Jan. 23, 1951 H. E. ROSEBROOK 2,539,105

TWO-TEMPERATURE REFRIGERATOR

Filed Jan. 15, 1943 6 Sheets-Sheet 1

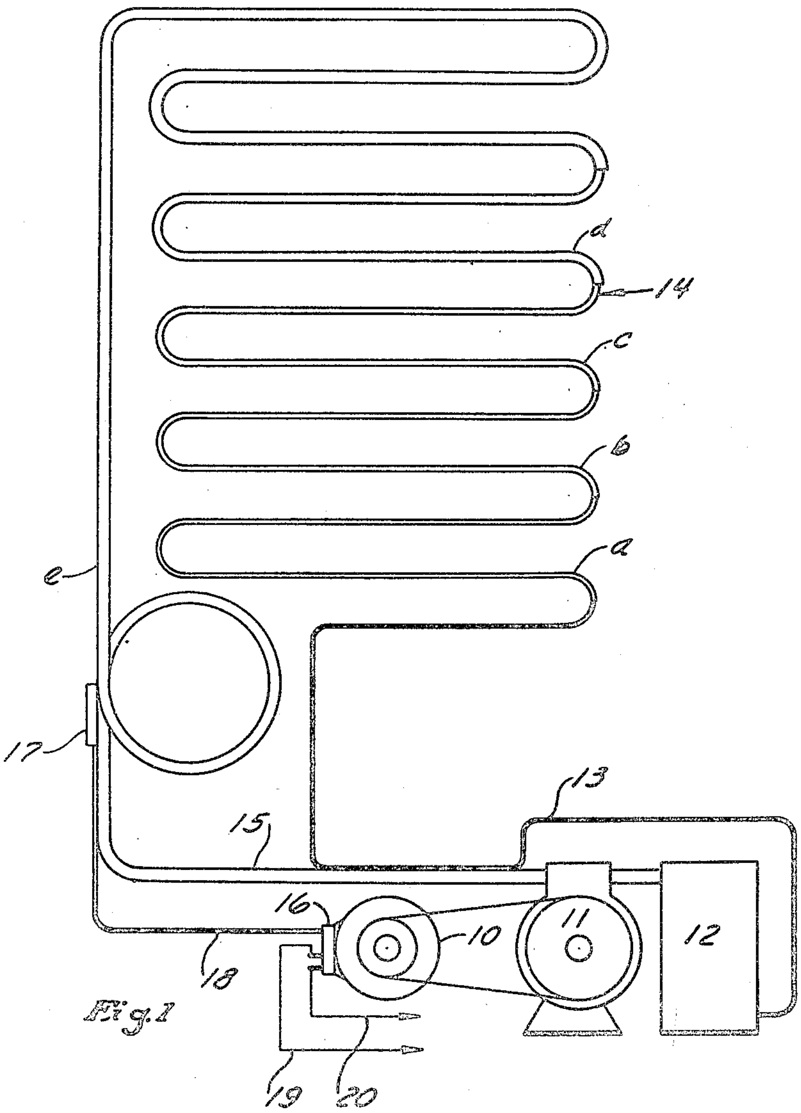

Fig. 1

