July 6, 1948. R. E. DAVIS 2,444,593

AUTOMATIC TEMPERATURE CONTROL FOR REFRIGERATED OPEN TOP DISPLAY CASES

Filed July 31, 1944 2 Sheets-Sheet 1

Fig. 1.

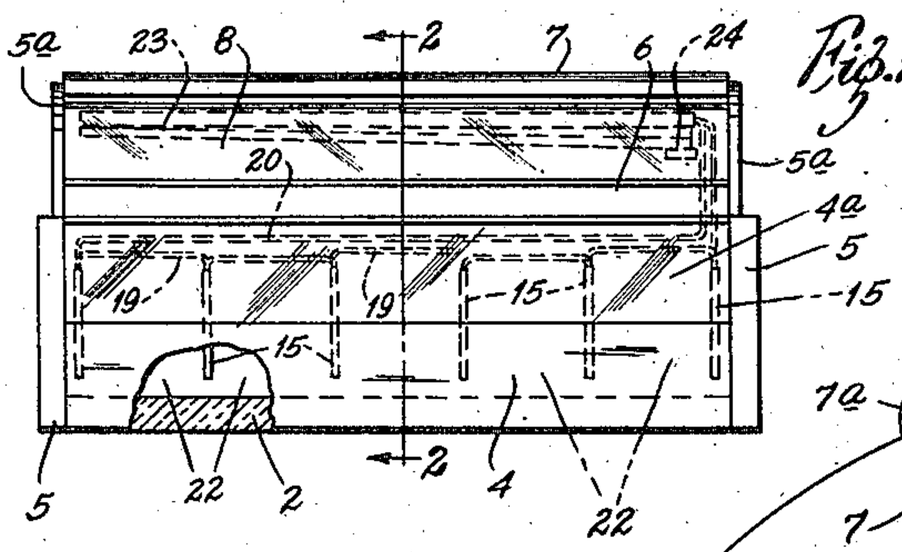


Fig. 2.

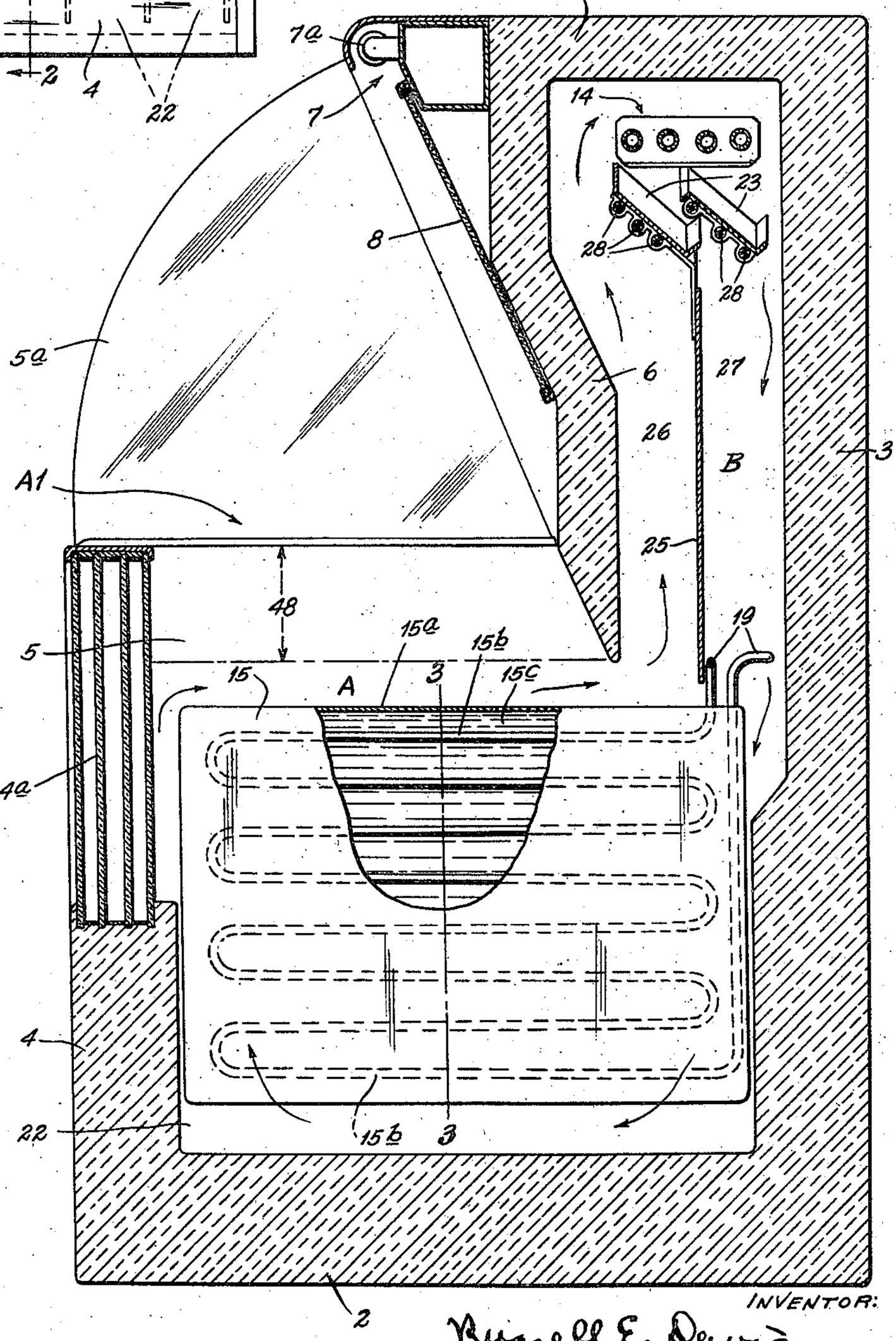
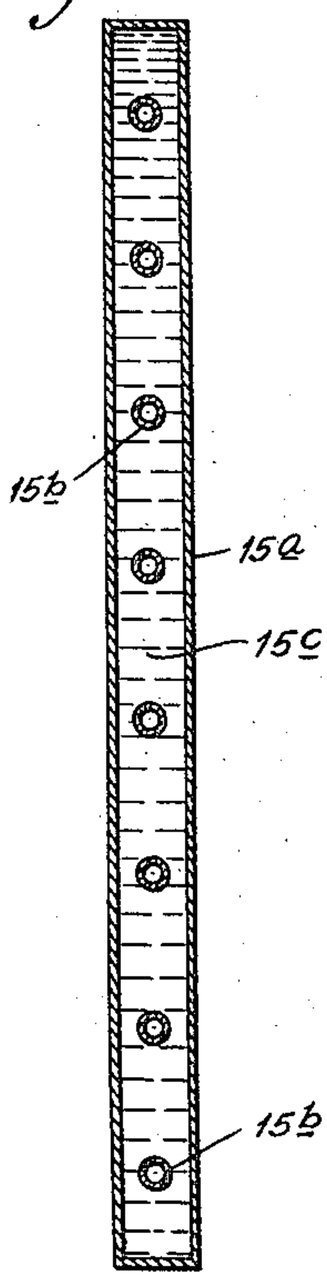


