June 9, 1942. M. KALISCHER 2,285,946

REFRIGERATION APPARATUS

Filed Dec. 30, 1939 3 Sheets-Sheet 1

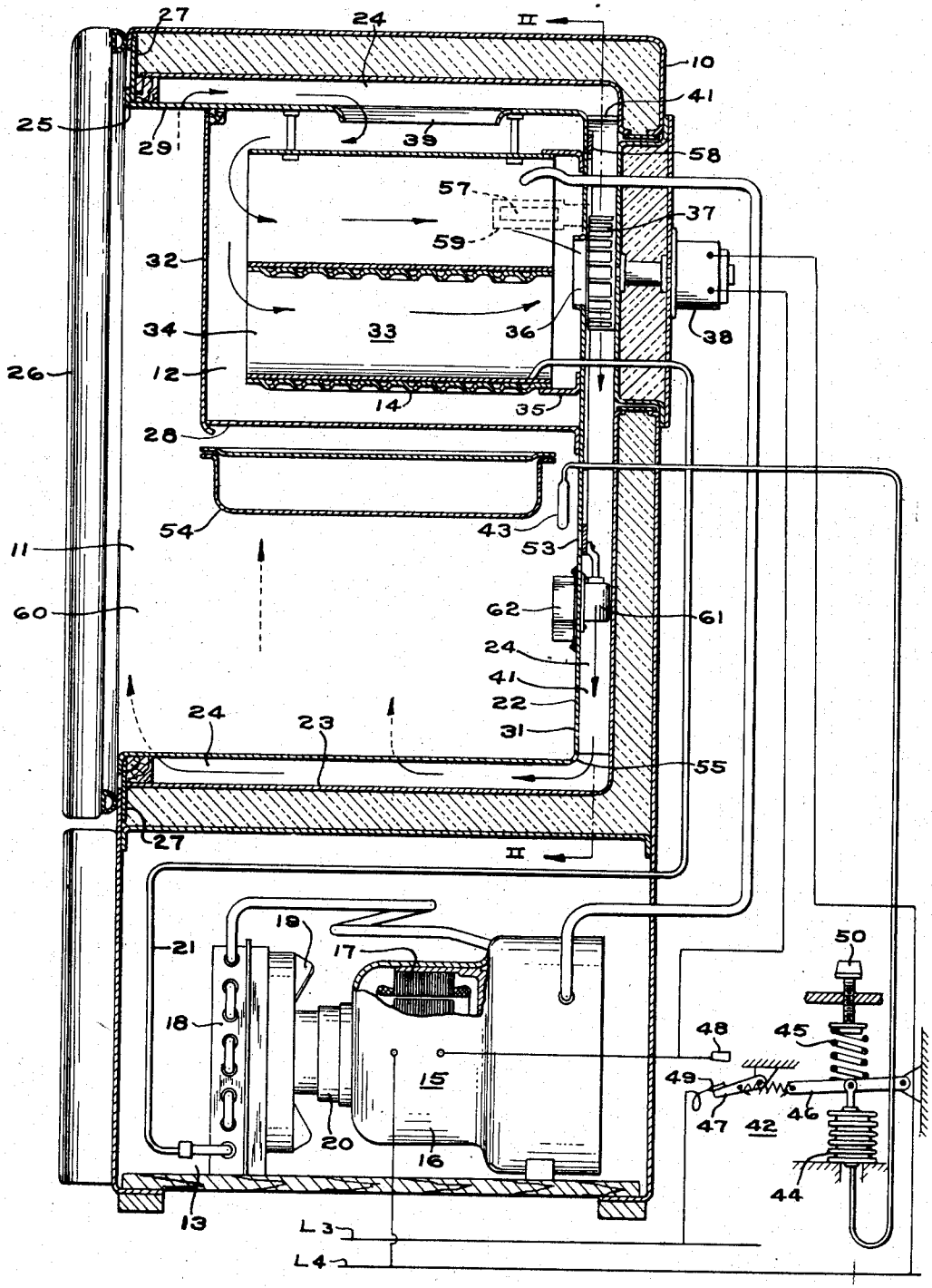


Fig. 1.