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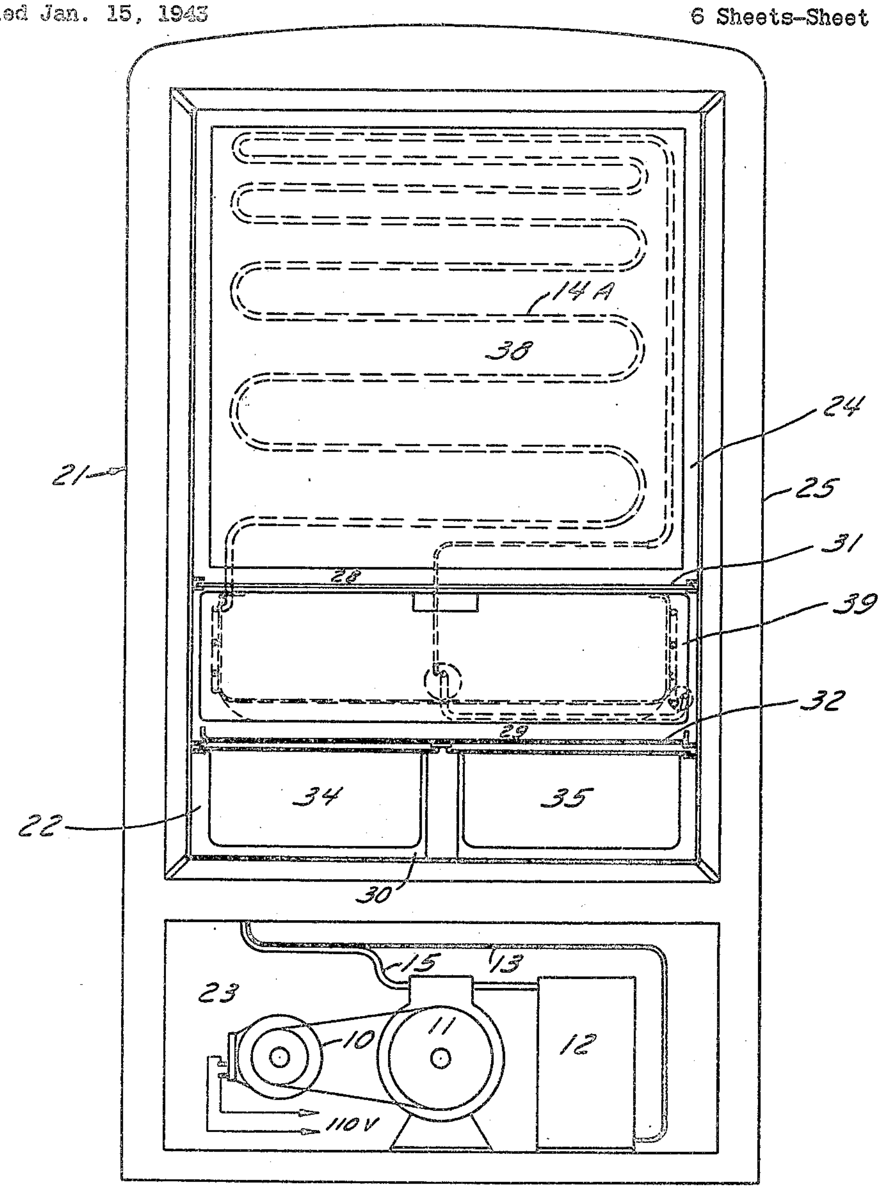

Fig. 2

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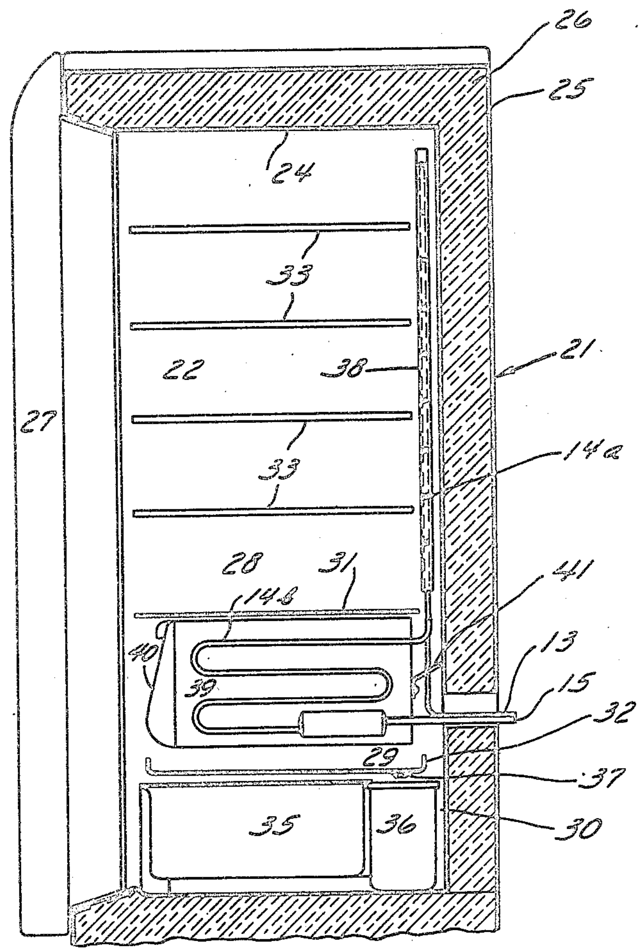

