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AIR CIRCUIT MEANS FOR COMBINED FREEZER AND REFRIGERATOR APPARATUS

Filed April 24, 1961

2 Sheets-Sheet 1

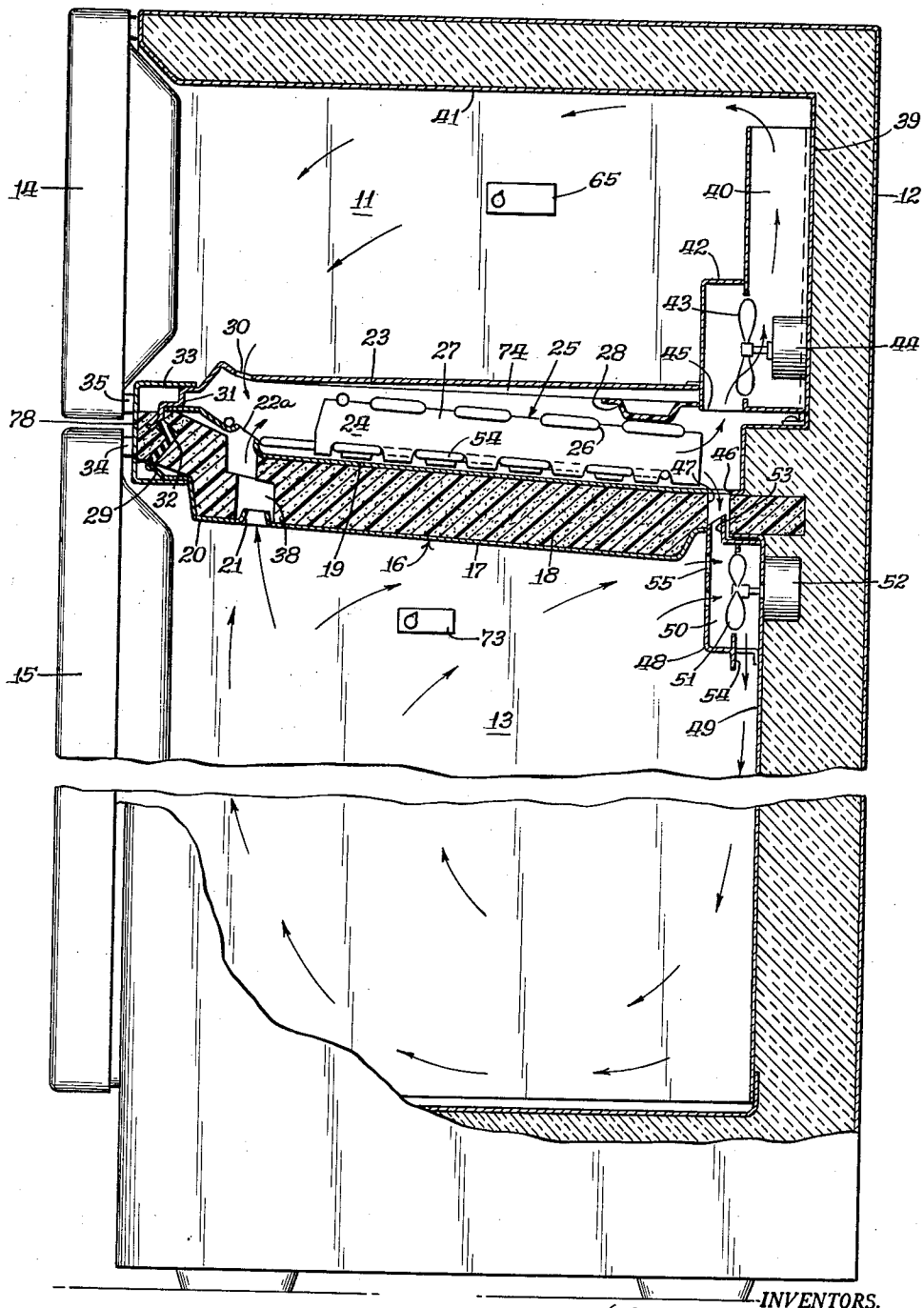


Fig. 1.