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REFRIGERATION APPARATUS

Filed Dec. 30, 1939 3 Sheets-Sheet 2

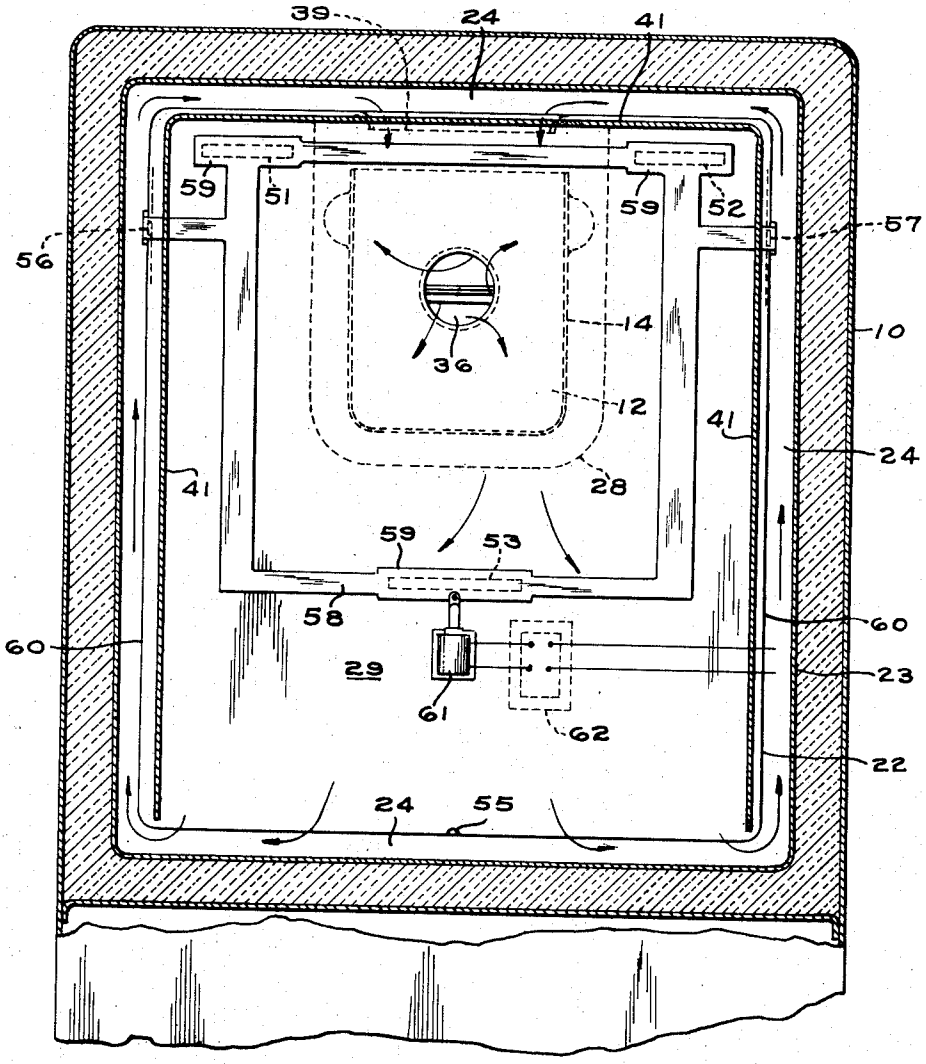


Fig. 2.

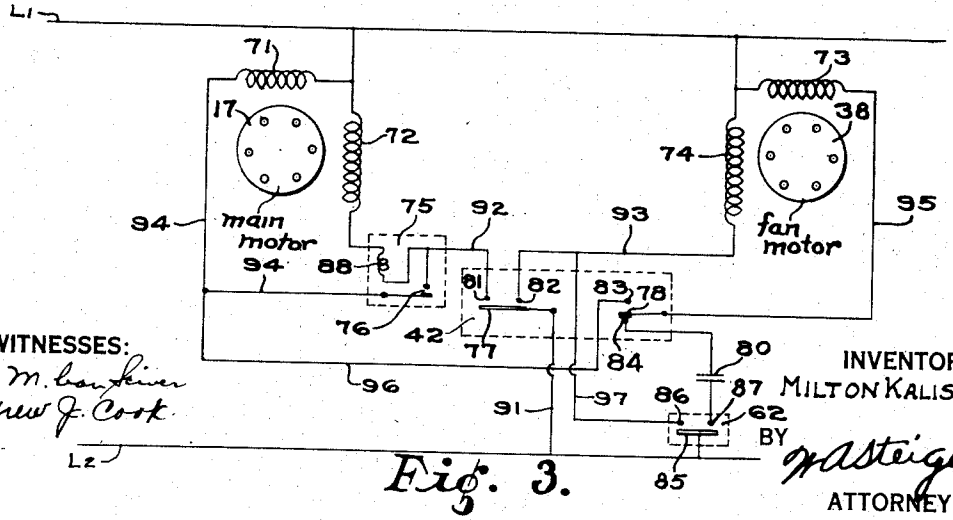


Fig. 3.

