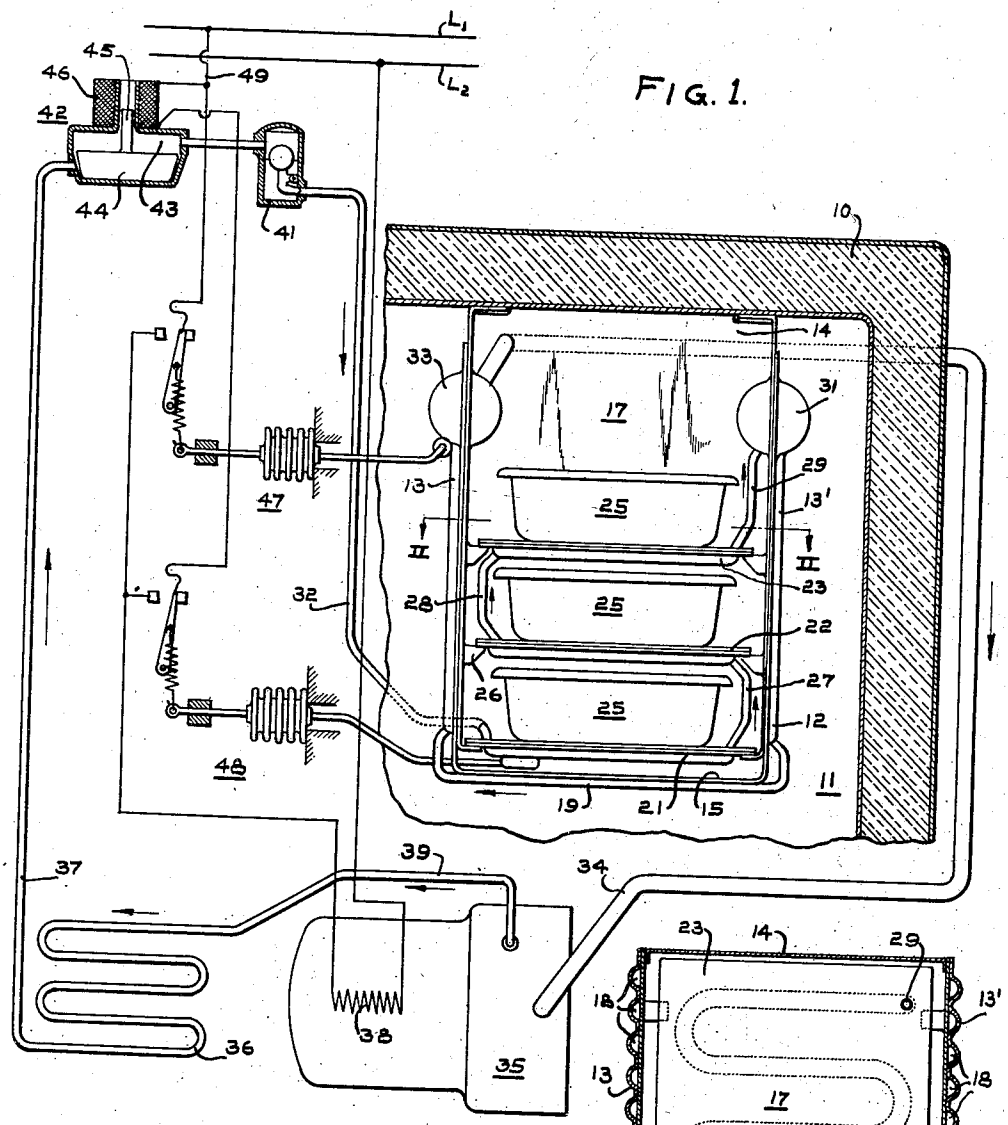
Oct. 25, 1938. L. B. M. BUCHANAN 2,133,953

REFRIGERATING APPARATUS

Filed May 21, 1936

FIG. 1.



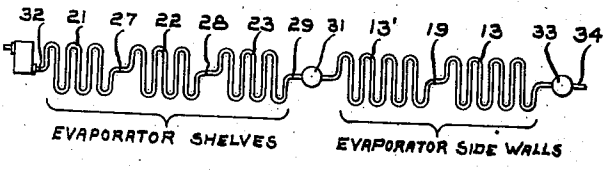


FIG. 3.

