Jan. 11, 1949. K. P. GROAT 2,458,589

TWO TEMPERATURE REFRIGERATION UNIT

Filed Feb. 1, 1945 2 Sheets-Sheet 1

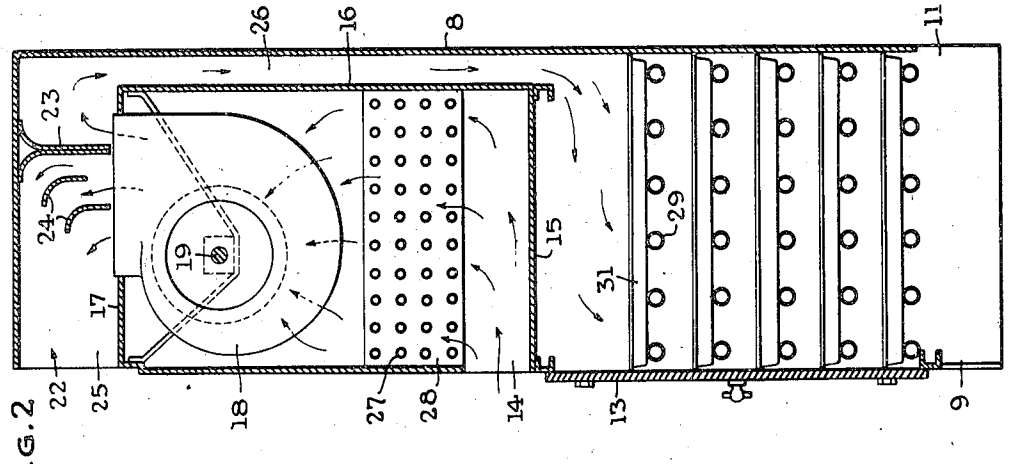


Fig. 2

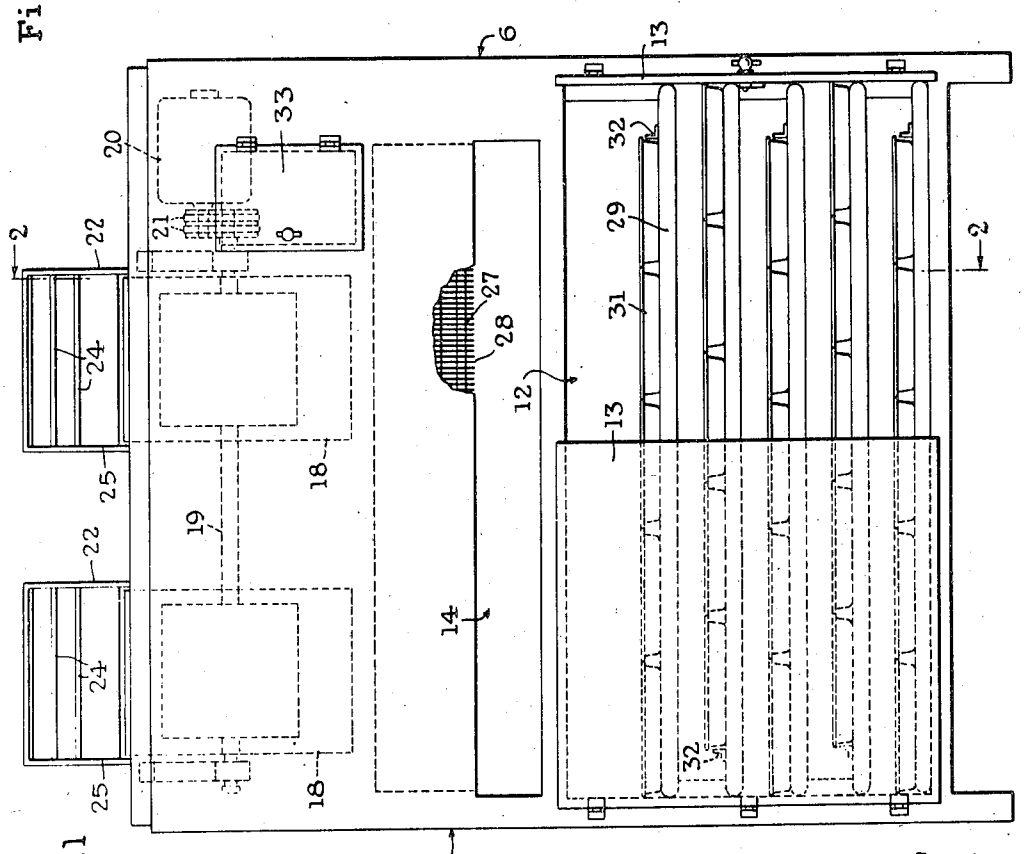


Fig. 1

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Fig. 3

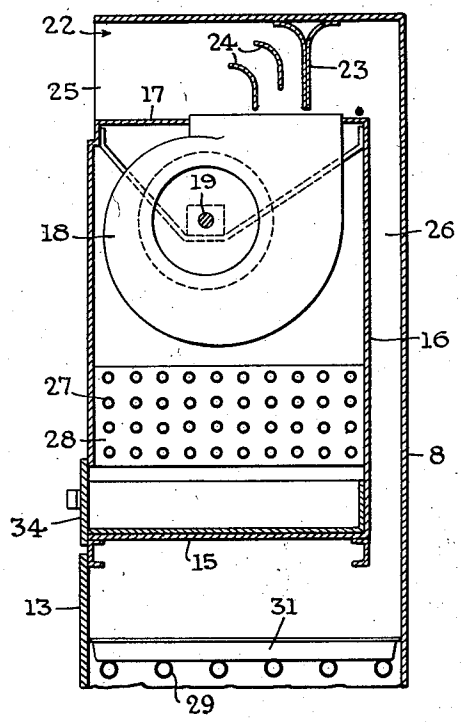
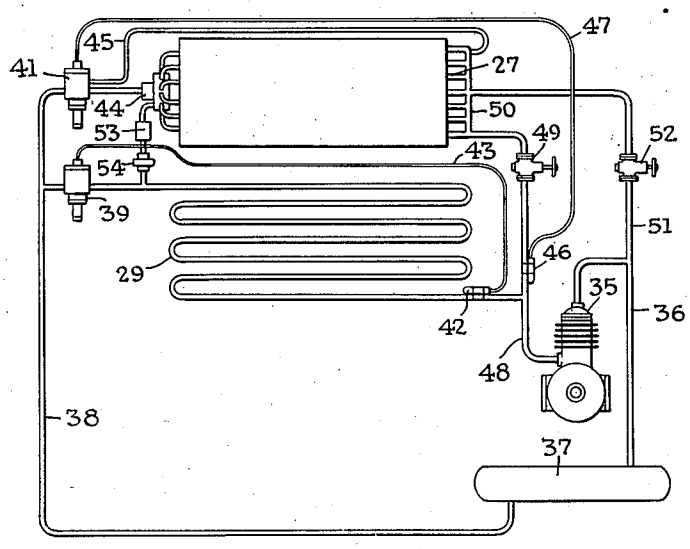


Fig. 4



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TWO TEMPERATURE REFRIGERATION UNIT

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9 Claims. (Cl. 62—115)

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This invention relates to refrigerative units for use in food locker plants, and is particularly intended for use in small plants, though not strictly limited in utility thereto.

The invention provides a refrigerating unit which is mounted within and refrigerates the room in which the lockers are enclosed to temperatures between −5° and +10° F. This unit also contains a sharp freezer operated at temperatures of the order of 10° below zero F. These two operations are ordinarily carried on at the same time. The compressor and condenser are mounted outside the refrigerated room.