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REFRIGERATION APPARATUS

Filed Dec. 30, 1939 3 Sheets-Sheet 3

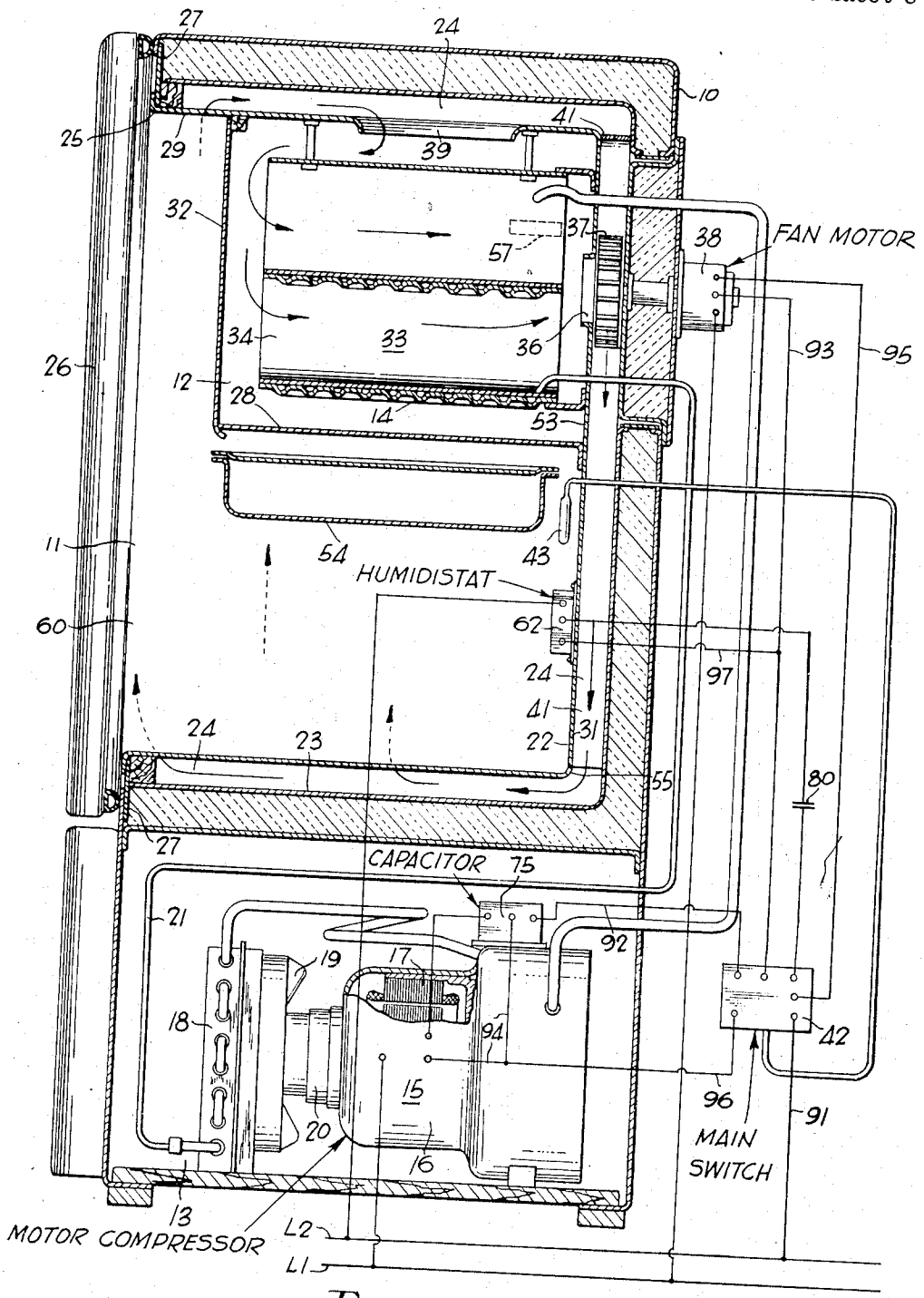


Fig. 4.

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2,285,946

UNITED STATES PATENT OFFICE

2,285,946

REFRIGERATION APPARATUS

Milton Kalischer, Longmeadow, Mass., assignor to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application December 30, 1939, Serial No. 311,845

14 Claims. (Cl. 62—6)

My invention relates to refrigeration apparatus and particularly to refrigeration apparatus embodying a high humidity compartment for the storage of moisture containing foods.

It is an object of my invention to provide an improved refrigerator of the high humidity type and to provide for better control of the humidity therein.

It is another object of my invention to provide improved apparatus for removing excess moisture from the high humidity compartment of a refrigerator.