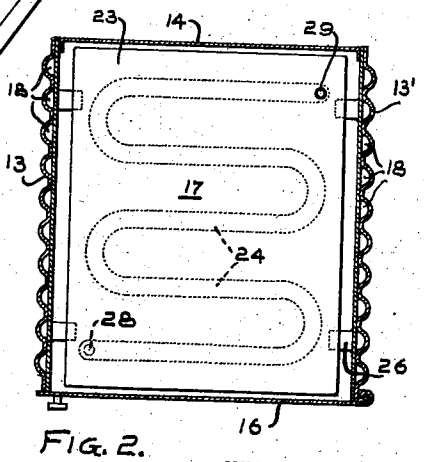


FIG. 2.

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UNITED STATES PATENT OFFICE

2,133,953

REFRIGERATING APPARATUS

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Application May 21, 1936, Serial No. 81,088

10 Claims. (Cl. 62—4)

My invention relates to refrigerating apparatus having a plurality of refrigerating elements and has for an object to provide improved apparatus of this kind.

A further object of my invention is to maintain the food storage compartment of a refrigerator at a desirable refrigerating temperature without excessive dehydration of the air or products stored therein and to effect congealing of fluids within the compartment.

A further object of the invention is to provide an improved evaporator structure wherein a portion of the same is operated to cool the ambient air and a second portion is effective to congeal fluids without materially affecting the temperature of said ambient air.

These and other objects are effected by my invention as will be apparent from the following specification and drawing.

In practicing my invention, I provide an evaporator structure disposed within the compartment of a refrigerator and including a plurality of wall members which define a high temperature refrigerating element for cooling the air in the compartment. A relatively low temperature refrigerating element is disposed within said wall members and includes provisions for congealing desserts or freezing water.

Refrigerant is conducted serially through the low and high temperature elements in the order named and means are provided for varying the effective charge of refrigerant conducted thereto. The latter means may constitute a chamber for condensed refrigerant and a displacing member for the refrigerant. The member normally occupies the chamber and displaces the refrigerant therein, so that the total charge of refrigerant is rendered available for circulation. In this position, refrigerant substantially fills both the low and high temperature elements, and, as the latter operates at a relatively high temperature, vaporization is effected therein for cooling the air in the food storage compartment.

In the other position of the displacing member, a portion of the refrigerant fills the chamber so that the effective charge of refrigerant in the system or the charge available for circulation is reduced in an amount equivalent to the amount of refrigerant collected in the chamber. Accordingly, the amount of refrigerant in the evaporator structure is reduced so that it occupies the low temperature element only and vaporization is effected therein at a relatively low temperature. The vaporized gas from the low temperature element passes through the walls of the high temperature element, so that some slight cooling thereof would be effected, the amount of heat abstracted from the walls being only the sensible heat added to the gas as superheat.

Suitable means are provided for automatically varying the effective charge of refrigerant during operation of the system dependent upon which evaporator requires refrigeration.

Cooling of the air in the food compartment to a low degree is prevented during operation of the low temperature element so that the air therein is not dehydrated to an undesirable degree. During operation of the higher temperature element, the air in the compartment is cooled to the desired degree without reducing its moisture content excessively as the element is operated at a temperature low enough to effect cooling but high enough to prevent a material reduction in the dew point temperature of the air.

In the drawing:

Fig. 1 is a diagrammatic view of a refrigerating system embodying my invention;

Fig. 2 is a sectional view of the evaporator shown in Fig. 1 and is taken along the line II—II thereof; and,

Fig. 3 illustrates diagrammatically the connections between the high and low temperature evaporating elements.

Referring to the drawing, I have diagrammatically shown a refrigerator cabinet structure 10 having a storage compartment 11 formed therein for articles to be refrigerated. An evaporator structure 12 is arranged within the compartment 11 and includes a plurality of side wall members 13 and 13', a rear wall 14, a bottom wall 15 and a door member 16. The various walls of the evaporator structure 12 define a chamber 17 therebetween which is preferably disposed at the top of the compartment 11 and which is rendered accessible by opening the door 16. A portion of the walls of the structure 12 such as, for example, the side walls 13 and 13', are provided with passages 18 in which condensed refrigerant is vaporized. Cooling of the air in the compartment 11 is effected by the walls 13 and 13' which are in heat exchanging relation therewith. The walls 13 and 13' may be connected together by a conduit 19 providing communication between the bottoms of the passages 18.