Fig. 3.



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AUTOMATIC TEMPERATURE CONTROL FOR REFRIGERATED OPEN TOP DISPLAY CASES

Filed July 31, 1944 2 Sheets-Sheet 2

Fig. 4.

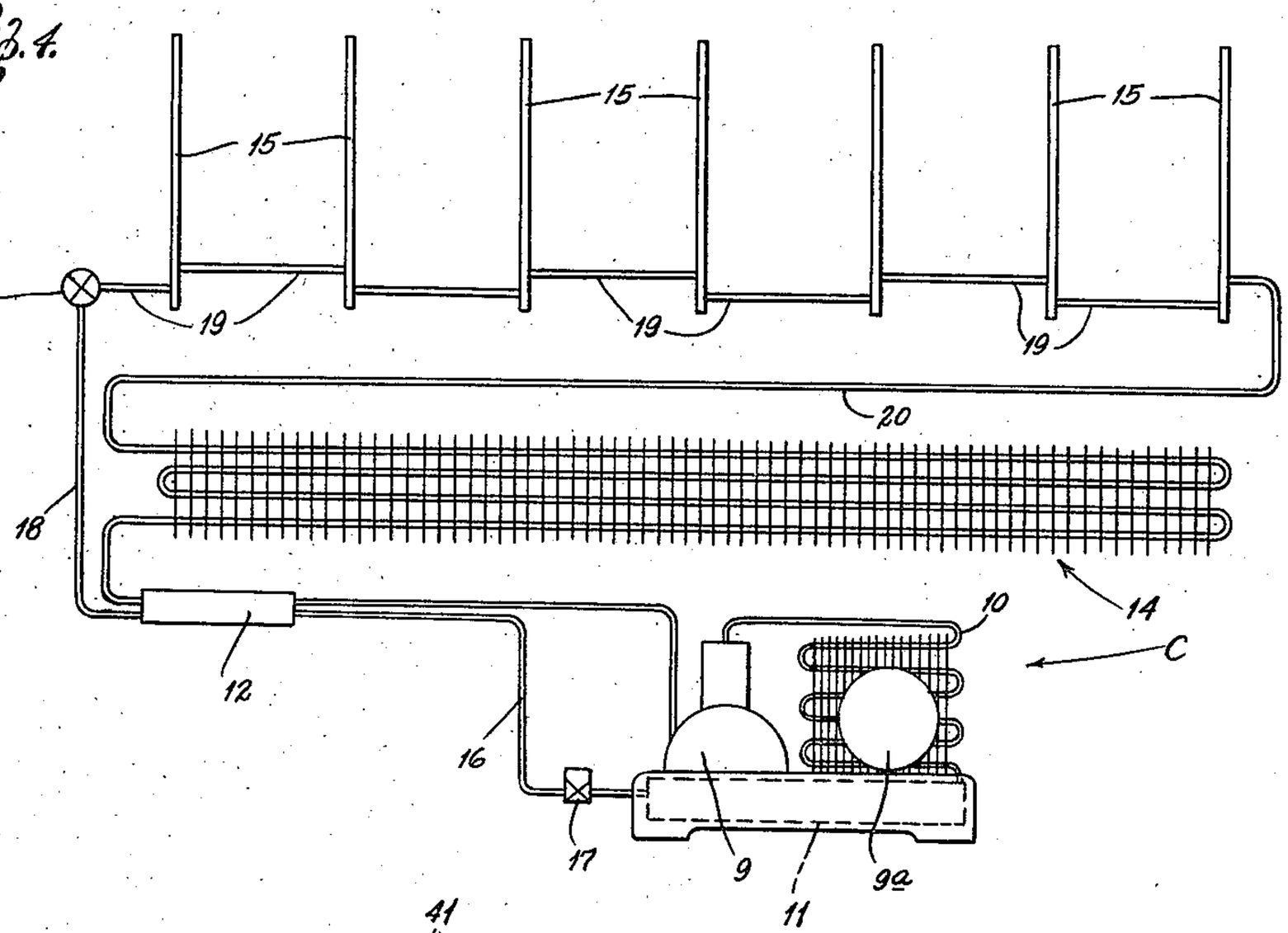
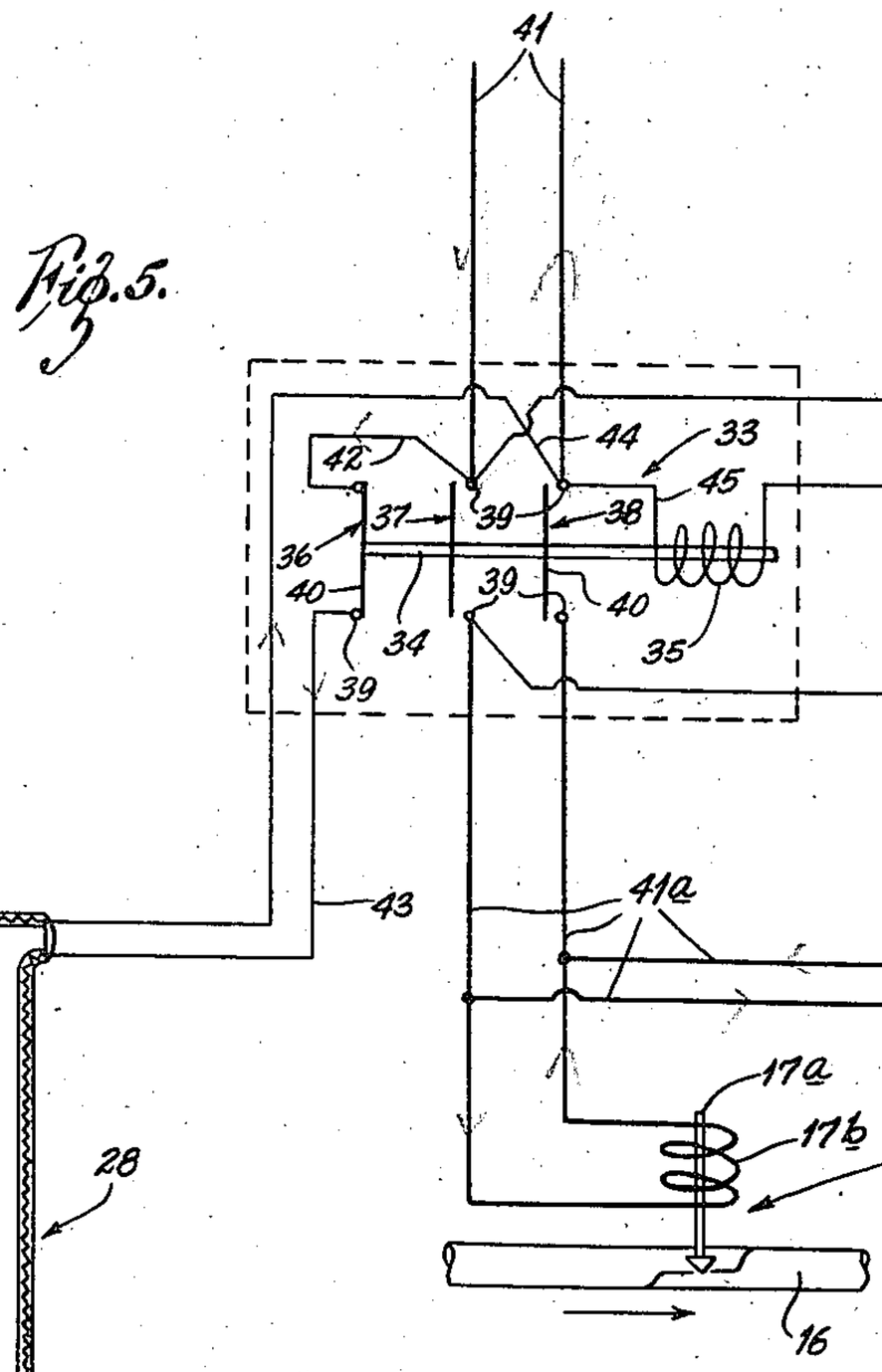