Fig. 3

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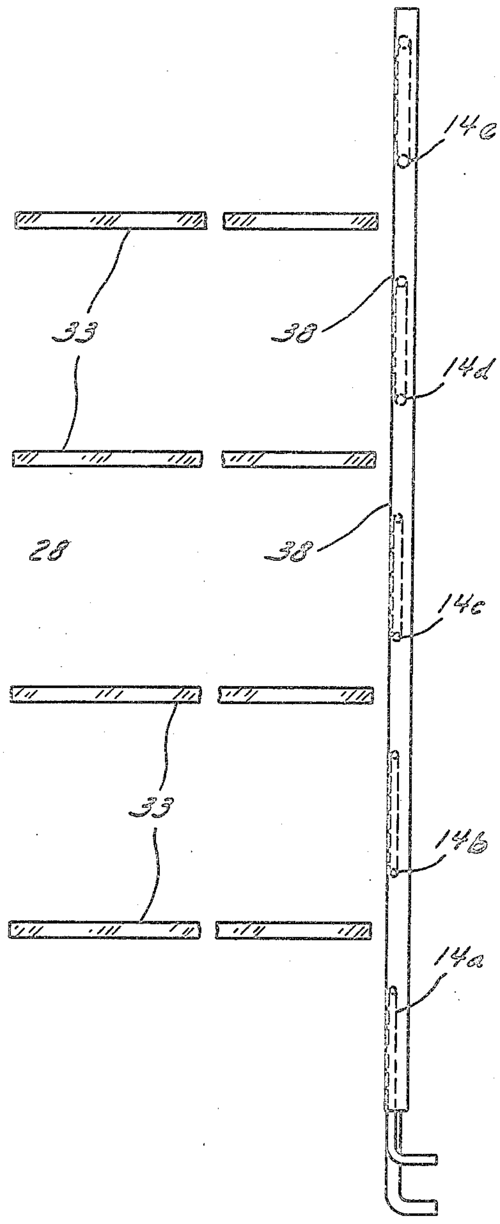

Fig. 5

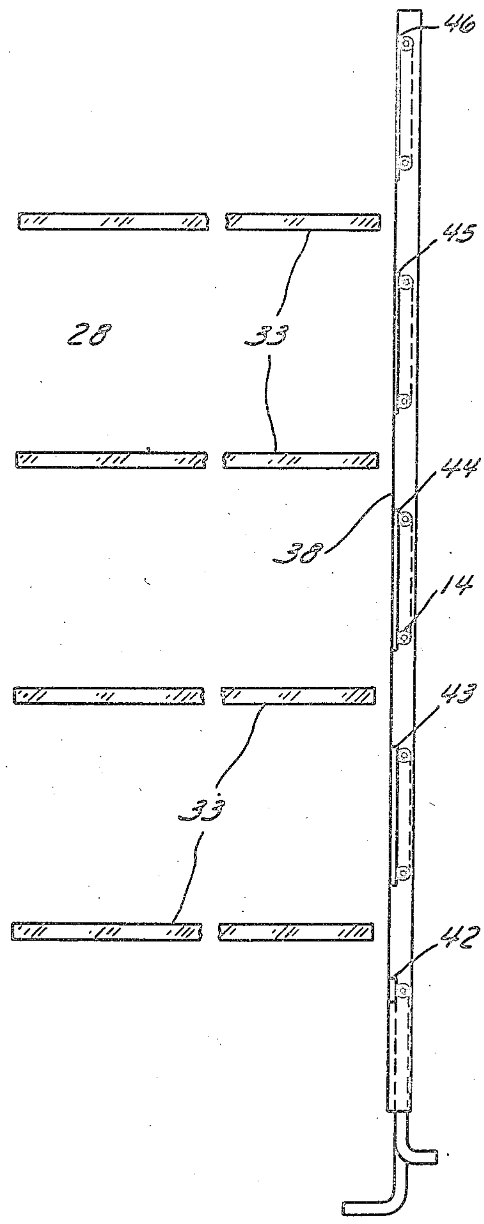

Fig. 4

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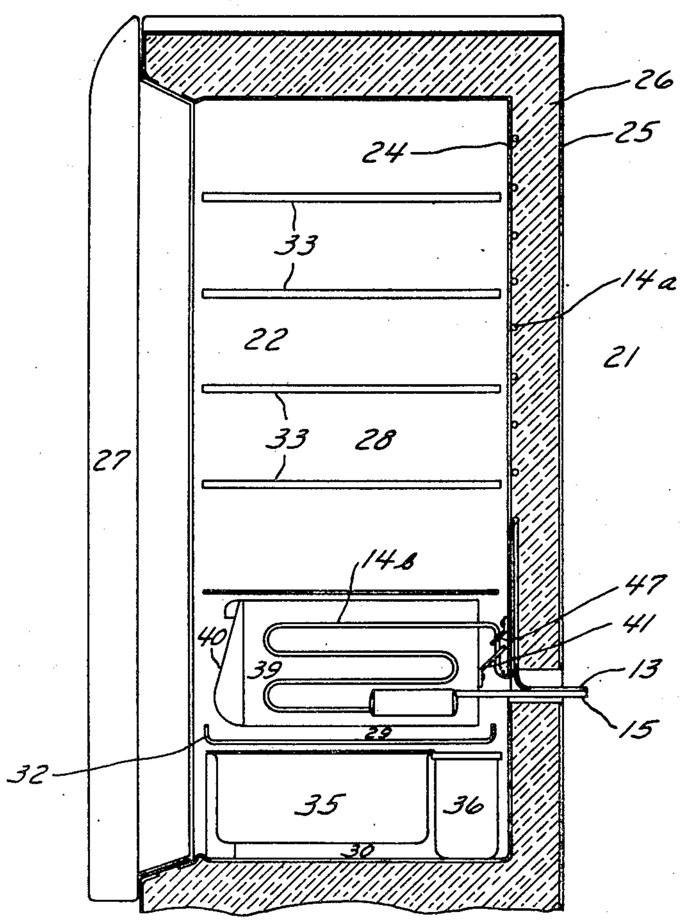