Arranged within the chamber 17 is a relatively low temperature refrigerating element shown by way of example, as a plurality of shelves 21, 22, and 23, each of which may be formed with a passage 24 for refrigerant. Trays 25 may be supported upon the shelves for congealing fluids

contained therein. The shelves 21, 22, and 23 may be supported within the chamber 17 in any suitable manner as, by means of projections 26 extending inwardly from the walls 13 and 13'. In order to minimize heat leakage between the walls 13 and 13' and the shelves, the supporting projections 26 are made as small as possible, consistent with the required strength.

As the shelves 21, 22, and 23 are shielded from the air within the compartment 11, by the various walls of the structure 12, they are effective when refrigerated for cooling the fluid in the trays 25 and do not materially reduce the temperature of the air in the compartment 11. The shelves 21, 22, and 23 are, preferably, connected in series for the flow of refrigerant therethrough by means of conduits 27 and 28. A conduit 29 provides communication between the shelf 23 and a header 31 carried by the wall 13'. Condensed refrigerant is delivered to the lower shelf 21 by means of a conduit 32 and vaporized refrigerant is drawn from a header 33 provided on the wall 13 by means of a conduit 34. The shelves 21, 22, and 23 and the walls 13' and 13 are connected for series flow of refrigerant therethrough in the order named, as shown in Fig. 3.

A suitable refrigerant condensing mechanism, such as, for example, a motor-driven compressor unit 35 and a condenser 36, is employed for withdrawing vaporized refrigerant through the conduit 34 and for delivering condensed refrigerant to a conduit 37. The motor compressor unit 35 may be of any suitable type, but I have preferred to show one of the hermetically sealed type; the motor winding of which is shown at 38. Refrigerant compressed by the compressor unit 35 is delivered at relatively high pressure to the condenser 36 through a conduit 39. As the operation of a refrigerating system of the compressor-condenser-expander cycle is well known, it is not deemed necessary to recite in detail this operation.

A suitable float valve 41 for regulating the flow of condensed refrigerant to the evaporator structure 12 is connected to the conduit 32 and, a device 42 that operates to vary, in effect, the refrigerant charge is disposed between the liquid conduit 27 and the float valve 41. The device 42 includes a casing having a chamber 43 for condensed refrigerant formed therein and a movable displacing element 44 for varying the liquid storing capacity of the chamber 43. The element 44 may be raised and lowered by a solenoid having a core 45 and a winding 46; said element 44 being raised to permit condensed refrigerant to collect in the chamber 43 when the solenoid winding 46 is energized and being lowered when the winding 46 is deenergized for displacing the refrigerant in the chamber 43.

When the element 44 is in its first, or lower position, it occupies the chamber 43 and prevents the collection of condensed refrigerant therein, and, therefore, substantially all of the refrigerant in the system is circulated by the compressor mechanism 35. Raising the element 44 to a second position reduces the effective charge of refrigerant in the system, as condensed refrigerant gathers in the chamber 43 and does not circulate through the evaporator. The effective charge of refrigerant is, therefore, reduced in an amount equivalent to the amount of liquid which was displaced by element 44 when in the first or lower position.

The purpose of varying the effective charge of refrigerant is to change the operation of the system, so that, in the first position of the device 42, cooling of the air in the chamber 11 to a desirable temperature is effected and, in the second position of the device, quick freezing of liquids at a low temperature is obtained without materially reducing the temperature of the air in the chamber 11.

The charge of refrigerant in the system is such that when the displacing member 44 is in its lower position condensed refrigerant fills the passages 24 of the shelves 21, 22 and 23 and a substantial portion of the passages 18 of the walls 13 and 13'. Since the shelves 21, 22 and 23 are operated at a low temperature and are shielded from the relatively warm temperature of the air in the compartment 11, vaporization is effected, mainly, in the passages 18 of the walls 13 and 13' which abstract heat from the air in the compartment 11. The mean temperature at which the walls 13 and 13' operate is determined by the setting of a thermostat 47 and is of such value that the air in the compartment is cooled to the required degree but not low enough to effect excessive dehumidification thereof.

When the displacing member 44 is raised, the amount of refrigerant collected in the chamber 43 reduces the charge available for circulation so that condensed refrigerant is present in the passages 24 of the shelves only. At this time the motor compressor unit 35 is controlled by a thermostat 48 which reflects the temperature of the shelves and which is set to maintain a relatively low or freezing temperature. Vaporization is effected in the shelf passages 24 until the desired temperature is attained at which time the thermostat 48 operates to stop the compressor. The vaporized gas passing from the passages 24 through the conduit 29 passes serially through the wall 13', the conduit 19 and the wall 13 to the suction conduit 34. The gas is superheated somewhat during its passage through the walls 13 and 13' and therefore effects slight cooling thereof, but the quantity of heat abstracted is relatively small.