Fig. 5.



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AUTOMATIC TEMPERATURE CONTROL FOR REFRIGERATED OPEN-TOP DISPLAY CASES

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14 Claims. (Cl. 62—6)

1

This invention relates to refrigerated cases or cabinets for frozen foods. Previous frozen food cabinets have all required the use of doors or covers, thus increasing the difficulty of customer access to the goods and detracting from the easy visibility and attractive appearance of the display; besides which, the opening of the doors causes the frozen food products to become encrusted with frost and ice, thus detracting from their appearance and sales appeal. Further, too frequent opening of the doors may involve a dangerous rise in temperature in the cabinet and there is always the risk of doors being left open by customers.

While open display refrigerated self-service display cases have been known, they have not been capable of producing the sub-zero temperature required for frozen foods.

The present invention, therefore, relates to a new type of refrigerated display case to-wit: a case capable of maintaining the sub-zero temperatures required for storing frozen foods, but which has a continuously open self-service chamber for the display of frozen foods.

The principal object of the present invention, therefore, is a refrigerated display case providing for frozen foods those important advantages that have been provided for nonfrozen (but still refrigerated) foods by previously known display cases having refrigerated continuously open self-service food display chambers. Another object is to prevent frosting or ice encrustation of the merchandise in the open food display chamber. Another object is an arrangement of cooling elements that will provide a closed thermo-siphon system of refrigerated air in the food chamber and food bins therein. Other objects are simplicity and cheapness of construction and operation.

The invention consists in providing the refrigerating circuit with a second cooling element that is located in the open food display chamber and cooperates with a top cooling element located in an upper chamber to maintain a predetermined freezing temperature in said display chamber; it also consists in arranging said second cooling element to form bins in said display chamber; it also consists in providing means for rapidly defrosting the top cooling element; it also consists in providing means responsive to a predetermined temperature of the cooling element in the display chamber for stopping the operation of the refrigerating circuit and starting the defrosting means for the top cooling element and in providing means responsive to a

2

predetermined temperature of said top cooling element for starting the operation of said refrigerating circuit and cutting off said defrosting means; and it also consists in the parts and in the construction, combinations and arrangements of parts hereinafter described and claimed.

In the accompanying drawings, which form part of this specification and wherein like symbols refer to like parts wherever they occur,

Fig. 1 is a front elevational view of a refrigerated open-top, self-service display case embodying my invention,

Fig. 2 is an enlarged vertical cross-sectional view through said case on the line 2—2 in Fig. 1,

Fig. 3 is a vertical cross-sectional view through one of the plate coils on the line 3—3 in Fig. 2,

Fig. 4 is a diagrammatic view illustrating the refrigerating circuit for said case; and

Fig. 5 is a diagrammatic view illustrating the electric control circuit for the refrigerating circuit.