It is still another object of my invention to provide a novel control for the temperature and humidity of a refrigerated enclosure.

It is a further object of my invention to provide an improved high humidity refrigerator utilizing forced circulation of air for cooling the high humidity chamber and also to effect humidity control without materially affecting the normal forced circulation of air over the cooling element of the refrigerator.

It is still a further object of my invention to provide a novel control for the refrigerating unit motor and the fan motor of a high humidity refrigerator to effect improved control of humidity therein.

These and other objects are effected by my invention as will be apparent from the following description and claims taken in connection with the accompanying drawings forming a part of this application, in which:

Fig. 1 is a sectional view of a refrigerator cabinet and a diagrammatic control illustrating one embodiment of my invention;

Fig. 2 is a partial sectional view taken on line II—II of Fig. 1;

Fig. 3 is a wiring diagram illustrating the electrical connections utilized in a second embodiment of my invention; and

Fig. 4 is a sectional view of a refrigerator cabinet comprising the second embodiment of my invention and showing the application thereto of the wiring illustrated diagrammatically in Fig. 3.

Description of Figs. 1 and 2

Referring specifically to the drawings for a detailed description of the first embodiment of my invention shown in Figs. 1 and 2, numeral **10** designates, generally, an insulated refrigerator cabinet embodying a high humidity compartment **11**, an evaporator compartment **12** and a machinery compartment **13**. An evaporator or cooling element **14** is disposed in the evaporator compartment **12** and is connected by suitable conduits to a refrigerating unit generally indicated at **15** disposed in the machinery compartment. The refrigerating unit **15** includes a sealed casing **16** enclosing a main motor **17** which drives a compressor (not shown). The compressor withdraws refrigerant vapor from the evaporator **14** through a conduit provided for this purpose and compresses it into a condenser **18** where the high-pressure refrigerant is cooled and liquefied, aided by air blown over the condenser by a cooling fan **19** driven by a motor **20**. Condensed refrigerant is then fed to the evaporator **14** through a capillary tube flow-restricting device **21**, after which the refrigerant evaporates and absorbs heat. The cycle is then repeated.

The high humidity compartment **11** is formed by a liner **22** which is spaced from an inner shell **23** of the refrigerator cabinet, thus providing a passageway **24** around the top, bottom, sides and rear of the liner **22**. The liner **22** is preferably formed of a material of good heat conductivity, such as porcelainized steel, although any material through which the thermal drop is small is suitable, and is provided with an access opening **25** at its front which is closed by a door **26**. The space at the front of the cabinet between the inner shell **23** and the liner **22** is sealed by a breaker strip **27**.

The evaporator compartment **12** is formed to substantially isolate the evaporator **14** from direct contact with the air in the high humidity compartment **11** and comprises a shroud **28** spaced from the sides and bottom of the evaporator **14** and fastened to top and rear walls **29** and **31** of the inner liner **22**. An auxiliary access door **32** seals the front of the shroud **28** and affords access to the evaporator **14** where ice is usually frozen in ice trays (not shown) in a freezing space **33** formed by imperforate walls **34** of the evaporator.

The high humidity chamber **11** is primarily cooled by conduction of heat through the metallic liner **22** to the air in the passageway **24** in the following manner. The rear of the evaporator is connected to the rear wall **31** of the inner liner **22** by a ring **35** and a fan inlet opening **36** in the rear wall **31** communicates with the freezing space **33**. A fan **37** driven by a motor **38** is disposed in the passageway **24** in registry with the fan inlet opening **36**. A second opening **39** in the top wall **29** of the inner liner **22** establishes communication between the passageway **24**, and the interior of the evaporator compartment **12**. A baffle **41** is disposed completely across the width of the passageway **24**, and, as shown in Fig. 2,

extends across the top of the inner liner 22 and down its sides almost to the bottom thereof.

Air is, therefore, drawn into the evaporator chamber 12 through the upper opening 39, passes over the outer surfaces of the imperforate walls 34 of the evaporator 14, thence over the inner surfaces of the imperforate walls 33 to the fan inlet opening 36. The air in passing over the cold evaporator is cooled and dehumidified, it being preferable that the fan motor 38 and the main motor 17 be energized at the same time, as explained hereinafter. Cold air from the fan 37 is discharged over the entire exterior surface of the rear wall 31 of the inner liner 22, this part of the passageway 24 constituting a high air pressure zone. The baffle 41 guides the cold air to the bottom of the inner liner 22, and, as shown by the arrows in Figs. 1 and 2, the cold air is conveyed along the bottom, up the sides and over the top of the inner liner 22 to the upper opening 39 therein, thus completing the air circuit. It is to be noted that the cold, dry air does not enter the high humidity chamber 11 and that the air pressure in the passageway 24 progressively decreases from the point of discharge at the fan to the upper opening 39 in the inner liner 22. Furthermore, the high humidity compartment 11 is cooled primarily by conduction of heat through the metal walls thereof to the air in the passageway 24. This air flow system is described and claimed in copending application, Serial No. 295,710, filed September 20, 1939, by Theodore W. Rundell, and application, Serial No. 320,042, filed February 21, 1940, by Martin G. Sateren, both of which are assigned to the Westinghouse Electric & Manufacturing Company, the assignee of the present application.

