat tender compartment 54 so that this compartment is always kept at a desirable temperature for preserving meat. The air flow to the above freezing compartment 60 is controlled by a damper 84 rotatable upon a horizontal axis within the duct 70 opposite the dividing wall 58. This damper 84 is operated by a thermostatic motor 86 located in and responsive to the temperature of the above freezing compartment to regulate the amount of air flowing to the above freezing compartment 60 to maintain the proper temperature therein. If desired, all the air may discharge from the opening 82 in which event the duct 70 may terminate at this point. However, to provide more uniform cooling, the duct 70 preferably extends to the top of the cabinet and is provided with a second or upper discharge opening 88 in the upper right-hand corner of the rear wall 72. The openings 82 and 88 may be made of such size as to provide proper distribution of the cold air within the above freezing compartment.

Upon the opposite side of the rear wall 72 is provided the return duct 90 which may likewise be cast into the rear wall and has one or more openings from the above freezing compartment 60, such as an upper outlet opening 92 in the upper left-hand corner of the rear wall and a lower outlet opening 94 behind the high humidity moisture vegetable storage section. At the lower left-hand corner of the freezing compartment 62, there is provided a third outlet opening 96 communicating with a separate return air duct 121. The upper compartment 60 is provided with suitable full and half shelves 98.

These supply and return ducts are arranged at the bottom as shown in FIGURE 4. The duct 90 connects directly with the outwardly formed portion 123 of a metal container 125 containing a vertical fin and tube evaporator 127 dividing the container 125. The portion of the container 125 to the rear of the evaporator 127 provides a space 129 which communicates with the return air duct 121 from the freezing compartment 62 and through the offset portion 123 with the return air duct 90. The evaporator 127 is spaced away from the opposite side of the container 125 to provide a space 131 communicating with the outlet aperture 133 connecting with the centrifugal impeller 135 within the fan scroll 137. The impeller 135 is connected to the adjacent end of the motor shaft 139 of an electric motor 141 provided with a centrifugal or propeller fan 143 upon the opposite end of its shaft which draws in air through the condenser 145 and discharges over the motor-compressor unit 161 for discharge forwardly through the right front of the machinery compartment 157.

The impeller 135 discharges the air drawn through the evaporator 127 into a duct 147 having discharge portions 149 beneath the air duct 68 with an offset portion 151 extending beneath the air duct 70. The container 125 as well as the air ducts 147, 149 and the extensions 123 and 151 are enclosed in suitable insulation, such as cast foam insulation 153. This is mounted upon a suitable base 155 which is slidable into and out of the cabinet 30 from the front. For this purpose, the machinery compartment 157 is located beneath the insulated bottom wall 159 of the below freezing compartment and has a front opening through which the entire refrigerating system mounted upon the base 155 may be inserted and removed. The cabinet 30 may be provided with slideways for slidably supporting the base 155. The machinery compartment 157 has an ornamental front containing a toe recess 158 harmonizing with the toe recesses 24 and 36.

The base 155 is provided with resilient mountings for resiliently supporting the sealed motor-compressor unit 161 which withdraws evaporated refrigerant from the evaporator 127 through the suction conduit 163 and discharges the compressed refrigerant through the discharge conduit 165 into the superheat remover coil 167 beneath a shallow pan 168 which receives defrost water through tubing 169 from the bottom of the container 125 and conducts the defrost water to the pan on top of the superheat coil 167. The cold water cools the coil 167 while the heat of the coil 167 evaporates the water into the air circulated through the condenser 145 and through the remainder of the machinery compartment 157 in front of the insulation 153. The cooling air enters and leaves the machinery compartment 157 at the front so that no arrangement for air circulation need be provided at the sides and the rear. The refrigerant, after being cooled in the superheat coil 167, is returned by the conduit 170 to another portion of the sealed motor-compressor unit 161 where it will deposit a portion of the lubricant entrained therein. This refrigerant partially cooled and partially freed from entrained lubricant will be conducted through the conduit 171 to the condenser 145 where the refrigerant will condense and be conducted by the conduit 172 to a filter drier unit 173 from which the liquid refrigerant will flow through the capillary restrictor tube 175 to the evaporator 127.

As shown in FIGURE 12, the sealed motor-compressor unit **161** is connected in series with the thermostatic switch **177** across the supply conductors L_1 and L_2. The fan motor **141** is connected directly across the supply conductors L_1 and L_2 and is not subject to the control of the switch **177**. The switch **177** is preferably an adjustable snap action switch set to operate upon a defrosting cycle. Its operating bellows **179** is connected by a capillary tube **181** to a thermostat bulb **183** mounted upon the evaporator **127**.