In the accompanying drawings, my invention is shown embodied in an open-top, self-service refrigerated display case comprising a top wall 1, a bottom wall 2, a relatively high rear wall 3, a relatively low front wall 4 and end walls 5. As shown in the drawings, the top wall 1 extends from the rear wall 3 of the case and terminates short of the front wall 4 thereof in a depending baffle or curtain wall 6 that extends below the level of the top edge of the front wall 4. The above described arrangement of walls provides a lower food storage and display chamber A with an access or reach-in opening A^1 in the top thereof between the front wall 4 and the baffle wall 6, and an upper chamber B communicating with the upper portion of said food chamber rearwardly of said access opening. As shown in the drawings, a sealed multi-pane glass panel 4*a* constitutes the upper portion of the low front wall 4 of the case; and sector-shaped glass panels 5*a* constitute the upper portions of the end walls 5 of said case between said front wall and the baffle wall 6. A suitable light, such as fluorescent tubing 7*a*, is mounted in a suitable wiring conduit, shade and reflector 7, which is secured to the front face of the baffle wall 6 flush with the upper surface of the top wall 1; and an inclined mirror 8 inclines downwardly and rearwardly from said conduit to said baffle wall.

The hereinbefore described display case is provided with a mechanical refrigerating apparatus of the compressor-condenser-expander type. As illustrated in the diagram shown in Fig. 4, the refrigerating circuit comprises a suitable con-

densing unit C, including the usual compressor 9 and electric driving motor 9*a*, condenser 10 and liquid receiver 11 therefor. The refrigerating circuit also includes a suitable heat exchanger 12, a suitable throttle or expansion valve 13, and evaporators or expanders in the form of a fin-type cooling coil 14 and a series of plate type cooling coils 15. The refrigerant flows from the compressor 9 to the receiver 11 through the condenser 10, thence from the receiver to the heat exchanger 12 through a conduit 16 having a solenoid valve 17 therein, thence from the heat exchanger to the expansion valve 13 through a conduit 18, thence from the expansion valve through the series of plate coils 15 and connecting conduits 19 therefor, thence from the plate coils to the fin coil 14 through a conduit 20 and thence from the fin coil and through the heat exchanger back to the compressor through a return conduit 21. As shown in Fig. 2, the fin coil 14 is located in the upper portion of the rear upper chamber B of the food case and extends longitudinally thereof substantially from end to end thereof, while the plate coils 15 are mounted on edge in the cold storage food display chamber A in spaced apart relation so as to form bins 22 therein that preferably extend from front to back thereof. As shown in Figs. 2 and 3, each of the plate coils 15 comprises a sealed casing 15*a* containing a flat cooling coil 15*b* and a suitable eutectic solution 15*c* which surrounds said coil and has a relatively low freezing point.

Mounted in the rear upper chamber B of the case immediately below the fin coil 14 therein are two drains or gutters 23 for receiving and carrying away moisture that drips from said coil. The gutters 23 extend longitudinally of the fin coil from end to end thereof and are inclined from one end to the other so as to discharge into a suitable drain pan 24 mounted in said chamber below the discharge end of said gutters. As shown in Fig. 2, a vertical baffle or partition wall 25 extends from end to end of the upper chamber B of the case beneath the fin coil 14 therein substantially midway between the rear wall 3 and the baffle wall 6 with its upper edge fixed to the under side of one of the gutters 23 and with its lower edge disposed in the lower display chamber A slightly below the level of the lower edge of said baffle wall. The partition or baffle wall 25 divides the portion of the upper chamber below the fin coil 14 therein into vertical front and rear flues 26 and 27, respectively. The rear upper chamber B is provided with means for rapidly defrosting the fin type cooling coil 14 therein, said means comprising an electric heater preferably in the form of electric resistance wires or cables 28 secured to the undersides of the gutters 23 for receiving the liquid condensate from said cooling coil.

As shown in Fig. 5, the refrigerating circuit is provided with an electric control circuit including a suitable thermostatic switch 29 having a feeler bulb 30 in thermal contact with the fin coil 14 in the chamber B, a suitable thermostatic switch 31 having a feeler bulb 32 in thermal contact with one of the plate coils 15 in the lower, food display chamber A, a suitable magnetic contactor 33, and the solenoid valve 17 and electric fin coil heaters or defrosters 28 hereinbefore referred to. The magnetic contactor 33 preferably comprises an armature 34, a solenoid coil 35 for operating said armature, a normally closed switch 36 and two normally open switches 37 and 38, respectively. One element of each of these

switches comprises a pair of stationary contact posts or terminals 39 and the other element comprises a contact plate 40 movable with the armature 34 into and out of engagement with said contact posts. The valve 17 in the conduit 16 is fixed to the armature 17*a* of a solenoid coil 17*b*; and said coil and the motor 9*a* are connected with a two-wire service or power line 41 by an electric circuit 41*a* controlled by the two normally open switches 37 and 38.

