May 21, 1935. W. E. CARPENTER 2,002,309

REFRIGERATING APPARATUS AND METHOD

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FIG. 1.

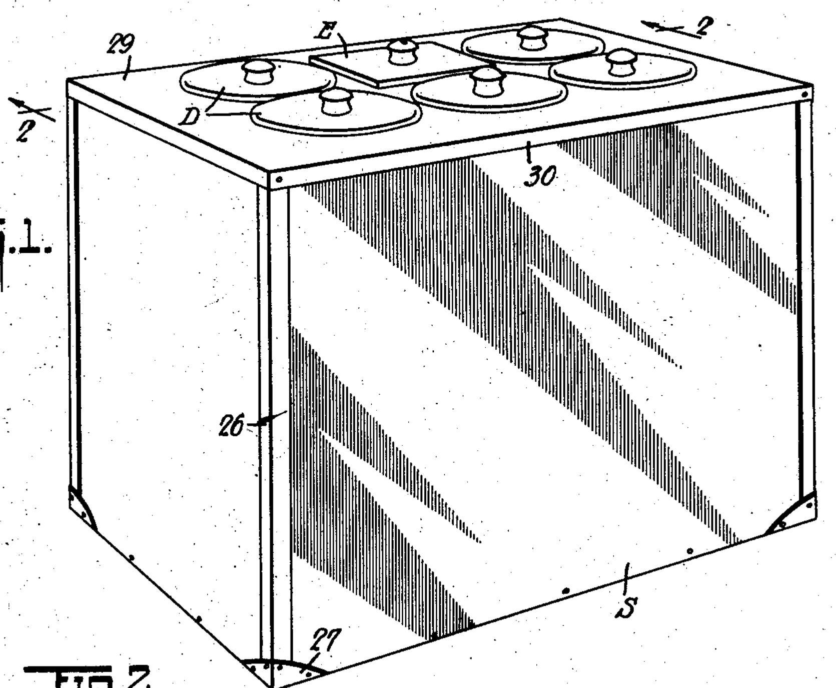

FIG. 2.

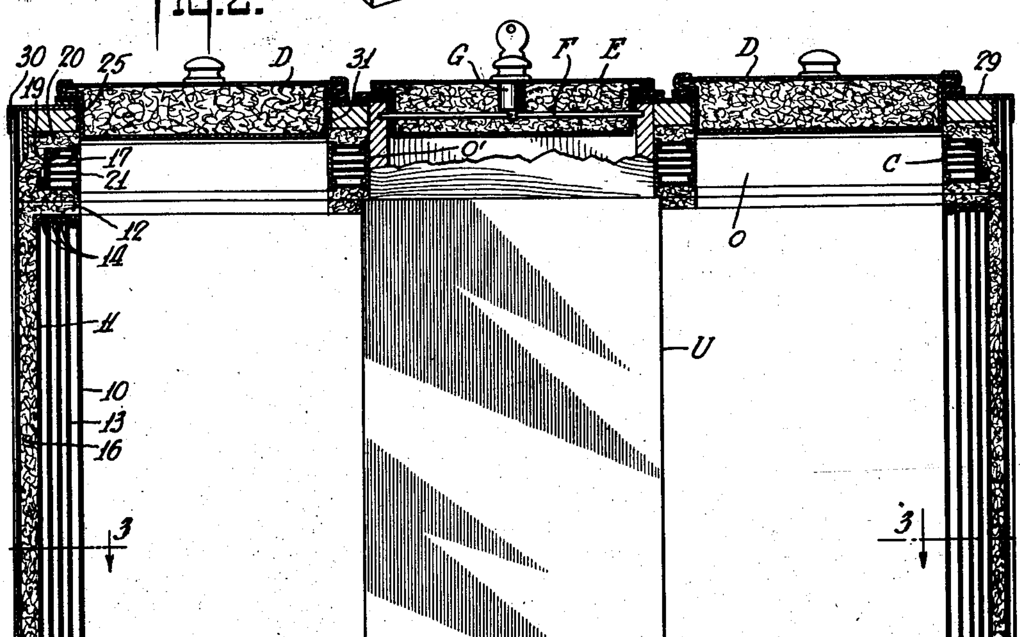

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FIG. 3.