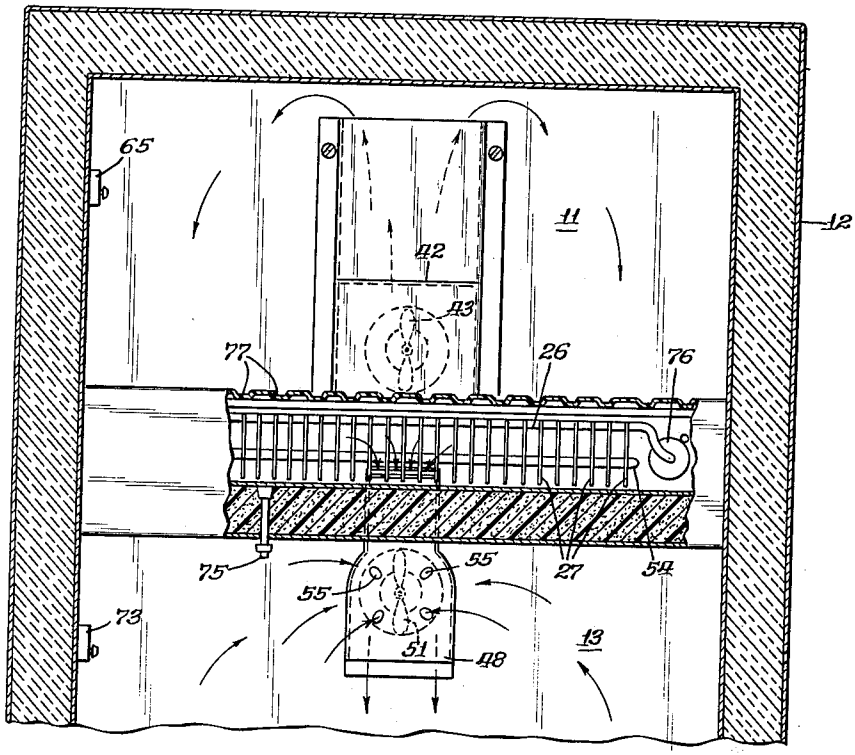
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Fig. 2.



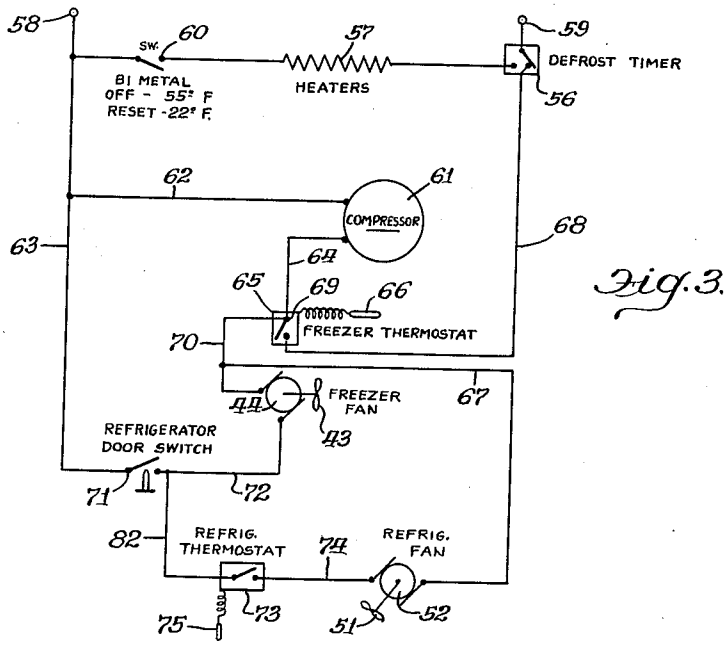


Fig. 3.

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AIR CIRCUIT MEANS FOR COMBINED FREEZER AND REFRIGERATOR APPARATUS

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This invention relates to refrigerating apparatus and in particular to combined freezer and refrigerator apparatus.

The association of a freezer with a refrigerator, as in refrigerator-freezer combination apparatus, has proven highly desirable in that it offers the user improved facility in the handling of food products and the like. In such refrigerator-freezer combinations, apparatus is provided for maintaining the refrigerator chamber at an above-freezing temperature such as approximately 35° F., and concurrently maintaining the freezer chamber at a subfreezing temperature such as approximately 0° F. Further, it is desirable in such combinations to provide cooling means which is adjustable so that the user may vary the respective refrigerator and freezer temperatures over a substantial range. Illustratively, it is desirable to provide for adjustment of the refrigerator tempertaure over a range from approximately 32° F. to approximately 40° F. and provide for adjustment of the freezer temperature over a range from approximately —5° F. to approximately 10° F. Heretofore, the refrigerating means and associated control for providing this desirable differential and range of temperatures in such combinations has been relatively complicated and costly. The present invention is concerned with such means and comprehends new and improved apparatus providing the desirable temperature differential and range in a simple and economical manner.