Fig. 6

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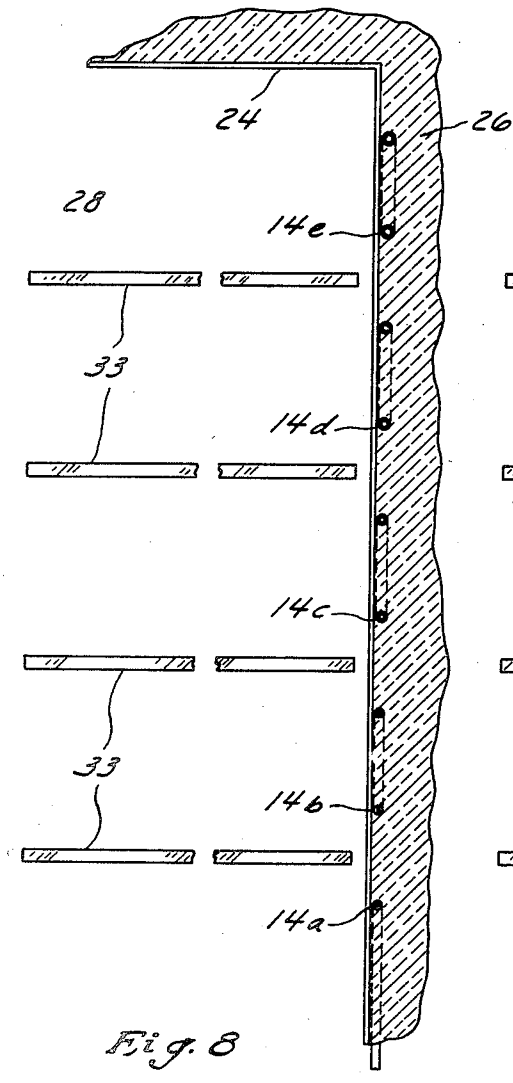

Fig. 8

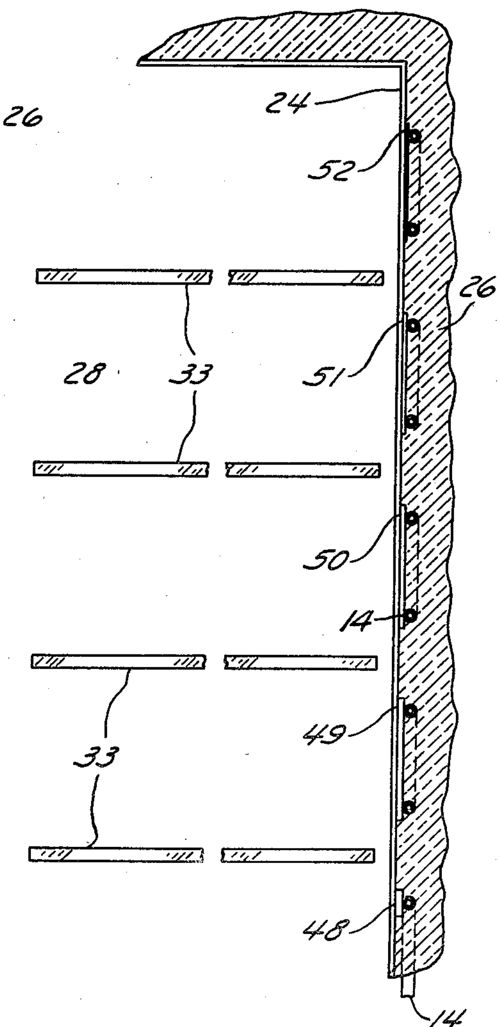

Fig. 7

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UNITED STATES PATENT OFFICE

2,539,105

TWO-TEMPERATURE REFRIGERATOR

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Application January 15, 1943, Serial No. 472,473

6 Claims. (Cl. 62—116)

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This invention relates to a novel method of and apparatus for producing multiple humidity and multiple temperature refrigerating effects.