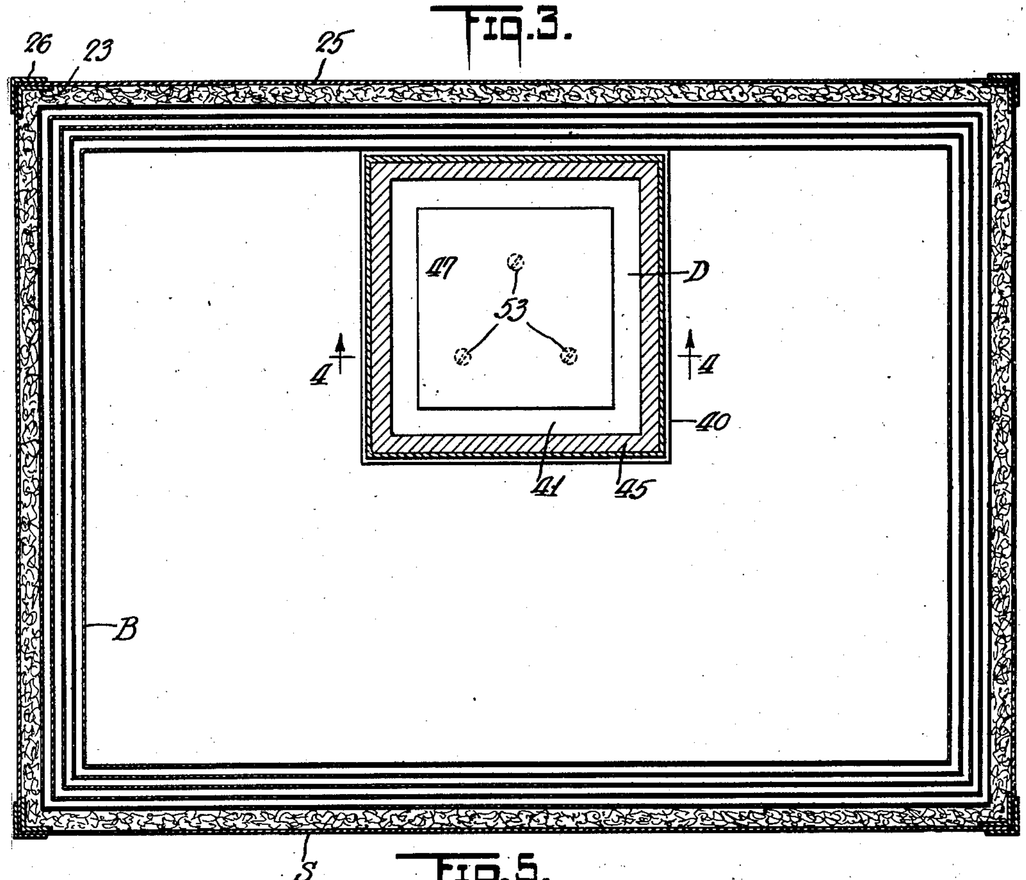

FIG. 5.