A control device generally indicated at 42 effects operation of the refrigerating unit 15 and the fan 37 when the temperature in the high humidity compartment 11 rises to a predetermined degree and renders the fan and refrigerating unit inactive when the temperature therein drops to a predetermined degree. A control bulb 43 filled with a volatile refrigerant is disposed in the high humidity chamber 11 and reflects the temperature thereof by causing a control bellows 44 to expand and contract. The bias of the bellows 44 is opposed by a spring 45 and movement of the bellows is transmitted to a lever 46 which operates an over-center snap-acting mechanism 47 to open and close contacts 48 and 49 which are connected to a line L_3, L_4, thus energizing and deenergizing main motor 17 and fan motor 38 in response to the temperature in the compartment 11. An adjusting device 50 changes the bias on spring 45, thus changing the temperatures in compartment 11 at which contacts 48 and 49 open and close.

In accordance with this embodiment of my invention, openings 51, 52 and 53 are provided in the rear wall 29 of the inner liner 22 and establish communication between the high-pressure zone of passageway 24 and the interior of the compartment 11. The openings 51 and 52 are adjacent the top horizontal wall 29 of inner liner 22 on each side of the evaporator shroud 28 and the opening 53 is adjacent the bottom of a storage receptacle 54, which is positioned close to the bottom of the shroud 28. The horizontal surfaces of the wall 29 and of the storage receptacle 54 tend to collect moisture which may drip on foods stored in compartment 11 and affect them deleteriously, while if moisture collects on other surfaces of the inner liner 22 it will drain to the bottom thereof without harming foods. A small opening 55 may be provided in the bottom of liner 22 to drain moisture into the passageway 24 where it is absorbed by the dry air therein and deposited on the evaporator 14, which is periodically defrosted, a suitable pan being inserted in the evaporator compartment 12 under the evaporator 14 for this purpose. A similar drain for excess condensate is disclosed and claimed in a copending application of John H. Ashbaugh, Serial No. 301,354, filed October 26, 1939, and assigned to Westinghouse Electric & Manufacturing Company.

Openings 56 and 57 are disposed near the top of the liner 22 in side walls 60 thereof and establish communication between the high humidity compartment 11 and the low-pressure zone of the passageway 24. A damper generally indicated at 58 and including a plurality of flaps 59 is operated by a solenoid 61 electrically connected to a humidostat 62, which is disposed in the high humidity compartment 11. If the humidity in compartment 11 becomes too high, the humidostat 62 effects energization of the solenoid 61 which operates damper 58 and lowers flaps 59, so that all of the openings 51, 52, 53, 56 and 57 are opened.

A circulation of air is, therefore, established from the high-pressure zone of passage 24 through openings 51, 52 and 53, across the horizontal surfaces of the upper wall 29 of the inner liner 22 and the lower surface of food container 54, then through openings 56 and 57 into the low-pressure zone of passage 24. The velocity of the air so circulated depends on whether the fan 36 is operating or not, it being obvious that a greater amount of air will circulate in a given time with the fan operating than if thermosyphonic circulation alone is depended upon. The air which enters the openings 51, 52 and 53 is cold and dry, having just passed over the cold evaporator 14 and, therefore, has relatively great capacity for absorbing moisture. After the air from openings 51, 52, and 53 has absorbed moisture from the aforesaid horizontal surfaces and from the air in the high humidity compartment 11, and has passed through openings 56 and 57 to passage 24, it again passes over the evaporator 14 where the moisture is condensed and, if the evaporator 14 is sufficiently cold, as it is when the refrigerating unit 15 is operating normally, the moisture is frozen on the evaporator.

When the humidity of the air in the compartment 11 is reduced to the desired value, the damper 58 closes the openings 51, 52, 53, 56, and 57 through the action of the humidostat 62 and solenoid 61. Considerable quantities of the free moisture on the upper wall 29 of the high humidity compartment 22 and on the lower surface of food compartment 54 will also have been absorbed. Air is thereafter circulated through passage 24 without entering the high humidity chamber 11, but it is to be noted that, when the damper 58 is open, the air circulation through passage 24 and over the evaporator 14 is not materially affected, only relatively small amounts of air being circulated through the high humidity compartment 11 even when the fan 36 is operating. However, the humidity in compartment 11 is properly controlled and excess free moisture is removed therefrom, both resulting in better and safer food storage conditions since too high a relative humidity deleteriously affects some foods as does dripping of free moisture.