Thus, a principal feature of the present invention is the provision of new and improved refrigeration apparatus.

Another feature of the invention is the provision of such refrigeration apparatus utilizing a single evaporator and a pair of air moving means in a novel air distribution arrangement.

A further feature of the invention is the provision of such refrigeration apparatus further provided with a new and improved control arrangement.

Other features and advantages of the invention will be apparent from the following description of one embodiment thereof as shown in the accompanying drawings. Of the drawings:

FIGURE 1 is a fragmentary vertical sectional view through a household refrigerator-freezer embodying the invention.

FIGURE 2 is a fragmentary sectional view partially broken away for clarity of illustration and showing the back of the freezer chamber and the top portion of the refrigerator chamber in elevation.

FIGURE 3 is a wiring diagram of the apparatus of the illustrated embodiment.

The refrigerating apparatus **10** illustrated in the accompanying drawings is of the household type and includes a first or freezer chamber **11** in the top portion of an insulated cabinet **12** and a second or refrigerator chamber **13** in the bottom of this cabinet. The first chamber is normally closed by a door **14** while the second chamber is normally closed by a second door **15**. These doors of course may be opened in the usual way to provide access to the respective chambers.

Separating the chambers **11** and **13** is a transverse wall **16** extending across the interior of the cabinet **12**. This wall **16** comprises a bottom plate **17**, which is the top portion of refrigerator chamber **13**, on top of which is

a mass of insulation **18** with a second plate **19** being located on top of the insulation. The plate **17** is a part of the bottom chamber **13** liner while the plate **19** is a part of the upper chamber **11** liner.

The plate **17** has the forward portion **20** provided with a series of openings **21**. These openings extend from side-to-side across the forward portion **20** of the bottom plate **17**. This forward portion has the front edge **29** joined to a spacer block **32** of synthetic resin.

Spaced above the top insulation plate **19** is a metal, such as aluminum, bottom plate **23** defining the bottom of the first or freezer chamber **11**. Between the plate **19** and the plate **23** is an air passage **24** and in this air passage is positioned an evaporator **25**. The evaporator **25** includes parallel connected sections of refrigerant tubing **26** connected at their ends to form a continuous tube. In order to achieve efficient heat transfer there are provided the usual substantially parallel spaced fins **27** of a heat conducting metal such as aluminum. These fins extend from front to rear of the air passage **24** and support the refrigerant tubing **26** adjacent the top of the passage **24**. Resting on top of the evaporator **25** and transverse of the fins **27** is a metal channel **28** which is fastened to the bottom of plate **23** and which serves to confine air flow to the evaporator **25** and also to give support to the back portion of bottom plate **23**. As can be seen in FIGURE 1, the transverse wall **16** including plates **17** and **19** and insulation **18** slopes rearwardly and downwardly from the front to the back of the refrigerating apparatus **10**. The evaporator **25** has a similar slope.

The front edge of the plate **23** defining the bottom of the chamber **11** is provided with air openings **30**. Forwardly of these openings **30** is a downwardly projecting portion **31** joined to the lower plate portion **29** by means of the spacer block **32**. The forward portions of plates **29** and **31** and the block **32** are enclosed in a decorative front strip **33**. Sealing gaskets **34** and **35** are provided between this strip **33** and doors **14** and **15**, respectively.

The plate **23** is provided with a plurality of substantially parallel downwardly extending embossments **74**, all of which provide small air passages beneath the articles placed on the plate **23** and also give strength to the plate.

The plate **19** slopes upwardly as indicated at **22** at the front of the evaporator **25** and then forwardly as indicated at **36**. This front portion is provided with a series of openings **22***a*. The forward edge of portion **36** is joined to plate portion **31** as shown in FIGURE 1.

The openings **21** and **22***a* communicate with an air passage **38** formed within insulation **18** as shown in FIGURE 1.

At the rear of the first chamber **11** forwardly of the rear liner wall **39** there is provided an upwardly extending flue **40** terminating short of the top liner **41**. The bottom of this flue communicates with a fan shroud **42** in which is located a first fan **43** operated by an electric motor **44**. The bottom of the shroud **42** is provided with an opening **45** communicating with the rear end of the air passage **24**.