It is the principal object of this invention to produce different temperature and humidity conditions in designated zones within a refrigerator cabinet, for example, without the use of the usual valves or restrictors heretofore employed in the refrigerating system and without resorting to the use of the usual insulated walls between the designated zones.

It is also an object of this invention to arrange the zones of different temperature and humidity in a more suitable location for convenient access by the user than has been done heretofore.

These broad objectives are accomplished by a novel construction of the refrigerant evaporator; by a novel arrangement of the interior of the cabinet; and by a novel disposition of the evaporator in relation to the different zones of the cabinet.

In the preferred embodiment of the invention a conventional refrigerator cabinet is divided into two or more zones or spaces by means—such as glass shelves—which restrict the transfer of heat and moisture therebetween, whereby different temperature and humidity conditions can be maintained in the respective zones. An evaporator is provided which has one section associated in heat exchange relation with one zone and another section in heat exchange relation with another zone—both sections being connected together in series relation.

According to one form of the invention the evaporator sections are so constructed as to provide for a substantially greater pressure drop between the inlet and outlet of one section than between the inlet and outlet of the other section, whereby to produce different refrigerating effects in the two sections. In this form of the invention the two sections of the evaporator are preferably connected together without obstruction or restriction therebetween.

According to another form of the invention, provision is made for an efficient transfer of heat between one section of the evaporator and the zone with which it is associated while an inefficient transfer of heat is provided between the other evaporator section and the zone with which it is associated—whereby to produce different refrigerating effects upon the two zones. In this form of the invention, there may or may not be an obstruction or restrictor between the two sections of the evaporator.

According to still another form of the invention, both the variations in pressure and efficiency of heat transfer are employed.

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Where the present invention is utilized to provide a freezing temperature for a freezing zone and a cooling temperature for a cooling zone, the evaporator section associated with the cooling zone may be disposed within the refrigerator or on the outside of the liner which defines the interior of the refrigerator. Where the cooling zone is of substantial vertical extent the evaporator section associated therewith is preferably so arranged upon the liner or upon a plate as to distribute the refrigerating effect thereof to produce a substantially uniform temperature throughout the height of the cooling zone.

Where, in addition to a freezing zone and a cooling zone, the cabinet is provided with a chilling zone, the latter is preferably located below the freezing zone which is in turn disposed below the cooling zone. By this arrangement of the zones, the same evaporator section which refrigerates the freezing zone may also serve to refrigerate the chilling zone. Further, this arrangement places the cooling zone—to which access is most frequently desired—at the level most convenient for the user.

The foregoing and other objects will be made apparent in greater detail in the following description when read in connection with the accompanying drawings, wherein—

Figure 1 is a schematic illustration of a refrigerating system embodying the present invention;

Figure 2 is a front view, and Figure 3 is a vertical sectional view of a mechanical refrigerator embodying one form of the invention;

Figures 4 and 5 are fragmentary side elevational views of a structure similar to that shown in Figures 2 and 3 with modified arrangements of the cooling unit;

Figure 6 is a vertical sectional view of a mechanical refrigerator embodying another form of the invention; and

Figures 7 and 8 are fragmentary views of a structure similar to that shown in Figure 6 with modified arrangements of the cooling unit.

The refrigerating system schematically shown in Figure 1 will serve to illustrate one of the outstanding features of the invention. The system includes: a motor 10; a compressor 11; a condenser 12; a capillary liquid supply line 13; a continuous evaporator tube 14 comprising a plurality of sections of progressively increasing internal diameter, the sections being identified by the letters *a*, *b*, *c*, *d*, and *e*; a suction line 15; a thermostatic control for the motor 10 including a switch 16; a bulb 17 associated with section *e* of the evaporator 14; and a tube 18 connecting the bulb to the switch 16; and electrical lead lines 19 and 20 adapted to be connected to a source of electrical supply, not shown.

The principal feature of the system shown in Figure 1 is the division of the evaporator tube 14 into a plurality of sections of progressively increasing diameter. By properly coordinating the evaporator to a condensing unit, a progressively lower pressure can be maintained and a correspondingly greater refrigerating effect can be produced in each successive section of the evaporator without the use of the usual valves or restrictors between the successive sections. For example, with a one-fifth horse power compressor, such results can be obtained when the first evaporator section *a* is of 1/16 inch I. D. and the succeeding sections are increased by increments of 1/16 inch so that the last section *e* is of 5/16 inch I. D. This arrangement of parts will provide for a greater drop in pressure between the inlet and outlet ends of each section than between the inlet and outlet ends of the next and all succeeding sections.