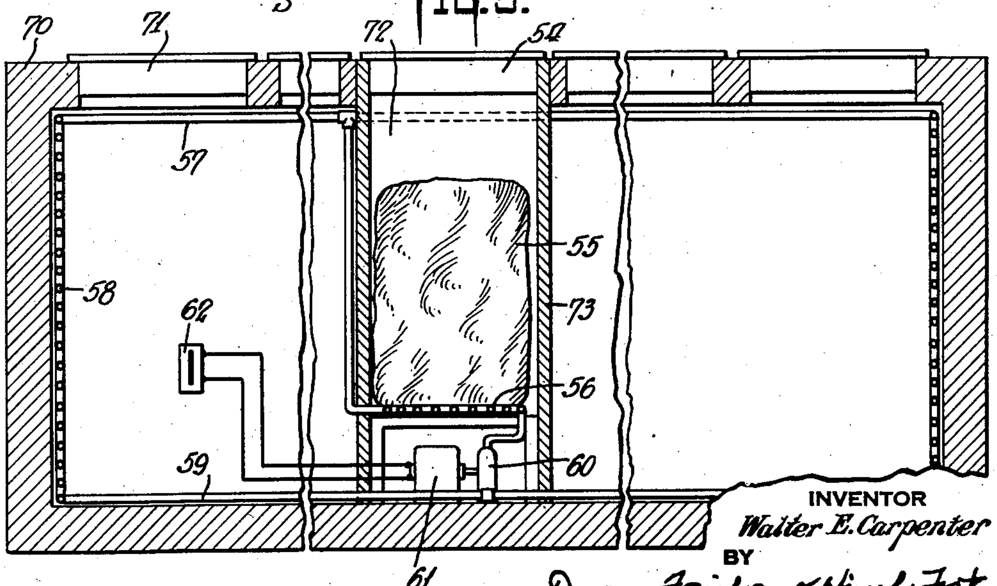

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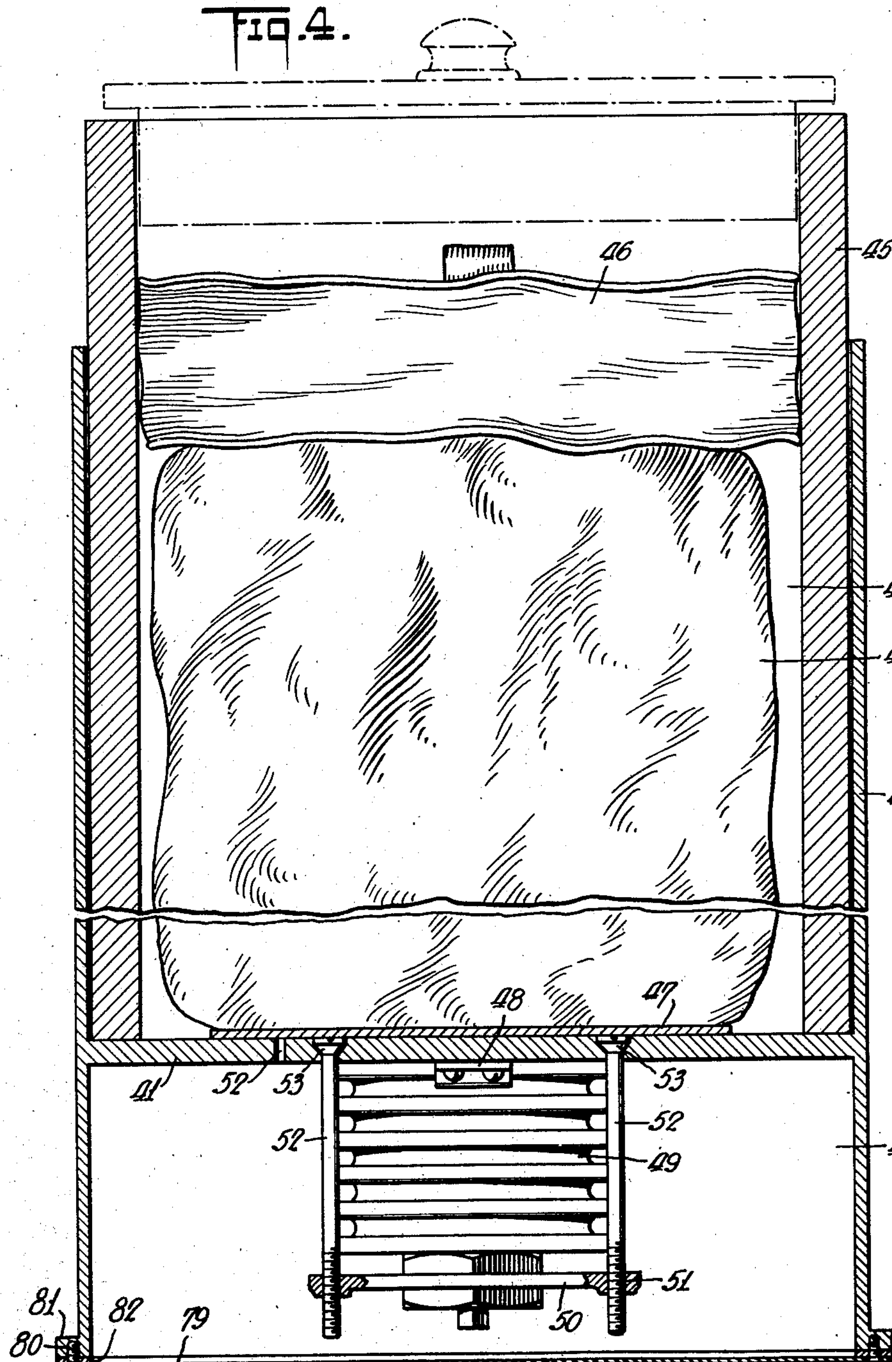
FIG. 4.