Top plate **19** extends rearwardly to subjacent shroud **42** and is provided with an opening **46** providing communication between air passage **24** and a downwardly extending passage **47** in the insulation **18**. A fan shroud **48** is mounted on the rear liner wall **49** and defines a chamber **50** in which a second fan **51** driven by a second motor **52** is disposed. Chamber **50** communicates with the upper flow passage **47** through an opening **53** in the upper portion of the shroud **48** and communicates with the refrigerator chamber **13** through an opening **54** in the bottom of the shroud **48** whereby the passage **47** and chamber **50** effectively define a conduit for passing air from air passage **24** into refrigerator chamber **13**. As shown in FIG. 1, the shroud may, if desired, be further

provided with a plurality of openings 55 providing direct communication between the refrigerator chamber 13 and the chamber 50 upstream of the fan 51 so that a portion of the air may be recirculated through chamber 13, by-passing the air passage 24.

A wiring diagram for the apparatus of this embodiment of the invention is shown in FIGURE 3. The apparatus includes a defrost timer switch 56 of the customary type adapted to be closed periodically to energize a defrost heater wire 57. The defrost timer is adapted to energize the heater 57 from power supplied by power lines 58 and 59. One example of a defrost timer 56 is one that is energized every twelve hours to energize the heater 57. Located in the circuit to the heater 57 is a thermostat 60 which is normally closed but which is openable at a predetermined high temperature to break the circuit to the heater 57. An example of such a switch 60 is one that is set to open at 55° F. and to close to reset the heater at about 22° F. The defrost timer at periodic intervals will energize the heater 57 to defrost the evaporator 25 but the operation of the defrost heater is terminated by the heater setting of the switch 60.

The apparatus also includes a motor compressor 61 of the ordinary type which is connected by a line 62 to a line 63 which leads to a power source 58. The other side of the compressor is connected by a line 64 to one side 69 of a freezer thermostat 65 which includes a temperature sensing bulb 66. The other side of the freezer thermostat 65 is connected to a line 68 leading through the defrost timer 56 to the other power line 59.

Connected to the same terminal 69 of the thermostat 65 to which the compressor is connected is the freezer fan motor 44 by means of a line 70. The other side of the freezer motor 44 is connected through a refrigerator door switch 71 to the line 63 by means of a line 72. One side of the motor 52 for the refrigerator fan 51 is connected to line 70 by means of a line 67 while the other side of motor 52 is connected to one side of a refrigerator thermostat 73 by means of a line 74. This thermostat 73 also includes a sensing bulb 75. The other side of thermostat 73 is connected through the refrigerator door switch 71 to line 63 by means of line 82.

During the normal operation of the apparatus illustrated in the drawings, the evaporator 25 cools air within the passage 24. The first fan 43 withdraws cool air which is cooled to a subfreezing temperature from this passage 24 through the shroud 42 and flue 40 and forces it into the top of the freezer chamber 11. The air flows through this chamber and then through the openings 30 into the front end of the air passage 24. At the same time the second fan 51 withdraws a quantity of air from the passage 24 by way of the opening 46. The fan 51 draws additional air from the top of the refrigerator chamber 13 through the openings 55 with this air being mixed with the incoming subfreezing temperature air in the shroud 48. The mixed air is then forced down through the opening 54 in shroud 48 and out into chamber 13. A portion of the air from the chamber 13 is drawn upwardly through the openings 21 into the front end of the evaporator air passage 24 for mixing with air from the freezer openings 30 and for further chilling.

As can be seen from the illustrated embodiment, a suitable quantity of subfreezing air is withdrawn from the passage 24 by the first fan 43 and circulated through the freezer chamber 11 and back into the passage 24 through the openings 30, to maintain the chamber 11 at a subfreezing temperature. In contrast, a suitable smaller quantity of subfreezing air is drawn from the evaporator passage 24 by fan 51 to flow into and through the refrigerator chamber 13 to maintain the temperature in the chamber 13 above freezing.