The electrical connections are shown in Fig. 1 and include line conductors L_1 and L_2 representing the source of electrical energy. The thermostat 47 is connected to the conductor L_1 and to the motor winding 38, the opposite terminal of the winding 38 being connected to the conductor L_2. A conductor 49 leads from the conductor L_1 to the low temperature thermostat 48 and includes the solenoid winding 46. The thermostat 48 also connects to the motor winding 38 as shown. It will be apparent from the foregoing that the high temperature refrigerating element or the walls 13 and 13' are given preference by this control system as the solenoid winding is shunted by the thermostat 47 when both thermostats 47 and 48 are closed and calling for cooling. Accordingly, the solenoid winding 46 is deenergized and the displacing element is in its lower position wherein all of the charge of refrigerant is circulated. It will be understood that the control forms no part of my invention and any other suitable method of controlling the system may be used. I have shown a different method of controlling my improved apparatus in a copending application Serial No. 66,808 filed March 3, 1936, and assigned to Westinghouse Electric & Manufacturing Company.

Operation

In the position of the apparatus shown in the Fig. 1, the motor compressor 35 is inactive due

to the fact that both thermostats 47 and 48 are open. Assume now that the temperature of the low temperature element or shelves 21, 22 and 23 rises above a predetermined value. The thermostat 48 closes and energizes the circuit including the conductor 49, the winding 46 of the device 42 and the motor winding 38. The compressor unit 35 now operates to circulate refrigerant as is well understood and the displacing element 44 is raised so that the charge of refrigerant available for circulation is reduced. Accordingly, the shelf passages 24 only receive condensed refrigerant as an insufficient amount is passed thereto to cause refrigerant to pass through the conduit 29 and spill into the wall 13'. It will be understood that any condensed refrigerant present in the walls 13' and 13 at the time that the compressor starts will be vaporized but this is soon exhausted after which vaporization continues only in the passages 24 of the shelves.

Operation continues until the temperature is reduced to a relatively low degree at which time the thermostat 48 is opened, and the solenoid winding 46 and the motor winding 38 are deenergized. Accordingly, the motor compressor 35 stops and the displacing device 44 drops. The refrigerant contained in the chamber 43 is displaced and drains back to the condenser 36 through conduit 37 although a small portion may pass to the float valve 41. Preferably, the conduit 37 connects to the chamber 43 at a level lower than the connection to the float 41 so that the major portion of the displaced refrigerant drains through conduit 37.

Assume that the wall temperature now rises to the value at which the thermostat 47 is set. The latter operates to close its contacts and energizes the motor winding 38, without energizing the solenoid winding 46. Refrigerant is circulated by the motor-compressor 35 and, as the full charge is available for circulation, the passages 24 and 18 are occupied by condensed refrigerant. Refrigerant contained within the passage 18 is vaporized by the heat of the walls 13 and 13', which heat is abstracted from the air within the compartment 11. As the shelves 21, 22 and 23 are at a relatively low temperature and are shielded from the air in the compartment 11, substantially no vaporization is effected therein. Refrigeration continues as long as the compressor unit 35 operates and, when the temperature of the air in the compartment 11 or the temperature of the walls 13 and 13' is depressed to the desired value, the thermostat 47 opens and terminates operation.

It will be understood that, during this operation, the refrigerant in the walls 13 and 13' and in the shelves 21, 22 and 23 will attain the same temperature as it is subjected to substantially the same pressure throughout. The temperature at which the thermostat 47 operates to terminate operation of the compressor 35 is lower than the temperature at which the thermostat 48 operates to initiate operation of the same. This is desirable in order that the compressor 35 is not maintained in operation by the thermostat 48 each time the thermostat 47 operates to terminate operation of the same, which condition would exist if the circuit closing temperature of the thermostat 48 were below the circuit opening temperature of the thermostat 47. Therefore, the mean or average temperature at which the walls 13 and 13' are operated is higher than the mean or average temperature of the shelves.