The refrigerating unit includes two evaporators connected in parallel, and hence operated at the same suction pressure and at substantially equal temperatures when both are operating.

The first or sharp-freezing evaporator takes the form of a shelf or grid on which trays containing packaged or other foods to be frozen are arranged in such a way as to serve as flow-directing baffles. This permits the evaporator to be so constructed that it can be mechanically defrosted while in operation. Thus it can be and is operated continuously.

The second, or space cooling evaporator is desirably a multiple unit finned coil with a distributor at the feed end and a suction manifold at the discharge end. A finned coil cannot be mechanically defrosted, but must be thermally defrosted, and hence must be shut down periodically.

When the second coil is being defrosted the temperature of the first coil tends to fall, since a constant speed compressor is used.

A feature of the invention is the provision of connections by which the second evaporator is connected as a condenser in circuit with the first evaporator and the compressor and so rejects heat which melts the frost. During defrosting of the second evaporator the fan is shut down and collecting slush boxes are inserted in the air duct beneath the second evaporator. Desirably the freezing pans supported by the first evaporator are freshly charged with unfrozen food at the start of defrosting, thus imposing a heavy heat load on the first evaporator which results in the delivery of plenty of hot gas to the second evaporator.

There are various details which are novel in addition to the general principles above outlined.

A commercial embodiment of the invention is illustrated in the accompanying drawings, in which:

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Figure 1 is a front elevation of the unit with one access door of the sharp freezing unit closed and the other open.

Figure 2 is a section on the line 2—2 of Figure 1.

Figure 3 is a fragmentary view similar to the upper portion of Figure 2 but showing a slush box in place.

Figure 4 is a diagram of the refrigerative circuit, including the compressor, condenser and certain regulatory components not visible in the other figures.

Refer first to Figures 1 and 2.

The refrigerative unit is enclosed in a generally rectangular housing having closed sides 6 and 7 and a closed back 8. The bottom of the housing is open and there are discharge openings 9 and 11 at the front and back of the unit through which refrigerated air flowing downwardly through the housing is discharged back into the room. There is a large access opening 12 immediately above this, and when the device is in use this opening is closed by a pair of hinged doors 13, one of which is shown closed and the other open in Figure 1.

Immediately above the opening 12 is an air inlet opening 14. This leads to the lower portion of a secondary enclosure mounted within the main housing and made up of a bottom 15, a back plate 16 spaced from the back 8 of the main housing, and a top 17, which is in effect also the top of the main housing.

Suspended in the upper portion of the secondary housing are a pair of coaxial rotary fans 18. The impellers of these fans are mounted on a common shaft 19 and are driven by a single electric motor 20 through belts 21. These fans operate to draw air in through the opening 14 and discharge it through bonnets 22 mounted on the top of the main housing. In each of the two bonnets a splitter 23 and flow-directing louvers 24 are mounted.

The principal portion of the air discharged by the fans is directed forward into the room through outlets 25, but a minor portion is directed to the rear and downward through a passage 26 between the back 8 of the main housing and the back wall 16 of the secondary enclosure.

Mounted in the secondary enclosure is an evaporator composed of a plurality of parallel horizontal tubes 27 with closely spaced vertical fins 28. This is the so-called "second" evaporator. The connections to this evaporator will be described hereinafter.

Below the wall 15 and within the main housing is the other or "first" evaporator which is

made of a plurality of parallel zigzag bare tubes 29 arranged to form a plurality of superposed horizontal shelves. Five such shelves are indicated in Figures 1 and 2, and they make a single evaporator.

The air discharging downward through the passage 26 could flow directly to the outlets 9 and 11, or either of them, except for the fact that when the apparatus is in use for sharp freezing a series of trays 31 are supported on each of the evaporator shelves 29 and collectively form flow-directing baffles. These trays are long enough to fill the interval between the back 8 of the housing and the doors 13 and they are of such width that the maximum number received by any shelf will not completely cover the shelf. Each shelf carries a stop 32, the stops on successive shelves being alternately arranged so that when all the trays are in place a zigzag passage is afforded around the end of the trays on the top shelf, then to the left between it and the next lower shelf, then below that shelf back to the right, and so on.