Where the openings 55 are provided in the fan shroud 48, a portion of the air circulated through chamber 13 is recirculated without a cooling thereof, thereby providing an increased air movement through the chamber

13 for improved distribution of the cooling air therethrough. Further, the recirculation of a portion of the air in chamber 13 back to chamber 50, by-passing the evaporator 25 and mixing with the cold air drawn through openings 53, causes the temperature of the air delivered through opening 54 to chamber 13 to be higher than the temperature of the air delivered to the freezer chamber 11. Thus, injury to freezing-susceptible food products and the like in refrigerator chamber 13 is effectively precluded. Still further, the moderating or tempering of the chilled air delivered from air passage 27 permits a substantially lower gradient of temperature through chamber 13 so that all portions of the chamber 13 may effectively be brought to the desired refrigerating temperature. Still another desirable feature obtained through the provision of the openings 55 is the circulation of the air in chamber 13 partially along the underside of the bottom plate 17 of the dividing wall 16. Thus, any moisture condensing on bottom plate 17 from the relatively moist air in chamber 13 is withdrawn therefrom by the air flow thereagainst to the openings 55 during the operation of the fan 51.

In one embodiment of the invention the total air passing through the second fan 51 and thus fed into chamber 13 by way of the opening 54 totalled 37 cubic feet per minute. Of this amount 23 cubic feet per minute were drawn back through the openings 55, thus by-passing the evaporator passage 24 while the remaining 14 cubic feet per minute were passed through the openings 21 for passage through air passage 24 in heat transfer association with the evaporator 25. The rate of flow of the chilled air through the freezer chamber 11 by means of the fan 43 and flue 40 totalled 46 cubic feet per minute. These rates of flow effectively maintained a subfreezing temperature within the chamber 11 and an above-freezing temperature within the chamber 13. Desired rates of flow for any embodiment of this invention are easily determined by those skilled in the art. The temperature in the freezer chamber 11 is controlled by the thermostat 65 which closes at a predetermined high temperature to operate the compressor 61 and which opens at a predetermined low temperature to stop the compressor. This, of course, is the customary manner for controlling the temperature in a freezer. This opening and closing of the thermostat 65 also causes the freezer fan motor to stop or start, respectively. The temperature in the second or refrigerator compartment 13, however, is controlled by the thermostat 73 which makes and breaks the circuit to the fan motor 52. As shown in FIG. 3, however, the refrigerator fan 51 is further connected in series with the freezer thermostat 65 so that the refrigerator fan operates only when both the refrigerator thermostat 73 and freezer thermostat 65 are closed. Thus, circulation of air through refrigerator chamber 13 is effected only when the evaporator 25 is being cooled by operation of the compressor 61. In addition, the apparatus is provided with a refrigerator door switch 71 which stops the operation of the refrigerator fan motor 52 and the freezer fan motor 44 whenever the refrigerator door is opened.

At periodic intervals, as explained above, the defrost timer 56 energizes the defrosting heater 57. This melts the frost on the evaporator 25 and defrost water is conveyed to a place of disposal in the customary manner through a drain 75. The operation of the heater, although started by the defrost timer 56, is terminated by the thermostat switch 60 in the manner explained above.

The refrigerating apparatus of this invention is simple and compact in construction and regulates the temperatures in the two chambers by suitably circulating chilled air through the freezer chamber alone or concurrently through both chambers. The refrigerant system is of the conventional type including the evaporator 25 and accumulator 76 and the compressor 61.

Having described our invention as related to the embodiment shown in the accompanying drawings, it is our intention that the invention be not limited by any of the details of description, unless otherwise specified, but rather be construed broadly within its spirit and scope as set out in the accompanying claims.

The embodiment of the invention in which an exclusive property or privilege is claimed is defined as follows:

1. Refrigerating apparatus, comprising: means forming an air passage having an outlet portion; refrigerating means for cooling air in said air passage; means forming first and second chambers; first conduit means interconnecting said outlet portion of said air passage and said first chamber; first air moving means in said first conduit means for flowing air through said first conduit means from said outlet portion of said air passage to said first chamber; second conduit means interconnecting said outlet portion of said air passage and said second chamber; second air moving means in said second conduit means for flowing air through said second conduit means from said outlet portion of said air passage to said second chamber; means for conducting air from said chambers to said air passage; first control means responsive to the temperature within said first chamber for simultaneously interrupting operation of said refrigerating means and said first air moving means when the temperature in said first chamber drops to a preselected temperature; and second control means responsive to the temperature within said second chamber for interrupting operation of said second air moving means when the temperature in said second chamber drops to a preselected temperature.