With the thermostat 48 set to close at a higher temperature than the opening temperature of the thermostat 47, evaporation is effected in the shelves when the walls are refrigerated, although in a small amount. It might appear from the foregoing that, where the difference between the closing temperature of the low temperature thermostat 48 and the opening temperature of higher temperature thermostat 47 is small, operation of the compressor 35 would be initiated by the low temperature thermostat 48 shortly after termination of its operation by the high temperature thermostat 47. This is not the case as the low temperature shelves are shielded from the air in the compartment 11 and are subjected to the cooling effect of the stored ice in the trays 25 so that a relatively long period of time will usually elapse before the shelves are increased in temperature to the value at which the thermostat 48 closes.

If the low temperature thermostat 48 is closed for refrigerating the low temperature shelves 21, 22 and 23 and the thermostat 47 closes, it will be seen that the solenoid coil 46 will be shunted thereby and will be deenergized. Accordingly, the member 44 drops and the supply of inactive refrigerant in the chamber 43 is displaced and passed to the evaporator structure. The increase in the supply results in condensed refrigerant passing upwardly in the conduit 29 and spilling over into the walls 13', the conduit 19 and the wall 13, so that refrigeration of the walls 13 and 13' is effected. If the thermostat 47 then opens and the thermostat 48 remains closed, operation of the compressor unit 35 continues and the coil 46 of the solenoid is again energized for raising the member 44. Refrigerant then collects in the chamber 43 and reduces the charge, in effect, so that refrigeration is effected only in the shelf passages 24.

With this system of control, it will be seen that the high temperature evaporating elements are given preference over the low temperature elements, but other suitable arrangements of the control apparatus may be employed.

In my copending application, Serial No. 15,003, filed April 6, 1935 and assigned to Westinghouse Electric & Manufacturing Company, I disclose and broadly claim a refrigerating system having high and low temperature evaporating elements and employing a device for varying the effective charge of refrigerant delivered thereto whereby refrigeration is selectively obtained in either element. From the foregoing, it will be apparent that I have provided an improved system of this kind wherein the high and low temperature elements are disposed in a single compartment and in which the low temperature element is so shielded from the air in the compartment that it effects substantially no reduction in temperature of the air when operating.

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

What I claim is:

1. In refrigerating apparatus, the combination of a cabinet structure having a compartment formed therein, an evaporator structure arranged within the compartment and including a relatively high temperature refrigerating element

exposed to the air within the compartment and having a passage for refrigerant formed therein, said structure including a relatively low temperature refrigerating element disposed within said high temperature element for receiving substances to be congealed and having a second passage for refrigerant formed therein, means for conveying condensed refrigerant to the evaporator structure, and means for selectively adjusting the flow of refrigerant conveyed by the last-named means to said passages wherein it is vaporized to primarily effect refrigeration of either the high or low temperature refrigerating elements.

2. In refrigerating apparatus, the combination of a cabinet structure having a compartment formed therein, an evaporator structure arranged within the compartment and including a plurality of wall members exposed to the air within the compartment, said wall members having a passage therein for refrigerant, said evaporator structure including a shelf disposed within the wall members and having a passage therein for refrigerant, means for conveying condensed refrigerant to the evaporator structure and means for selectively controlling the flow of condensed refrigerant to said passages wherein it is vaporized to primarily effect refrigeration either of the wall members or of the shelf.

3. In refrigerating apparatus, the combination of a cabinet structure having a compartment formed therein, an evaporator structure disposed within said compartment and including wall members for cooling the air in the compartment and constituting a high temperature refrigerating element, said evaporator structure including a shelf disposed within the wall members and constituting a low temperature refrigerating element, means for condensing refrigerant vapor and for translating it to said refrigerating elements, and means for controlling the flow of refrigerant translated by the last-named means so that it is effective for refrigerating primarily, either the low or high temperature evaporating elements.

4. In a refrigerating system, the combination of a cabinet having a compartment formed therein, an evaporator structure disposed within the compartment and including a plurality of wall members defining a chamber therebetween, at least a portion of said wall members including a passage for refrigerant, a shelf arranged within the chamber and having a passage therein for refrigerant, means for circulating refrigerant in series through the passages of the shelf and wall member in the order named and means for selectively varying the flow of refrigerant translated by the last-named means to said passages wherein it is vaporized to primarily effect refrigeration either of the wall members or of the shelf.

5. In refrigerating apparatus, the combination of a cabinet structure having a compartment formed therein, an evaporator structure arranged within said compartment and including a plurality of wall members defining a high temperature evaporating element, said structure including a shelf member disposed within the wall members and defining a low temperature evaporating element, a refrigerating machine for condensing refrigerant vaporized in said evaporating elements and for translating it in series through said low and high temperature evaporating elements, and a device for varying the effective charge of refrigerant translated by the refrigerating machine and movable to a first position wherein condensed refrigerant occupies the low and high temperature evaporating elements, said device being adjustable to a second position in which condensed refrigerant occupies the low temperature evaporating element only.