The control circuit for the defrosting heater 28, thermostatic switches 29 and 31 and the magnetic contactor 33 comprises a wire 42 leading from the service line terminal of the switch 37 to the corresponding terminal of the switch 38, a wire 43 leading from said last mentioned terminal to said heater, a wire 44 leading from said heater to the service line terminal of the switch 38, a wire 45 leading from said last mentioned terminal through the solenoid coil 35 to one terminal of each of said thermostatic switches, a wire 46 leading from the other terminal of the magnetic switch 39 to the service line terminal of the switch 37, and a wire 47 leading from the other terminal of said last mentioned switch to the other terminal of the thermostatic switch 31.

The thermostatic switch 29 is responsive to a predetermined maximum temperature of the top coil 14 to cut off the defrosting heater therefor and to cut in the compressor motor 9*a*, while the thermostatic switch 31 is responsive to a predetermined minimum temperature of the plate coils 15 to cut in said heater and cut off said motor. The two thermostatic switches 29 and 31 are preferably set to operate within a range of three degrees and to open with a rise in temperature and close with a decrease in temperature, the cut-in switch 29 being set to start the electric motor 9*a* at a fin coil defrosting temperature of say about thirty-seven to forty degrees Fahrenheit, while the cut-out switch 31 is set to cut off said motor at a plate coil temperature of say about minus ten to seven degrees Fahrenheit.

As indicated in Fig. 2 by the flow arrows, when the refrigerating circuit is operating to reduce the case temperature to the desired sub-zero level in the communicating lower and upper chambers A and B, respectively, there is a continuous circulation of refrigerated air downwardly from the upper fin coil cooling unit 14 through the flue 27 into the lower display chamber A and a return flow of said air from said display chamber to said upper fin coil cooling unit through the flue 26. The baffle or curtain wall 6 of the case extends below the level of the top edge of the front wall 4 of the case and thus permits the refrigerated air in the open top display chamber to rise above said lower edge and said curtain wall until this height, plus the atmospheric pressure exerted on the display space opening A^1 balances the weight of the refrigerated air in the sealed space back of the curtain wall and forms in said opening a layer 48 of stratified or dead insulating air which tends to prevent the escape of the refrigerated air therethrough.

When the refrigerating circuit is operating, the thermostatic switch 29 is open and the thermostatic switch 31 is closed, the magnetic contactor 33 is energized to close the motor and solenoid valve controlling switches 37 and 38 and to open the heater control switch 36. Thus, the gas passes from the condensing unit C through the open solenoid valve 17, heat exchanger 12, expansion or throttle valve 13 into the expansion

coils 15 and 14, respectively, where the condensed gas evaporates and absorbs heat and is then returned to said condensing unit through said heat exchanger, the defrosting heater being inoperative during this operative portion of the refrigerating cycle. When the case temperature reaches a predetermined low level, the thermostatic switch 31 is opened, thereby deenergizing the magnetic contactor 33 and thus opening the switches 37 and 38 and closing the switch 36. The opening of the switches 37 and 38 stops the motor 9*a* and the compressor 9 driven thereby and deenergizes the solenoid valve 17, thereby permitting said valve to close and stop the flow of the refrigerant through the refrigerating system. The closing of the switch 36 establishes a circuit through the defrosting heater 28 which then operates to defrost the upper, fin type coil 14 in the upper chamber B. When the display chamber temperature rises a few degrees above the desired predetermined low level, the thermostatic switch 31 again closes, but the thermostatic switch 29 still remains open, thereby preventing the contactor 33 from becoming energized until the fin coil 14 reaches a predetermined defrost temperature, whereupon the thermostatic switch 29 closes and energizes the contactor 33 to close the switches 37 and 38 and start the motor 9*a* and open the solenoid valve 17 and to open the switch 36 and cut off the defrosting heater 28. When the motor controlled switches 37 and 38 are closed a circuit is established through the solenoid coil 35 of the contactor 33 and through the thermostatic switch 29 which is already closed. After the system has operated for a few minutes, the upper fin type coil 14 is chilled a few degrees and the thermostatic switch 29 is opened. The system continues to operate, however, because the solenoid coil 35 of the magnetic contactor remains energized by the circuit established through the closed thermostatic switch 31. The refrigerating system continues to operate until the desired display chamber temperature is again reached, at which point the thermostatic switch 31 opens, the magnetic contactor 33 is deenergized, the motor 9*a* stops running, the solenoid valve 17 is closed and the current flows through the defrosting heater 28. The refrigerating system remains inoperative until the top fin type coil 14 reaches the defrost temperature and the thermostatic switch 29 again closes to again start the hereinbefore described cooling cycle.