2. Refrigerating apparatus, comprising: means forming an air passage; refrigerating means for cooling air in said air passage; means forming a first chamber; first conduit means interconnecting said air passage and said first chamber; first air moving means for flowing air through said first conduit means from said air passage to said first chamber; means forming a second chamber subjacent said first chamber; second conduit means interconnecting said air passage and said second chamber; second air moving means for flowing air through said second conduit means from said air passage to said second chamber; means for conducting air from said chambers to said air passage; first control means responsive to the temperature within said first chamber for simultaneously precluding operation of said refrigerating means and said first and second air moving means when the temperature in said first chamber drops to a first preselected temperature; and second control means responsive to the temperature within said second chamber for precluding operation of said second air moving means when the temperature in said second chamber drops to a second preselected temperature higher than said first preselected temperature.

3. Refrigerating apparatus, comprising: means forming an air passage; refrigerating means for cooling air in said air passage; means forming a first chamber; first conduit means interconnecting said air passage and said first chamber; first air moving means for flowing air through said first conduit means from said air passage to said first chamber; means forming a second chamber subjacent said first chamber; second conduit means interconnecting said air passage and said second chamber; second air moving means for flowing air through said second conduit means from said air passage to said second chamber; means for conducting air from said chambers to said air passage; first control means responsive to the temperature within said first chamber for simultaneously precluding operation of said refrigerating means and said first and second air moving means when the temperature in said first chamber drops to a below-freezing preselected temperature; and second control means responsive to the temperature within said second chamber for precluding operation of said second air moving means when the temperature in said second chamber drops to an above-freezing preselected temperature higher than said below-freezing preselected temperature.

4. Refrigerating apparatus, comprising: means forming an air passage; refrigerating means for cooling air in said air passage; means forming first and second chambers; first conduit means interconnecting said air passage and said first chamber; first air moving means for flowing air through said first conduit means from said air passage to said first chamber; second conduit means interconnecting said air passage and second chamber, said second conduit means having successive first and second portions; second air moving means in said second portion of the second conduit means for flowing air from said air passage through said second conduit means and into said second chamber; means for conducting air from said chambers to said air passage; and means defining a flow passage interconnecting said second chamber and said first portion of the second conduit means for circulating air from said second chamber to the second air moving means.

5. The refrigerating apparatus of claim 4 wherein said flow passage is closely adjacent the second air moving means and the means for conducting air from the second chamber to the air passage comprises another flow passage spaced substantially from said second air moving means.

6. The refrigerating apparatus of claim 5 wherein said chamber forming means includes a member confronting said second chamber and adjacent said air passage whereby moisture in the air in said second chamber tends to collect on said member, and said flow passage and second conduit are cooperatively associated to cause a portion of the air flowed through said second chamber by said second air moving means to flow against said member and withdraw the collected moisture therefrom.

7. Refrigerating apparatus, comprising: means forming an air passage; refrigerating means for cooling air in said air passage; means forming a first chamber superjacent said air passage; first conduit means interconnecting said air passage and said first chamber; first air moving means in said first conduit means for flowing air through said first conduit means for said air passage upwardly to said first chamber; means forming a second chamber subjacent said air passage; second conduit means interconnecting said air passage and said second chamber for passing air from said air passage downwardly to said second chamber; control means operating said refrigerating means when the temperature in said first chamber rises to a preselected below-freezing temperature and concurrently operating said first air moving means; and means forcing air from said air passage through said second conduit means to said second chamber only whenever the temperature in said second chamber rises to a preselected above-freezing temperature and said refrigerating means is operating.

8. Refrigerating apparatus, comprising: means forming an air passage; refrigerating means for cooling air in said air passage; means forming first and second chambers; first conduit means interconnecting said air passage and said first chamber; first air moving means for flowing air through said first conduit means from said air passage to said first chamber; second conduit means interconnecting said air passage and said second chamber; second air moving means for flowing air through said second conduit means from said air passage to said second chamber; means for conducting air from said chambers to said air passage; first control means responsive to the temperature within said first chamber for simultaneously interrupting operation of said refrigerating means and said first air moving means when the temperature in said first chamber drops to a preselected temperature; and second control means responsive to the temperature within said second chamber for interrupting operation of said second air moving means when the temperature in said second chamber drops to a preselected temperature, said first control means including means preventing opera-

tion of said second air moving means whenever operation of said refrigerating means and said first air moving means is interrupted.

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