6. In refrigeration apparatus, the combination of a cabinet structure having a cooling compartment therein, a relatively high temperature evaporating element arranged in heat exchanging relation with the air in the compartment and including wall members for defining a chamber therebetween, a relatively low temperature evaporating element arranged within said chamber for chilling substances to be congealed, a refrigerating machine for conveying condensed refrigerant to said low temperature element, means connecting said low and high temperature elements and providing for series flow of refrigerant therebetween, and a device for varying the effective charge of refrigerant in the refrigerating machine and operative, in a first position, to deliver condensed refrigerant to the high and low temperature evaporating elements, said device being adjustable to a second position in which condensed refrigerant is delivered to said low temperature evaporating element only.

7. In refrigeration apparatus, the combination of a cabinet structure having a cooling compartment therein, a relatively high temperature evaporating element arranged in heat exchanging relation with the air in the compartment and including wall members for defining a chamber therebetween, a relatively low temperature evaporating element arranged within said chamber for chilling substances to be congealed, a refrigerating machine for conveying condensed refrigerant to said low temperature element, means connecting said low and high temperature elements and providing for series flow of refrigerant therebetween, and a device for varying the effective charge of refrigerant in the refrigerating machine and operative, in a first position, to deliver condensed refrigerant to the high and low temperature evaporating elements, said device being adjustable to a second position in which condensed refrigerant is delivered to said low temperature evaporating element only, means for initiating operation of the refrigerating machine and for effecting movement of the device to its second position, said last-mentioned means effecting movement of the device to its first position, when terminating operation of the refrigerating machine and means for initiating and terminating operation of the refrigerating machine without effecting movement of said device.

8. In refrigerating apparatus, the combination of a cabinet structure having a compartment therein, a relatively high temperature refrigerating element disposed in said compartment for cooling the air therein, a relatively low temperature refrigerating element disposed within said higher temperature element, means for condensing the refrigerant vaporized in said refrigerating elements, means for conveying refrigerant from the condensing means to said elements in such manner that liquid refrigerant flows into the low temperature element in preference to the higher temperature element, and means for selectively varying the amount of refrigerant in said elements so that liquid refrigerant at one time fills a substantial portion of the higher temperature element for effecting refrigeration thereof at relatively high temperature and pres-

sure, and at another time, the high temperature element receives substantially no liquid refrigerant so that vaporization at relatively low temperature and pressure is effected in the low temperature element and means for selectively producing the effect of increasing the refrigerant charge to the extent of causing liquid refrigerant to fill a substantial portion of the higher temperature element, for effecting refrigeration at relatively high pressure and temperature in the higher temperature element or producing the effect of decreasing the refrigerant charge to the extent that the higher temperature element receives substantially no liquid refrigerant, for effecting refrigeration at low pressure and temperature in the low temperature element.

9. In refrigerating apparatus, the combination of a zone to be refrigerated, a relatively high temperature evaporating element disposed for cooling the air in said zone and forming a cooling chamber within the zone, a relatively low temperature element for cooling media in the chamber to a relatively low temperature, said low temperature element being shielded by the high temperature element from the air within said zone, and means for supplying condensed refrigerant to said elements and adjustable to a first position wherein condensed refrigerant substantially fills the low temperature element and a portion of the high temperature element, said means being adjustable to a second position wherein condensed refrigerant is delivered to the low temperature element only.

10. In refrigerating apparatus, the combination of means defining a zone to be refrigerated at a relatively high temperature, an evaporating element disposed for cooling the air in said zone and defining a chamber therein, a second evaporator element disposed within said chamber and shielded by the first evaporating element from the air in the zone for refrigerating media in the chamber to a relatively low temperature and means for translating refrigerant in series first through the second element and thence through the first element.

LESLIE B. M. BUCHANAN.

CERTIFICATE OF CORRECTION.

Patent No. 2,133,953. October 25, 1938.

LESLIE B. M. BUCHANAN.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 5, first column, line 5, claim 8, beginning with the words "and means for" strike out all to and including the word "element", in line 16, same claim; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 6th day of December, A. D. 1938.

Henry Van Arsdale

(Seal) Acting Commissioner of Patents.