The door 33 indicated in Figure 1 is an access door through which the motor 20 and its belt drive 21 to the shaft 19 may be reached, as well as valves 49 and 52 mentioned below.

During defrosting the fans 18 are stopped and slush boxes 34 are inserted in the opening 14. In a unit of ordinary size two boxes, arranged side by side, are used because a single box would be unwieldy. The fronts of the boxes 34 close the opening 14 completely and the boxes proper extend the full depth of the opening so as to collect all water and slush melted from the coil 27 and the fins 28. See Figure 3.

In Figure 4 there is illustrated a compressor 35 which discharges through the hot gas line 36 into a combined condenser and receiver 37. The liquid line 38 receives liquified refrigerant from the condenser-receiver 37 and delivers it to two thermal expansion valves 39 and 41.

Expansion valve 39 may be, and is shown as an ordinary automatic expansion valve which feeds the evaporator 29. This evaporator is diagrammed in Figure 4 as a simple zigzag coil. The thermal bulb 42 of the expansion valve 39 is located at the discharge end of the evaporator 29 and is connected by the capillary tube 43 with the expansion valve 39 in the usual manner. Expansion valve 41 delivers through a mixing unit 44, of familiar type, into various subdivisions of the evaporator 27. The purpose of the mixing unit 44 is to ensure that all of the subdivisions of the evaporator 27 receive the same proportions of vapor and liquid. The use of such a mixing unit 44 is a familiar expedient in the art.

The expansion valve 41 is shown as of the type which has an external pressure transmitting connection 45 connected to the discharge manifold 50 of the evaporator 27. It has a thermal bulb 46 mounted on the suction line leading to the compressor from the evaporator 27 and connected by a capillary tube 47. Expansion valves having an external pressure connection are well known. As ordinarily used the purpose is to sense temperature and pressure at approximately the same point, i. e. at the suction connection of the evaporator. One purpose of using such an external connection in the present case is to assure closure of the expansion valve 41 when pressure is built up in the evaporator 27 during the defrosting operation.

Both of the evaporators 27 and 29 are connected to the suction connection 48 of the compressor 35. The suction connection from the evaporator 27 however may be interrupted by closing a normally open stop valve 49. This valve is interposed between the discharge manifold 50 of the evaporator 27 and the point on the suction connection at which the thermal bulb 46 is applied. Thus when the valve 49 is closed, as it is during defrosting, the bulb 46 is not subjected to the relatively high temperature which is then developed in the evaporator 27. There is also a defrosting connection 51 which leads from the discharge line 36 of the compressor to the discharge manifold 50 of the evaporator 27. In this connection there is interposed a normally closed stop valve 52.

For the purpose of transferring from the evaporator 27 to the evaporator 29 liquid refrigerant which is condensed in the evaporator 27 during the defrosting operation, a restricted but constantly open liquid drain connection is provided. This leads from the distributor 44 to the entrance end of the evaporator 29 and comprises a strainer 53 and an orifice fitting 54 designed to permit limited liquid flow during defrosting, without unduly interfering with the automatic control of the two expansion valves during normal operation.

When the plant is operating normally with the valve 49 open and the valve 52 closed, the two evaporators 27 and 29 are connected in parallel each under the control of its own automatic expansion valve.

Under these conditions both of the evaporators will accumulate frost, but the frost on the bare tubes 29 of the first or sharp freezing evaporator can be scraped off. This is done when the trays are removed and the frost merely falls to the bottom of the unit from which it may be readily shoveled out. For this reason no thermal means for defrosting the evaporator 29 is provided, and the evaporator is kept in operation, substantially without interruption.