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UNITED STATES PATENT OFFICE

2,002,309

REFRIGERATING APPARATUS AND METHOD

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Application March 28, 1932, Serial No. 601,504

13 Claims. (Cl. 62—91.5)

My present invention, considered from one aspect, is concerned with the construction of heat insulating containers.

Certain principles of the invention are applicable to all types of such containers, from small portable packages to large storage vaults or freight cars.

Considered from another aspect, the invention is concerned with the provision of an extremely economical method and apparatus for utilizing solidified carbon dioxide as a refrigerating agent.

Considered from another aspect, the invention is concerned with a fully automatic temperature controlling apparatus, especially an apparatus for maintaining constant unusually low temperatures, say around zero F. without employing mechanical refrigerating systems of any character.

Considered from another aspect the invention is concerned with the provision of an ice cream cabinet having holes to receive a plurality of the usual ice cream cans or ice cream packages, and provided with a heat exchange system arranged to permit heat exchange between the contents of the cabinet and a body of solidified refrigerant, in such an efficient and effective manner that a relatively small quantity of refrigerant of the solid sublimating type will maintain uniform temperatures in the box or cabinet over long periods of time.

More specifically an object of the invention is to provide an ice cream cabinet which in its construction embodies the principles of heat reflection disclosed in my prior application, Serial No. 557,749 filed August 18, 1931, but which is designed to facilitate and lessen the cost of manufacture and assembly, and which is equipped with a self-contained, non-mechanical, self-regulating refrigerating unit, using solid CO_2 as a refrigerant.

Another object is to provide a self-contained refrigerating unit of the general character shown in my prior application Serial No. 562,002 filed September 10, 1931, but which is so constructed and designed that the formation of frost on any of the heat absorbing surfaces of the unit is prevented.

Another object is to provide such a unit having a relatively delicate, although simple, control mechanism for shifting the dry ice supply into and out of direct heat exchanging relationship with the heat absorbing surface while preventing the formation of frost on any part of the control apparatus, despite the fact that the latter is disposed in a region of intense cold.

Another object is to provide a heat exchanger which will permit direct heat interchange between a refrigerant and a medium to be refrigerated which is more than one hundred degrees F. warmer than the refrigerant itself, while completely avoiding the problem of frosting which heretofore tended to insulate the cold, heat exchanging surfaces and retard the rate of heat exchange.

In accordance with the preferred embodiment of the invention, a heat insulating cabinet of proper size to receive a number of ice cream cans is equipped with a refrigerator unit arranged in proximity to all of the cans. Separate hatches are provided for the insertion and removal of the individual cans and also for the insertion of the carbon dioxide refrigerant into the refrigerator unit. The chamber for the carbon dioxide is insulated on all sides except at the bottom thereof, and through the metal bottom of this chamber and through any suitable arrangement of metallic heat conducting plates heat exchange takes place between the solid CO_2 and the contents of the cabinet.

The metal bottom of the refrigerant container includes a platform or elevator, which under thermostatic action is automatically operative to lift the body of dry ice out of direct contact with the bottom of the refrigerant container, thereby substantially fully insulating the refrigerant and substantially retarding sublimation thereof. This control, preferably effected through a thermostatic bellows, is so accurate that a cabinet containing approximately fifty gallons of ice cream may be maintained at the temperature of zero F. without a variation of more than one degree in either direction over a period of twenty-four hours, by the use of a ten pound block of the soldified refrigerant. A remarkable feature of the above described arrangement is the fact that the temperature is maintained uniform until all but the last few ounces of refrigerant are gone in direct contradistinction to other systems where the temperature varies directly with the amount of water ice or solid CO_2 being used.

It will be realized that in such an arrangement the intensely cold heat exchange surfaces would tend to frost over and the frost coating forming on them would materially retard heat exchange and cause the temperature in the cabinet to rapidly rise. It will also be evident that in the absence of some special means for preventing it, the controlling bellows itself would quickly become covered with a heavy coating of ice, and either become jammed or broken as the result of such coating.

I have discovered that by the simple expedient of bathing the thermostatic bellows in the gases which are evolved upon sublimation of the solidified CO_2, the thermostat is kept absolutely dry and that by permitting the proper leakage of gas from the refrigerant chamber into the cabinet proper the heat exchange surfaces will also be maintained absolutely dry and free from frost, despite the fact that the cabinet contains a large quantity of moist material such as ice cream. In fact, even when frost is deliberately formed on the thermostat and the heat exchange surfaces of the apparatus, the mere introduction of a quantity of solid CO_2 into the chamber results in rapidly removing the frost, the extremely dry CO_2 gas quickly absorbing the moisture of the water ice which may be present.