Description of Figs. 3 and 4

The wiring diagram shown in Fig. 3 illustrates another embodiment of my humidity control, the same elements being used as in Figs. 1 and 2 except that the damper **58** and damper solenoid **61** may be dispensed with, as shown in Fig. 4. When this is done, dry air circulates into and out of the high humidity compartment **11** at all times through the openings **51**, **52**, **53**, **56**, and **57**; thermosyphonically when the fan **38** is not operating and by forced circulation when it is. Under some conditions, however, the degree of humidity and free moisture in the compartment **11** may still be too high and the present embodiment of my invention is designed to correct such a condition. Briefly, it comprises operating the fan **38** in response to a humidity condition in compartment **11** even when the refrigerating unit **15** is inactive because the temperature in the high humidity compartment **11** is at a satisfactory low value.

Referring specifically to Figs. 3 and 4 for a detailed description of the second embodiment of my invention, I have illustrated the main motor **17** for the refrigerating unit as a single phase motor having a starting winding **71** and a running winding **72**. As shown, the main motor **17** produces a polyphase output to drive fan motor **38**, which is of the two-phase type having an auxiliary winding **73** and a running winding **74**. A starting relay **75**, the main thermostat **42**, the humidostat **62** and a capacitance **80** complete the elements of the circuit. The starting relay **75** is provided with one set of contacts **76**. The main thermostat **42** is provided with two movable contacts **77** and **78** and four stationary contacts **81**, **82**, **83**, and **84** and the humidostat **62** with one movable contact **85** and two stationary contacts **86** and **87**.

When the temperature in the high humidity compartment **11** reaches a predetermined high value, the bulb **43** and bellows **44** effect closing of the movable contact **77** and fixed contacts **81** and **82** of the main thermostat **42** and also causes movable contact **78** to engage stationary contact **83**. The starting relay contacts **76** are also closed by a solenoid, the winding of which is shown at **88**, due to the surge of current drawn by the running windings of the motors **17** and **38** on starting. The running windings **72** and **74** are, therefore, connected directly across line L_1, L_2 through a conductor **91** connecting the movable contact **77** with line L_2 and through conductors **92** and **93** connecting the running windings **72** and **74** respectively to contacts **81** and **82** and line L_1.

Since the starting relay contacts **76** are also closed at this time, the starting winding **71** of the main motor **17** is connected directly across line L_1, L_2 through conductors **94** and **92**, contacts **81** and **77** and conductor **91**. Auxiliary winding **73** of fan motor **38** is connected across line L_1, L_2 through conductor **95** through contacts **83** and **78**, conductors **96**, **94**, contacts **76**, conductor **92**, contacts **81** and **77** and conductor **91**.

After the main motor **17** has come up to speed the current in solenoid winding **88** is reduced and starting relay contacts **76** open. The windings **71** and **73** are, therefore, no longer across the line L_1, L_2, but winding **73** of the fan motor **38** thereafter receives power by induction from the starting winding **71** of the main motor **17** through conductors **94**, **96**, contacts **83** and **78** and conductor **95**. The fan motor **38** therefore runs as a two-phase motor, the main motor **17** delivering one of the phases. It is desirable to utilize a two phase fan motor because of reliability and cheapness. During operation of the refrigerating unit **15**, therefore, dry air is being circulated through the high humidity compartment **11** and its humidity is being reduced and free moisture is being removed therefrom, the air circulation being the same as described with respect to the first embodiment of my invention.

In accordance with my invention, when the main thermostat contacts **77**, **81**, and **82** are opened because a desired low temperature is reached in compartment **11**, the fan **37** is still operated or again starts to operate if the humidity in compartment **11** is at too high a value. To accomplish this with a two-phase fan motor it is necessary to provide the capacitor **80** to supply out-of-phase power to one of the windings **73** of the fan motor **38**.

When the humidostat contacts **85**, **86**, and **87** are closed, contacts **78** and **84** of the main thermostat will be closed only if the movable contact **77** thereof is in the "off" position, as shown in Fig. 3. A circuit is then established from line L_2, through contacts **85** and **87**, through capacitor **80**, through contacts **84** and **78**, through conductor **95** and winding **73** to line L_1. A second circuit is established from line L_2, through contacts **85** and **86**, through conductors **97** and **93** and through running winding **74** to line L_1. It is clear, therefore, that fan motor **38** will start and run when the main thermostat contacts **77**, **81**, **82** are open. Excess humidity and free moisture will therefore be removed from the high humidity compartment **11** by the dry air circulated therethrough in the manner set forth above, the circulated air being dried by contact with the evaporator **14** which is normally cold enough to condense moisture even when the refrigerating unit **15** is not operating.