Connected in parallel with the sealed motor-compressor unit **161** is a solenoid actuator **185**. This actuator is operably connected to the rotatable damper **187** provided at the top of the duct **147** directly beneath the ducts **68** and **70**. This horizontally pivoted damper **187**, when the solenoid **185** is deenergized is propelled by a spring **189** to close the bottom of the duct **68** to prevent the circulation of air through the below freezing compartment **62** during idle periods of the motor-compressor unit **161**. When the solenoid **185** is deenergized, it permits the free flow of cold air from the duct **147** through the duct **70** to the above freezing compartment **60**. When the solenoid **185** is energized, the damper **187** is pivoted to a position against a stop screw **191** so as to allow a limited flow of colder air through the duct **70** for cooling the above freezing compartment **60** while the major proportion of air will flow through the below freezing compartment **62**. During this time of flow through the below freezing compartment, the motor-compressor unit will be operating to keep the air at temperatures far below freezing, such as 0° F. During the off periods when the switch **177** is open, the temperature of the evaporator **127** will rise and finally pass above the freezing point to melt all the frost therefrom. This melting will be assisted by the circulation of the air from the above freezing compartment **60** which will be at above freezing temperatures. The circulating air during this off period will be considerably warmer than during the operating period so that a greater volume can be circulated through the above freezing compartment without cooling it to freezing temperatures. When the evaporator **127** rises sufficiently above freezing temperatures to insure complete defrosting, the switch **177** will close and start a new refrigeration cycle. A bimetal switch **186** located in the space **131** is connected in series with the solenoid **185** and is set to open at temperatures above 15° F. to prevent warm air from being sent to the below freezing compartment before the evaporator is sufficiently cool.

In the form shown in FIGURE 5, the refrigerator cabinet and the return air ducts are similar to that shown in FIGURES 1 to 4, and the description thereof will not be repeated. The exterior of the cabinet is also similar as well as the drawer arrangement for the meat tender compartment and the high humidity vegetable storage compartment in the drawer **50**. However, this form differs in that a novel reversible blower **220** is substituted for the impeller **135** and the scroll **137**. This reversible blower **220** includes a novel impeller **222** (FIGURE 7) having radial blades **224** inclined at an angle of about 45° and terminating in a solid rim **226** having its inner surface **228** curving to the left and having apertures **230** therein extending diagonally upward at the right. The impeller **222** is housed in a novel housing **232** having an air entrance **234** communicating with the discharge side of the evaporator **127** for drawing air through the evaporator **127** from the return air ducts. The operation of the motor-compressor unit **161** is controlled by an adjustable thermostatic switch **244** having its thermosensitive bulb **259** mounted on the rear face of the evaporator **127** to operate the bellows **261**. It is set to close at 36° F. and to open at 0° F., for example, to insure defrosting of the evaporator every cycle.

When the fan shaft **236** rotates with the nearest portion of the rim **226** moving upwardly, the cold air drawn in the inlet **234** will be discharged through the outlet duct **238** into the main duct **240** connecting with the hollow shelf **74**. A smaller duct **242** connecting with the upwardly extending duct **265** and the outlets **267**, **269** provides a small amount of cold air for the above freezing compartment **60** during this operation of the reversible blower **220**. Preferably, a thermostatically controlled damper similar to the damper **84** controlled by a thermostatic operator **86** controls the supply of air to the above freezing compartment **60** to maintain desirable refrigerating temperatures. The operation of the reversible blower **220** is controlled by a thermostatically operable reversing switch **246** shown diagrammatically in FIGURE 10. This reversing switch **246** preferably has a low differential and is located on the outlet side of the evaporator **127** adjacent the inlet **234** of the reversible blower **220**. The reversing switch **246** is set so that when its temperature falls below plus 10° F. it will move to its lower position connecting the conductor **249** with the capacitor **251** connected to a point between the two windings **253** and **255** of the reversible fan motor **257**. The winding **253** connects to the supply conductor L_1 while the winding **255** connects to the supply conductor L_2. When the thermostat bulb **259** mounted upon the evaporator **127** reaches a predetermined low temperature, it will contract the bellows **261** to open the switch **244**. The consequent rise in temperature of the air coming out of the evaporator **127** above 15° F. will actuate the reversing switch **246** to connect the capacitor **251** to the supply conductor L_2 to reverse the fan motor **257**.

This will reverse the operation of the shaft **236** and the impeller **222** causing the blower to cease discharging air through the discharge duct **238** and to begin to discharge air through its second alternate discharge duct **263** which only delivers air through the duct **265** to the above freezing compartment **60** through the lower opening **267** and the upper opening **269**. Operation of the blower **220** in the reverse direction will continue with the motor-compressor unit idle until the evaporator **127** defrosts and the switch **244** returns to the normal running position and reduces the temperature of the air out of the evaporator and the switch **246** below 10° F. In FIGURE 10, the starting relay **271** is shown for providing split phase starting of the motor-compressor unit **161**. The fan motor **257** may connect at the opposite end to either a centrifugal or propeller condenser fan **273**. If a centrifugal fan is provided, the air circulation through the condenser **145** will be in the same direction for both the on and off cycles; while if a propeller fan is provided, the air circulation through the condenser **145** will be reversed. The thermostatically controlled reversing of the blower **220** assures that air will be delivered to the below freezing compartment **62** only when its temperature is sufficiently low, for example, below 10° or 15° F.