Where the evaporator sections are all of the same length, the difference in refrigerating producing capacity is determined solely by the difference in size of the sections. The refrigerating capacity of each section can be further varied by varying the length of the section as well as the internal diameter.

The foregoing characteristic of the system shown in Figure 1 may be utilized to provide multiple temperatures within different zones of a refrigerator cabinet. One such application is illustrated in Figures 2 and 3. As there shown, a cabinet 21 is provided with the usual insulated storage chamber 22 and machinery compartment 23. The storage compartment 22 is defined by an inner liner 24 and an outer shell 25 with insulation 26 therebetween. The storage compartment 22 has an opening at its front adapted to be closed by a conventional form of door 27.

As shown in Figure 2, the storage chamber 22 is divided into three vertically spaced compartments 28, 29 and 30, by the partitions 31 and 32 which are preferably formed of glass or other non-metallic material, and arranged so as to restrict the transfer of heat between the compartments and to limit but not preclude the circulation of air therebetween.

Compartment 28 comprises a cooling compartment and may be provided with a plurality of storage shelves 33, as shown in Figure 3. Partition 31 also serves as a storage shelf for cooling compartment 28. The shelves 33 are here shown as being imperforate, but perforate type may be utilized if desired.

Compartment 29 comprising the space between partitions 31 and 32 is a freezing compartment.

Compartment 30 comprising the space below the partition 32 is a chilling compartment, and there is mounted therein a pair of crisper pans 34 and 35 and a drip collector 36. Immediately above the drip collector 36, the partition 32 is provided with a drip discharge opening 37 through which moisture collected upon the upper surface of partition 32 is discharged. Partition 32 is provided with upstanding flanges about its edges and is formed to incline downwardly toward opening 37 to direct the moisture which accumulates thereon during the defrosting operation to the discharge openings.

A modified form of the refrigerating system shown in Figure 1 is applied to the cabinet 21 shown in Figures 2 and 3. Preferably the motor 10, the compressor 11 and the condenser 12 are disposed in the machinery compartment. According to this particular embodiment, the evaporator tube 14 of the system comprises only two sections *a* and *b*. Section *a* being preferably 1/8 I. D., and section *b* being preferably 1/4 I. D.

The cooling section *a* of the evaporator 14 is here shown as mounted upon a plate 38 which is positioned in the cooling compartment 28 adjacent the rear wall thereof, and as shown in Figure 2, is substantially coextensive therewith. The evaporator section 14*a* is mounted upon the rear side of the plate 38 and is preferably secured thereto in good heat exchange relation therewith. In order to provide for a proper distribution of the refrigerating effect of evaporator section 14*a* the inlet end of the section is preferably located at the bottom of the plate 38 and the section arranged in reverse bends upon the plate progressing from the bottom toward the top, with the convolutions toward the top being closer together than those on the lower part of the plate. In this manner, a greater refrigerating effect is produced in the upper and warmer part than in the lower part, whereby to provide for a substantially uniform temperature throughout the vertical extent of the compartment.

A second and larger section 14*b* of the evaporator tube is disposed within the freezing compartment 29 and associated with a metallic sleeve 39 adapted to receive conventional freezing trays or the like. The sleeve 39 is here shown as provided with a closure 40 for the front end thereof whereby to prevent the spilling out of the cold air therefrom when the main storage chamber door 27 is opened.

As previously mentioned, the first section 14*a* of the evaporator tube 14 which is disposed in the cooling compartment 28 is of a smaller I. D. than the second section 14*b* which is disposed in the freezing compartment 29. Thus, even though the two sections are connected together in unobstructed series relation, a lower pressure is maintained within the freezing section 14*b* than within the cooling section 14*a*. Accordingly, a greater refrigerating effect is produced by a given length of the freezing section 14*b* than by the same length of the cooling section 14*a* whereby a relatively colder temperature is maintained in the freezing compartment 29 than in the cooling compartment 28.

In actual practice the temperature maintained within the cooling compartment 28 will be above freezing, whereas the temperature maintained inside of the freezing sleeve 39 disposed within the freezing compartment 29 will be below a freezing temperature. These results—different temperature conditions in the compartments 28 and 29—are obtained in part by reason of the different refrigerating effects produced by the evaporator sections 14*a* and 14*b*, and in part by reason of the fact that a better heat exchange is provided between the freezing section 14*b* and the materials to be frozen thereby than between the cooling section 14*a* and the articles disposed on shelves 33 and 31.