If the contacts **77**, **81**, **82** are closed and fan motor **38** is energized as a two-phase motor in the manner described, and the humidostat contacts **85**, **86**, **87** close, nothing will occur because contacts **78**, **84** will be open and contacts **78**, **83** closed, so that power of a different phase than that induced by main motor **17** cannot be supplied to winding **73** of the fan motor **38**.

From the foregoing it will be apparent that I have provided an improved high humidity refrigerator and control therefor.

While I have shown my invention in several forms, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other changes and modifications without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are specifically set forth in the appended claims.

What I claim is:

1. In refrigeration apparatus, the combination of a refrigerator cabinet, a cooling element disposed in the cabinet for cooling and dehumidifying air circulated thereover, a substantially enclosed chamber formed of a material providing a small thermal drop therethrough disposed in the cabinet, a passageway surrounding at least a portion of said chamber for the circulation of said cool and dehumidified air and embodying a relatively high pressure zone and relatively lower pressure zones, said chamber being cooled primarily by the conduction of heat through said material to the air in said passage, whereby a

relatively high humidity is maintained in said chamber, means responsive to the humidity in said chamber for establishing a circulation of said dehumidified air from said high-pressure zone of said passage to said chamber and from said chamber to a lower pressure zone of said passage, and means for forcibly effecting said circulation at least part of the time.

2. In refrigeration apparatus, the combination of a refrigerator cabinet, a cooling element disposed in the cabinet for cooling and dehumidifying air circulated thereover, means for forcibly circulating said air over the cooling element, a substantially enclosed chamber formed of a material providing a small thermal drop therethrough disposed in the cabinet, a passageway surrounding at least a portion of said chamber for the circulation of said cool and dehumidified air and embodying a relatively high pressure zone and relatively lower pressure zones, said chamber being cooled primarily by the conduction of heat through said material to the air in said passage, whereby a relatively high humidity is maintained in said chamber and means for effecting a forced circulation of a relatively small quantity of said dehumidified air from said high-pressure zone of said passage to said chamber and from said chamber to a lower pressure zone of said passage.

3. In refrigeration apparatus, the combination of a refrigerator cabinet, a cooling element disposed in the cabinet for cooling and dehumidifying air circulated thereover, means for circulating a refrigerant through said cooling element, means for rendering said circulating means active or inactive, a substantially enclosed chamber formed of a material providing a small thermal drop therethrough disposed in the cabinet, said chamber having openings formed therein, a passageway surrounding at least a portion of said chamber and embodying a high pressure zone and lower pressure zones, means for effecting a forced circulation of said cool and dry air through said passageway, said chamber being cooled primarily by conduction of heat through said material to the air in said passage, whereby a relatively high humidity is maintained in said chamber, and means for intermittently effecting communication between said high pressure zone and said chamber to afford forced circulation of said dry air from said high-pressure zone to said chamber and from said chamber to a lower pressure zone without substantially affecting the circulation of air over the evaporator.

4. The combination set forth in claim 3 wherein there is provided temperature-responsive means for starting and stopping said refrigerant circulating means and said air circulating means, and wherein the means for intermittently effecting said communication includes means responsive to the humidity in said chamber which is effective at times when said temperature responsive means has rendered both said refrigerant and air circulating means inactive as well as when they are active.

5. In refrigeration apparatus, the combination of a refrigerator cabinet, a cooling element disposed in the cabinet for cooling and dehumidifying air circulated thereover, a substantially enclosed chamber disposed in the cabinet and formed of a material providing a small thermal drop therethrough, a passageway surrounding at least a portion of said chamber for the circulation of said cool, dry air and embodying a high pressure zone and lower pressure zones, said chamber being cooled primarily by the conduction of heat through said material to the air in said passage, whereby a relatively high humidity is maintained therein, said chamber embodying a horizontal surface on which moisture is likely to collect and having an opening adjacent said surface communicating with the high-pressure zone of said passage and another opening communicating with a lower pressure zone of the passage, so that said cool, dry air is first circulated from said passage directly over said surface to absorb moisture therefrom and then is circulated back to said passage and over said cooling element which, in turn, absorbs said moisture from the air.

6. The combination set forth in claim 5 wherein means are provided for forcibly circulating air through said passageway and over said cooling element.