The hereinbefore described arrangement provides a continuously open self-service refrigerated display case that will maintain a temperature in the food display chamber sufficiently low for the preservation of frozen foods. The heater is rendered operative to rapidly defrost the top fin type evaporating coil whenever the refrigerated circuit is inoperative. The top fin type coils and the lower plate type evaporating coils are included in a single refrigerating system with a common expansion valve and condensing unit; and the two thermostats are arranged so that one thermostat is responsive to the temperature of the upper cooling coil and determines the temperature at which the refrigerating circuit shall start its operation, while the other thermostat is responsive to the temperature of the lower cooling coil and determines the temperature at which the refrigerating circuit shall cease to operate. The top coil operates to set up a closed thermo-siphon system of air circulation in the display chamber A so that the colder region of

the display chamber is brought close to the access opening and makes it possible to display the merchandise in an accessible position. Due to the circulation of the refrigerated air between the lower food display chamber and the upper chamber, there is a tendency for moisture that enters the chambers through the access opening to deposit on the top coil, which is defrosted during each off cycle of the refrigerating circuit, thereby preventing any frosting or encrustation of the merchandise and retarding frost formation on the plate coils in the display chamber and thus greatly prolonging the time the case can be used without scraping or defrosting the plate coils. In dry weather, when the rate of moisture infiltration is reduced, there is a tendency for the frost on the plate coils to sublime and deposit on the top coil and drain off as liquid condensate when the top coil is defrosted. The plate coils are filled with an eutectic solution which freezes at low temperature, whereby the plates remain cold over a long period of time; and said plate coils may constitute the partition and/or main walls of the food display chamber.

Obviously, the hereinbefore described open, self-service low temperature refrigerated display case admits of considerable modification without departing from the invention. Therefore, I do not wish to be limited to the precise arrangements shown and described.

What I claim is:

1. A refrigerated display case having a lower display chamber and an upper chamber in continuous communication therewith, and a refrigerating circuit of the compressor-condenser-expander type including a motor for operating the compressor, an expansion coil in said lower chamber and an expansion coil in said upper chamber, a thermostat responsive to a predetermined temperature in said upper chamber for starting said motor, and a second thermostat responsive to a predetermined temperature in said lower chamber for stopping said motor.

2. A refrigerated display case having a lower food chamber with a continuously open access opening in the top thereof and an upper chamber in continuous communication with the upper portion of said lower chamber, and a compressor-condenser-expander type refrigerating circuit including a motor for operating the compressor, an expansion coil in said upper chamber and an expansion coil in said lower chamber, a thermostat responsive to a predetermined temperature of the expansion coil in said upper chamber for starting said motor, and a second thermostat responsive to a predetermined temperature of the expansion coil in the lower chamber for stopping said motor.

3. A refrigerated display case having a lower open-top display chamber and an upper chamber in continuous communication therewith, refrigerating devices in the respective chambers, a common operating means for said refrigerating devices, a thermostat responsive to a predetermined temperature in said upper chamber for rendering said operating means operative, and a second thermostat responsive to a predetermined temperature in said lower chamber for rendering said operating means inoperative.

4. A refrigerated display case having a lower open-top storage chamber and an upper chamber communicating with the upper portion thereof, and a refrigerating circuit of the compressor-condenser-expander type including a motor for operating the compressor, an expansion coil in

said lower chamber and an expansion coil in said upper chamber, a defrosting heater for the expansion coil in said upper chamber, means responsive to a predetermined temperature in said upper chamber for starting said motor and cutting off said heater, and means responsive to a predetermined temperature in said lower chamber for stopping said motor and starting said heater.

5. A refrigerated display case having a lower open-top storage chamber and an upper chamber in continuous communication therewith, and a refrigerating circuit including an expansion coil in said lower chamber, an expansion coil in said upper chamber, a condensing unit and a valve between the latter and said expansion coils, a thermostat responsive to a predetermined temperature in said upper chamber for starting said condensing unit and opening said valve, and a second thermostat responsive to a predetermined temperature in said lower chamber for stopping said condensing unit and closing said valve.

6. A refrigerated display case comprising a base, end walls, a low front wall, a high rear wall, a top wall projecting from said rear wall above the level of said front wall and terminating short of the latter and a curtain wall depending from the front edge of said top wall and extending below the level of the top edge of said low front wall, and a refrigerating circuit of the compressor-condenser-expander type including a motor for operating the compressor, an expansion coil in the upper portion of said case back of said curtain wall and entirely above the level of said top edge of said low front wall, an expansion coil in said case below the level of the lower edge of said curtain wall and below the level of said top front edge of said low front wall, a thermostat responsive to a predetermined temperature of the first mentioned coil for starting said motor, and a second thermostat responsive to a predetermined temperature of the second mentioned coil for stopping said motor.