When the evaporator 27 requires to be defrosted the fans 18 are stopped and the slush boxes 34 are inserted. The effect is practically to isolate the evaporator 27 from the interior of the locker room. The next step is to close the valve 49 and open the valve 52. This causes the evaporator 27 to operate as a condenser while the evaporator 29 continues to operate as an evaporator. The condenser 37 is still operative, but since the evaporator 27 is at a very low temperature because of the adhering frost, it will function actively as a condenser until it is defrosted. Vaporous refrigerant condensed in the evaporator 27 will drain through the orifice 54 to the evaporator 29 while the slush and drip water melted free from the evaporator 27 will collect in the slush boxes 34. At the termination of the defrosting operation the slush boxes are removed and the valve 52 is closed, whereupon the valve 49 is opened and the fans are started.

While it is not strictly necessary to do so, it is quite advantageous to charge the pans 31 with unfrozen food just before starting a defrosting operation. This imposes a high heat load on the evaporator 29. In consequence the compressor will deliver plenty of hot gas to the evaporator 27, ensuring rapid defrosting.

A number of modifications are possible. The evaporator shelves 29 might take other forms. The passage 26 could in some cases be eliminated, though its use is considered advantageous because it improves the sharp freezing action. Furthermore, it permits the effect of the evaporator

29 to be added to that of the evaporator 27 at times when there are no trays in the sharp freezer.

For the above reasons the particular embodiment chosen for description should be regarded as illustrative and not limiting, the scope of the invention being defined solely by the claims.

What is claimed is:

1. A combined space cooler and sharp-freezing unit, adapted to be mounted in a space to be cooled, comprising in combination, an air-cooling evaporator; a sharp-freezing evaporator; means for supporting material to be frozen in heat exchanging relation with the sharp-freezing evaporator; means for supplying volatile liquid refrigerant to said evaporators in parallel, and for withdrawing evaporated refrigerant therefrom; air circulating means; and guiding means for air circulated thereby, arranged to cause the circulating means to withdraw air from the space to be cooled, and after causing it to exchange heat with the air-cooling evaporator return said air to said space at different elevations, said guiding means being arranged to cause one part of the returning air to flow across said material-supporting means.

2. A combined space cooler and sharp-freezing unit, adapted to be mounted in a space to be cooled, comprising in combination, an air-cooling evaporator; a sharp-freezing evaporator; means for supporting material to be frozen in heat exchanging relation with the sharp-freezing evaporator; means for supplying volatile liquid refrigerant to said evaporators, and for withdrawing evaporated refrigerant therefrom; air circulating means; and guiding means for air circulated thereby, arranged to cause the circulating means to withdraw air from the space to be cooled, and after causing the air to exchange heat with the air-cooling evaporator return said air to said space through two paths, in one of which the air flows across said material-supporting means, and in the other of which the flow is directly to the space.

3. A combined space cooler and sharp-freezing unit, adapted to be mounted in a space to be cooled, comprising in combination, a finned air-cooling evaporator; a sharp-freezing evaporator comprising shelf-like tubular units having smooth surfaces capable of being mechanically defrosted while at sub-freezing temperatures; means for supporting material to be frozen in heat exchanging relation with the sharp-freezing evaporator, said supporting means serving to define a sinuous path for air in contact with the sharp-freezing evaporator and with the material so supported; means for supplying volatile liquid refrigerant to said evaporators and for withdrawing evaporated refrigerant therefrom; air-circulating means, and guiding means for air circulated thereby, arranged to cause the circulating means to withdraw air from the space to be cooled, and after causing the air to exchange heat with the air-cooling evaporator return said air to said space, said guiding means causing a part thereof to return to said space directly and the remainder through the path defined by said supporting means.

4. The combination defined in claim 3, in which the material-supporting means take the form of removable pans supported by the tubular shelves.