It will be observed from an inspection of Figure 3 that the plate with which the first section 14*a* of the evaporator is associated is so arranged in relation to the partition 31 that any moisture which collects on the plate 38 is free to drop by gravity directly into the freezing compartment. A deflector plate 41 (Figure 3) is associated with the back side of the freezing sleeve 39 so that any moisture which does drip into compartment 29 from plate 38 is deflected against the freezing sleeve. Thus, the moisture which collects on the plate 38 at times other than the defrosting period is deflected onto the freezing unit comprising the sleeve 39 and the evaporator section 14b and there frozen, to be subsequently collected upon the upper surface of partition 32 during the defrosting period.

Provision is made for a limited circulation of air between the freezing compartment 29 and the chilling compartment 30 by arranging partition 32 with certain of its edges spaced from the adjacent walls (see Figure 3). In this way, compartment 30 is refrigerated by the freezing section 14b of the evaporator 14, and may be maintained at a temperature higher than that of the freezing compartment 29 but lower than that of the cooling compartment 28.

With the construction and arrangement of parts shown in Figures 2 and 3: cooling compartment 28 can be maintained at a substantially uniform temperature slightly above freezing throughout its vertical extent; compartment 29 can be maintained (within sleeve 39) at a temperature below freezing; and chilling compartment 30 can be maintained at an intermediate temperature—all by use of only a single evaporator and without insulated walls between the compartments. By restricting the transfer of heat and limiting the circulation of air between the compartments, separate temperature and humidity conditions can be maintained in each compartment substantially independent of the conditions prevailing in the other compartments.

In Figures 4 and 5 there are illustrated alternative arrangements for producing different temperature conditions within the separate zones of cooling compartment 28 defined by the shelves 33.

According to the arrangement shown in Figure 4, a single U-loop of the evaporator 14 is arranged in heat exchange relation with each separate zone. In order to vary the refrigerating effect of the different loops upon their respective zones whereby to maintain predetermined temperatures in the different zones, provision is made for varying the efficiency of heat transfer between the several loops and their associated zones. For that purpose sheets of non-heat conducting material of varying thickness are disposed between certain of the loops and the adjacent surface of the plate 38. A relatively thick sheet of such material 42 is disposed between the lowest loop and the plate; and successively thinner sheets 43, 44, 45 and 46 are disposed between the loops progressively upward.

By this arrangement of parts, it will be recognized that a more efficient heat transfer is provided between top loop of evaporator section 14 and the zone above the top shelf 33 than between any of the other loops and the zones with which they are associated. By suitable rearrangement of the sheets of non-metallic material, substantially any desired temperature condition can be obtained in any zone.

Where a relatively poor heat transfer is provided between evaporator 14 and plate 38, the entire evaporator tube may be of uniform cross-sectional area. That is to say, the freezing sections and cooling sections may be of the same size. In that case, reliance is had upon the relative efficiencies of heat transfer to produce the different temperatures in the cooling (28) and freezing (29) compartments. However, for best results it is preferred to employ the evaporator construction shown in Figures 2 and 3, where the freezing section 14b is larger than the cooling section 14a.

According to the arrangement shown in Figure 5, each loop of the evaporator tube 14 is of a progressively increasing size proceeding from the bottom upwardly. In other words, this figure illustrates a specific application of the evaporator shown in Figure 1. Section 14a of the evaporator which has the highest internal pressure and produces the least refrigerating effect is associated with the lowest zone of compartment 28; and section 14e which produces the greatest refrigerating effect is associated with the top zone within the compartment 28. In this manner a different temperature may be produced in each of the zones. Obviously this result can best be obtained when shelves 33 are imperforate and of non-metallic construction. If conventional form of wire shelves are employed, the temperature would tend to equalize throughout the cooling compartment 28.

While no such construction is herein shown, it will be obvious that to obtain a wider variation in the temperature selection for each zone, the non-heat conducting material shown in Figure 4 may be combined with the evaporator sections of Figure 5. Likewise, it will be obvious that the range of temperature selection can be further varied by varying the length of the loop associated with each zone (as in lowest and next lowest loops of Figures 4 and 5). By thus combining the several features, it will be possible to obtain substantially any desired temperature condition within a relatively wide range—in each separate zone.

Figures 6, 7 and 8 illustrate a modified application of the invention to the cabinet 21. Referring first to Figure 6, the construction there shown is identical to the construction shown in Figures 2 and 3 except that the plate 38 has been eliminated and the first section 14a of the evaporator is mounted upon the outside of the back wall of liner 24; and the front side of the back wall of the liner 24 is provided with a drip deflector 47 which cooperates with the deflector 41 to direct the moisture collecting on the back wall onto the freezing unit. Except for these differences, the construction shown in Figure 6 is identical to that shown in Figures 2 and 3; and the results obtained in operation are substantially the same.