In FIGURE 11, the control of the fan motor **257** is responsive to the operation of the switch **244** but a time delay arrangement is provided so that the fan motor **257** will not reverse until the predetermined time after the motor-compressor unit **161** has resumed operation. This will allow the evaporator **127** to be cooled down below freezing temperature before any air is delivered to the below freezing compartment **62**. For this purpose, the reversing switch **247** is not operated by the thermostatic switch **244** directly but a high reactance solenoid **275** is connected in shunt with the switch **244** so that when the switch **244** closes the solenoid **275** will be deenergized. A time delay device **277** is connected to the armature to delay the movement of the reversing switch **246** to its lower position. This provides sufficient time for the evaporator to cool before the fan motor **257** and the blower **220** are reversed. The opening of the switch **244** reenergizes the solenoid **275** to operate the reversing switch to its upper position.

While the embodiment of the invention as herein disclosed constitute preferred forms, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. A refrigerator including a cabinet provided with insulated walls enclosing a below freezing compartment and an above freezing compartment, a refrigerating system including a liquefying means and an evaporating means, control means for controlling said refrigerating system to cause said evaporating means to alternately maintain below and above freezing temperatures, said cabinet having supply and return ducts extending from said evaporating means to said compartments, a reversible blower means operably connected to said ducts to circulate air through said evaporating means and both said compartments in a first direction of operation and to circulate air through said evaporating means and only said above freezing compartment in a second direction of rotation, and means for operating said blower means in said first direction during the time said evaporating means is maintained at below freezing temperatures and for operating said blower means in said second direction during the time said evaporating means is maintained at above freezing temperatures.

2. A refrigerator including a cabinet provided with insulated walls enclosing a below freezing compartment and an above freezing compartment, a refrigerating system including a liquefying means and an evaporating means, said liquefying means including electrical operating means, a thermostatic switch means set to operate upon a defrosting cycle responsive to the temperature of the evaporating means connected in electrical series circuit relation with said electrical operating means, an electrically operable reversible blower having means for circulating air from both compartments in heat transfer relation with said evaporating means and back into both compartments in one direction of rotation and for circulating air only from said above freezing compartment in heat transfer relation with said evaporating means and back to said above freezing compartment in the opposite direction of rotation, and a reversing switch connected to said blower and operated by said thermostatic switch means for reversing said blower in accordance with the opening and closing of said thermostatic switch means.

3. A refrigerator including a cabinet provided with insulated walls enclosing a below freezing compartment and an above freezing compartment, a refrigerating system including a liquefying means and an evaporating means, said liquefying means including electrical operating means, a thermostatic switch means set to operate upon a defrosting cycle responsive to the temperature of the evaporating means connected in electrical series circuit relation with said electrical operating means, an electrical operable reversible blower having means for circulating air from both compartments in heat transfer relation with said evaporating means and back into both compartments in one direction of rotation and for circulating air only from said above freezing compartment in heat transfer relation with said evaporating means and back to said above freezing compartment in the opposite direction of rotation, and a reversing switch connected to said blower and operated by said thermostatic switch means for reversing said blower in accordance with the opening and closing of said thermostatic switch means, and a time delay device associated with said reversing switch for delaying the operation of said reversing switch following the operation of said thermostatic switch means.

4. A refrigerator including a cabinet provided with insulated walls enclosing a below freezing compartment and an above freezing compartment, a refrigerating system including a liquefying means and an evaporating means, said liquefying means including electrical operating means, a thermostatic switch means set to operate upon a defrosting cycle responsive to the temperature of the evaporating means connected in electrical series circuit relation with said electrical operating means, a blower for circulating air from said compartments into heat transfer relation with said evaporating means and return, a damper means having one position for shutting off the circulation of air to said below freezing compartment and having a second open position, electrical operating means for said damper means controlled by said thermostatic switch means for operating said damper means to said one position during the open period of said switch means and to said second open position during the closed period of said switch means, and means for preventing the operation of said damper means to said second open position as long as said evaporating means is above a predetermined temperature.

5. A refrigerator including a cabinet provided with insulated walls enclosing a below freezing compartment and an above freezing compartment, a refrigerating system including a liquefying means and an evaporating means, control means for cyclically starting and stopping said refrigerating system to cause said evaporating means to alternately attain below freezing and above freezing temperatures, means effective during the operation following every starting of said refrigerating system for circulating air in heat transfer relation with said evaporating means and both said below and above freezing compartments and effective during the idle period following every stopping of said refrigerating system for circulating air in heat transfer relation with said evaporating means and only said above freezing compartment, and means for preventing the circulating of air in heat transfer relation with said evaporating means and both said below and above freezing compartments as long as said evaporating means is above a predetermined temperature.

6. A refrigerator including a cabinet provided with insulated walls enclosing a compartment to be cooled, a refrigerating system including liquefying means and evaporating means, means for circulating air in heat transfer relation with said evaporating means and said compartment to be cooled, means for stopping said refrigerating system and causing said evaporating means to rise above freezing temperatures, and means for preventing the circulation of air between said evaporating means and said compartment as long as said evaporating means is above a predetermined temperature.

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