5. A combined space cooler and sharp-freezing unit, adapted to be mounted in a space to be cooled, comprising in combination, an air-cooling evaporator; a sharp-freezing evaporator; means for supporting material to be frozen in heat exchanging relation with the sharp-freezing evaporator; means for supplying volatile liquid refrigerant to said evaporators, and for withdrawing evaporated refrigerant therefrom; and thermodynamic defrosting means for the air-cooling evaporator, operable while the sharp-freezing evaporator remains in operation, said defrosting means serving to suspend evaporation in the air-cooling evaporator, withdraw refrigerant vapor from the sharp-freezing evaporator, and deliver said vapor at elevated temperature to said air-cooling evaporator.

6. A combined space cooler and sharp-freezing unit, adapted to be mounted in a space to be cooled, comprising in combination, an air-cooling evaporator; a sharp-freezing evaporator; means for supporting material to be frozen in heat exchanging relation with the sharp-freezing evaporator; means for supplying volatile liquid refrigerant to said evaporators, and for withdrawing evaporated refrigerant therefrom; thermodynamic defrosting means for the air-cooling evaporator, operable while the sharp-freezing evaporator remains in operation, said defrosting means serving to suspend evaporation in the air-cooling evaporator, withdraw refrigerant vapor from the sharp-freezing evaporator, and deliver said vapor at elevated temperature to said air-cooling evaporator; means for circulating air in said space into contact with said air-cooling evaporator; and slush-collecting receptacle means removably positioned beneath the air-cooling evaporator and serving when in place to interrupt circulation of air in contact with the air-cooling evaporator.

7. A combined space cooler and sharp-freezing unit, adapted to be mounted in a space to be cooled, comprising in combination, a housing defining a sharp-freezing chamber open at its bottom to said space, and an air duct having at its bottom an air entrance, and at its top an air discharge arranged to direct part of the discharging air directly to the space and part downward through the sharp-freezing chamber; an air-cooling evaporator extending across the air duct adjacent the entrance thereto; air circulating means in the air duct above said evaporator; a sharp-freezing evaporator in said chamber; means for supporting material to be frozen in heat exchanging relation with the sharp-freezing evaporator; and means for supplying volatile liquid refrigerant to said evaporators, and for withdrawing evaporated refrigerant therefrom.

8. A combined space cooler and sharp-freezing unit, adapted to be mounted in a space to be cooled, comprising in combination, a housing defining a sharp-freezing chamber open at its bottom to said space, and an air duct having at its bottom an air entrance, and at its top an air discharge arranged to direct part of the discharging air directly to the space and part downward through the sharp-freezing chamber; an air-cooling evaporator extending across the air duct adjacent the entrance thereto; air circulating means in the air duct above said evaporator; a sharp-freezing evaporator in said chamber; means for supporting material to be frozen in heat exchanging relation with the sharp-freezing evaporator; means for supplying volatile liquid refrigerant to said evaporators, and for withdrawing evaporated refrigerant therefrom; thermodynamic defrosting means for the air-cooling evaporator, operable while the sharp-freezing evaporator remains in operation, said defrosting means serving to suspend evaporation in the air-cooling

evaporator, withdraw refrigerant vapor from the sharp-freezing evaporator and deliver said vapor at elevated temperature to said air-cooling evaporator; and slush-collecting receptacle means insertable into the entrance to the air duct and effective when inserted to obstruct circulation through the duct.

9. The combination of a compressor; a condenser to which the compressor discharges; two evaporators; thermally controlled expansion valves, one for each evaporator, connected to control the supply of liquid refrigerant from the condenser to corresponding evaporators; suction connections from each evaporator to the compressor; a restricted constantly open liquid transfer connection between the evaporators; defrosting valve means adjustable to disconnect the discharge of one evaporator from the compressor suction and

connect it to the compressor discharge; and means, effective when the defrosting valve means is adjusted to defrost, to prevent back flow through the expansion valve of the evaporator whose connections are so changed.

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