Figure 7 illustrates an arrangement generally similar to that shown in Figure 4. That is to say, sheets of non-heat conducting material 48, 49, 50, 51 and 52 are disposed between the successive loops of the evaporator tube 14 and the liner. The thickness of the material becomes progressively less from the bottom upward, whereby the refrigerating effect of each loop upon its associated zone becomes progressively greater from the bottom upward. As in the previously described device, a successively lower temperature may be maintained in each successively higher zone.

Figure 8 illustrates an arrangement generally similar to that shown in Figure 5 and which produces substantially the same result as the latter construction. Each loop of the evaporator tube 14 is of progressively larger size from the bottom upwardly, beginning with the smallest section 14a and ending with the largest section 14e. By this arrangement, successively colder temperatures may be produced in each zone of compartment 28, proceeding from the bottom upwardly.

It is contemplated that in certain applications of the invention the freezing section of the evaporator will be of larger internal cross-section than the cooling section of the evaporator, while in other applications the two sections may be of the same internal cross-sectional area.

While only one specific form of non-heat conducting material has been shown for providing a poor or inefficient transfer of heat between certain portions of the evaporator and the zones to be refrigerated thereby, it will be recognized that other forms of material and other means for controlling the efficiency of heat transfer may be employed.

Although but little has been said herein about humidity conditions, it will be recognized by those skilled in the art that the imperforate partitions 31 and 32 and the imperforate shelves 33 serve to limit circulation of air and thereby tend to isolate each compartment and zone from the others and thereby permit different relative humidity conditions to prevail in adjoining compartments or zones. That is to say, by refrigerating each isolated space independently of the other spaces, the temperature differential between the evaporator and the atmosphere of the space may be closely controlled with a corresponding close control of humidity. In this connection it will be observed that shelves 33 function in the same way as partitions 31 and 32. Accordingly, the term "zones" used in connection with shelves 33 and the term "compartments" used in connection with partitions 31 and 32 are to be understood as each defining a space set off by imperforate partitions or shelves.

The scope of the invention is indicated in the appended claims.

I claim:

1. In a mechanical refrigerator including an insulated storage chamber divided into an upper cooling compartment and a lower freezing compartment by a shelf, a metallic sheet defining one wall of the cooling compartment, an evaporator section mounted upon the back side of said sheet to form therewith a cooling unit to refrigerate the cooling compartment, a second evaporator section disposed within the freezing compartment to form a freezing unit to refrigerate the latter compartment, and a drip deflector associated with said units to direct the moisture which drips from the cooling unit onto the freezing unit.

2. A mechanical refrigerator comprising an insulated storage chamber divided into an upper cooling compartment and a lower freezing compartment by means restricting the transfer of heat and the circulation of air therebetween, said chamber being defined in part by a liner, and means for refrigerating both of said compartments comprising a condensing unit and an evaporator operatively associated therewith, said evaporator including a first section disposed on the outside of the metal liner in the zone thereof which defines the cooling compartment and a second section of the evaporator disposed within the freezing compartment, said sections being connected together in unobstructed series relation with each other.

3. A mechanical refrigerator as defined in claim 2 wherein the first section of the evaporator is arranged in poor heat exchange relation to the cooling compartment and wherein the second evaporator section is arranged in better heat exchange relation with the freezing compartment.

4. A mechanical refrigerator as defined in claim 2 wherein the first and second evaporator sections comprise a single elongated unobstructed passageway with the second section being of a larger internal cross-sectional area than the first section.

5. In combination, a mechanical refrigerator having an insulated storage chamber divided into spaces substantially isolated from each other, a separate evaporator section associated in heat exchange relation with each space, all of said section being connected together in unobstructed series relation and operatively connected to a condensing unit, certain of said sections being of greater evaporating capacity in comparison to the size of the associated space than are other sections in comparison to the sizes of the spaces with which the latter are associated, one of said evaporator sections being in better heat exchange relation with its associated space than are the other sections with their associated spaces.

6. A multiple temperature refrigerating system comprising a condensing unit and an evaporating circuit operatively connected thereto, the said evaporating circuit comprising a plurality of evaporating sections connected together in series relation, certain of said sections being insulated from the medium to be cooled thereby, at least one of said evaporating sections being insulated to a greater extent from the medium to be cooled by it than another of said sections is insulated from the medium to be cooled by the latter whereby said one section absorbs more heat than the other of said sections.

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