7. The combination set forth in claim 5 wherein the circulation of said cool, dry air through said high humidity chamber is controlled in response to the humidity therein.

8. In refrigeration apparatus, the combination of a refrigerator cabinet, a cooling element disposed in the cabinet for cooling and dehumidifying air circulated thereover, a substantially enclosed chamber disposed in the cabinet and formed of a material providing a small thermal drop therethrough, a passageway surrounding at least a portion of said chamber for the circulation of said cool dry air, a fan for circulating said cool dry air over said cooling element and through said passageway, thereby providing a high pressure zone and lower pressure zones, said chamber being cooled primarily by the conduction of heat, through said material to the air in said passageway, whereby a relatively high humidity is maintained in said chamber, said chamber being provided with openings communicating with said high-pressure zone and a lower pressure zone of said passageway, respectively, so that said cool, dry air is circulated through said chamber when the fan is operating to absorb moisture therefrom, a refrigerating unit for circulating refrigerant through said cooling element, temperature-responsive means for rendering said refrigerating unit and said fan active or inactive, and humidity responsive means effective independently of said temperature-responsive means for rendering said fan active or inactive when the refrigerating unit is inactive as well as when it is active to control the humidity in said chamber.

9. The combination set forth in claim 8 wherein an opening between the high-pressure zone of said passageway and said high humidity chamber is arranged adjacent to a horizontal interior surface of said chamber on which moisture collects, so that said moisture is adsorbed by said cool, dry air.

10. In refrigeration apparatus, the combination of a refrigerator cabinet, a cooling element disposed in the cabinet for refrigerating the same, a refrigerating unit for circulating refrigerant through said cooling element, a fan for forcibly circulating air over said cooling element and through the cabinet, temperature-responsive means for rendering said refrigerating unit and said fan active and inactive in response to a temperature condition of the cabinet, and humidity responsive means effective independently of said temperature-responsive means for rendering the fan active and inactive regardless of the opera-

tion of the refrigerating unit in response to a humidity condition in the cabinet.

11. In refrigeration apparatus, the combination of a refrigerator cabinet, a cooling element in the cabinet for refrigerating the same, a refrigerating unit for circulating refrigerant through said cooling element, said refrigerating unit including a driving motor having a single phase input and polyphase output, a fan for circulating air over said cooling element and through said cabinet, a polyphase motor for driving the fan and normally deriving one of its phases by induction from the refrigerating unit motor, temperature-responsive means for rendering said refrigerating unit motor and said fan motor active and inactive in response to a temperature condition in the cabinet, and humidity responsive means effective independently of said temperature-responsive means for rendering the fan active and inactive regardless of the operation of the refrigerating unit in response to a humidity condition in the cabinet, said humidity responsive means including means for operating the polyphase fan motor from a single phase source of power independently of the refrigerating unit motor.

12. In refrigerating apparatus, the combination of a refrigerator cabinet, a cooling element disposed in the cabinet for cooling and dehumidifying air circulated thereover, a substantially enclosed chamber disposed in said cabinet formed of a material providing a small thermal drop therethrough, a passageway extending around at least a portion of said chamber for the circulation of said cool, dry air, said chamber being cooled primarily by the conduction of heat through said material to the air in said passage, whereby a relatively high humidity is maintained therein, said chamber including a horizontal top wall on which moisture tends to collect and a storage pan in the upper portion of said chamber having a lower surface on which moisture tends to collect, and said chamber having openings communicating with said passage and positioned to direct streams of cool dry air over said moisture-collecting surfaces of said chamber and said container to absorb said moisture.

13. The combination claimed in claim 12 wherein the flow of air through said openings is controlled in response to the humidity in said chamber.

14. In refrigeration apparatus, the combination of a refrigerator cabinet, a cooling element disposed in the cabinet for cooling and dehumidifying air circulated thereover, means for circulating a refrigerant through said cooling element, means for rendering said circulating means active or inactive, a substantially enclosed chamber formed of a material providing a small thermal drop therethrough disposed in the cabinet, said chamber having apertures formed therein, and means for opening and closing said apertures, a passageway surrounding at least a portion of said chamber for the circulation of said cool dry air and embodying a relatively high pressure zone and lower pressure zones, said chamber being cooled primarily by conduction of heat through said material to the air in said passage, whereby a relatively high humidity is maintained in said chamber, means responsive to the humidity in said chamber for operating said means for opening said apertures to establish a flow of said dry air from said high-pressure zone to said chamber and from said chamber to a lower pressure zone without materially affecting the circulation of air over said cooling element, and means for forcibly creating said flow through said chamber at least part of the time said apertures are open.

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