7. A refrigerated display case comprising a base, end walls, a low front wall, a high rear wall, a top wall projecting from said rear wall above the level of said front wall and terminating short of the latter and a curtain wall depending from the front edge of said top wall and extending below the level of the top edge of said low front wall, and a refrigerating circuit of the compressor-condenser-expander type including a motor for operating the compressor, an expansion coil in the upper portion of said case back of said curtain wall and a plurality of plate-type expansion coils in said case forming upright partitions therein below the level of the lower edge of said curtain wall, means responsive to the temperature of the first mentioned coil for starting said motor, and means responsive to a predetermined temperature of the second mentioned coil for stopping said motor.

8. A refrigerated display case comprising a base, end walls, a low front wall, a high rear wall, a top wall projecting from said rear wall above the level of said front wall and terminating short of the latter and a curtain wall depending from the front edge of said top wall and extending below the level of the top edge of said low front wall, and a refrigerating circuit of the compressor-condenser-expander type including a motor for operating the compressor, an expansion coil in the upper portion of said case back of said curtain wall and an expansion coil in said case below the level of the lower edge of said curtain wall, a heater in said case adjacent to said first mentioned expansion coil for defrosting the same, means responsive to a predetermined temperature of the first mentioned coil for starting said motor and cutting off said heater, means responsive to a predetermined temperature of the second mentioned coil for stopping said motor and starting said heater.

9. A refrigerated display case having a lower open-top storage chamber and an upper chamber communicating therewith, a refrigerating circuit of the compressor-condenser-expander type including an electric motor for operating the compressor, an expansion coil in said lower chamber, an expansion coil wholly in said upper chamber and a magnetic valve between said compressor and said expansion coils, and an electric control circuit for said motor and valve including a thermostatic switch responsive to a predetermined temperature in said upper chamber for starting said motor and opening said valve and a second thermostatic switch responsive to a predetermined temperature in said lower chamber for stopping said motor and closing said valve.

10. A refrigerated display case having a lower open-top storage chamber and an upper chamber communicating therewith, a refrigerating circuit of the compressor-condenser-expander type including an electric motor for operating the compressor, an expansion coil in said lower chamber, an expansion coil in said upper chamber and a solenoid valve between said compressor and said expansion coils, an electric heater for defrosting the expansion coil in said upper chamber, and an electric control circuit for said motor, valve and heater including a thermostatic switch responsive to a predetermined temperature in said upper chamber for starting said motor, opening said valve and cutting off said heater and a thermostatic switch responsive to a predetermined temperature in said lower chamber for stopping said motor, closing said valve and turning on said heater.

11. An open-top, self-service refrigerated display case having a display chamber with a continuously open access opening in the top thereof and an upper chamber communicating with said display chamber at a level spaced below the top thereof, a refrigerating device in said lower chamber below the level of the point of communication of said upper chamber therewith, and a refrigerating device located in said upper chamber above such level, whereby circulation of refrigerated air is established between said chambers and a buffer layer of stratified air is created in said display chamber across the access opening between the air circulating in said display chamber and the air external thereto and water vapor entering said display chamber through said buffer layer of stratified air is carried by said circulating air from said display chamber to said upper chamber and deposits on the refrigerating device therein in the form of frost and thereby minimizes frost formation on the mechandise or refrigerating device in said display chamber.

12. The combination set forth in claim 11 wherein a heater is mounted in said upper chamber for defrosting the refrigerating device therein.

13. A refrigerated display case comprising a base, end walls, a low front wall, a high rear wall, a top wall projecting from said rear wall above the level of said front wall and terminating short of the latter and a curtain wall depending

from the front edge of said top wall and extending below the level of the top edge of said low front wall, and a refrigerating circuit including a fin-type expansion coil in the upper portion of said case back of said curtain wall and a plurality of plate-type expansion coils in said case forming upright partitions therein below the level of the lower edge of said curtain wall, whereby a buffer layer of stratified air is created in said case between the air circulating therein and the atmosphere external thereto and water vapor entering said case through said buffer layer of stratified air is picked up by said circulating air and deposits on said fin-type coil in the form of frost, thereby overcoming the tendency for frost to deposit on said plate-type cooling coil.

14. The combination set forth in claim 13 wherein a heater is located in said case adjacent to said fin-type coil for defrosting the same.

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