The invention may be more fully understood from the following description in connection with the accompanying drawings, wherein

Fig. 1 is a perspective view of an ice cream cabinet embodying the invention,

Fig. 2 is an enlarged longitudinally vertical sectional view therethrough, taken approximately on the line 2—2 of Fig. 1.

Fig. 3 is a sectional plan view taken approximately on the line 3—3 of Fig. 2,

Fig. 4 is a vertical sectional view through the refrigerator unit taken on the line 4—4 of Fig. 3,

Fig. 5 is a somewhat diagrammatic longitudinally vertical sectional view through an ice cream cabinet, illustrating a modified type of construction.

Referring first to Figs. 1, 2 and 3 of the drawings, I have used the reference numeral B to designate a heat insulating container which constitutes the inner shell of the ice cream cabinet illustrated in Fig. 1 and which is built up of a plurality of spaced metallic heat reflecting walls with the interspaces filled with an inert heat insulating gas. The details of construction of this box, which is of general elongated rectangular shape will be more fully hereinafter described. The box B with its hollow multiple walls is provided with a similarly constructed top C, the box and the top being held together by a skeleton frame structure which I shall later describe in detail, this frame structure mounting an outer sheet metal sheathing S.

The cabinet is designed to contain a number of cans of ice cream, typically five of the usual 10 gallon cans and with this end in view, the cover is provided with 5 openings O through which the cans (not shown) may be introduced into the cabinet. These openings are arranged three in one row and with two openings behind the end openings of the row of three. Between these latter two openings and behind the center opening of the row, I provide a rectangular opening O' in the cabinet top, to serve as a hatchway through which solidified carbon dioxide or equivalent refrigerant may be introduced into the refrigerating unit designated generally at U.

All of the openings for the ice cream cans are closed by the usual covers D and the ice hatchway is provided with a heat insulating cover E adapted to be locked in position, if desired, the lock being diagrammatically illustrated in Fig. 3 as comprising a pair of radial movable bolts F actuated from the spindle of a conventional type of key controlled tumbler mechanism F.

The arrangement described above, disposes the refrigerator unit in relatively close proximity to all five of the ice cream cans and is especially conducive to effective refrigeration of the cabinet by direct heat exchange and without the need for any circulating refrigerant or any secondary heat transfer agent.

Before describing the refrigerator unit and the automatic self-contained control apparatus thereon, I shall discuss in detail the construction of the cabinet itself. This cabinet embodies the principles of heat insulation disclosed in my prior application, Serial No. 557,749 above referred to, but presents peculiar structural problems in the effective housing and protection of the multiple walled shell structure shown in my prior application.

Referring first to the body of the cabinet, the inner and outer wall sections **10** and **11**, both of open ended rectangular construction and having highly polished surfaces, are nested one within the other and secured together by an open centered rectangular plate member **12**, the box of Fig. 2 being inverted during assembly. The next step is to introduce between the spaced shells **10** and **11** any suitable number of similarly shaped shells **13** also open ended but each provided at one end with a flange **14**, which serves as a spacer, so that as the shells are dropped into the hollow walled open-bottom compartment formed by the members **10** and **11**, they automatically space themselves from each other and from said walls.

The next operation is to apply the bottom plates **15** and solder or otherwise secure them in position and then to fill the hollow walled structure thus formed with carbon dioxide or some other suitable inert gas. After forming this portion of the box, the exterior thereof is completely covered with a relatively heavy layer of felt or equivalent insulating material **16**.

The cover C is also formed of a plurality of spaced sheets of highly polished sheet metal which may be relatively light gauge. It is a little difficult to see the exact construction of the cover in Fig. 2 due to the fact that this section is taken on a line where three of the openings occur, but it will be understood that the spaced horizontally disposed sheets **17** extend the full width and length of the cover, are spaced from each other by flanges **18** and are housed within a shallow rectangular box-like frame **19**, to which the uppermost and lowermost plates **17** may be soldered or otherwise secured. This cover is also preferably gas filled, is completely wrapped with felt **20** and the openings therein are formed by sleeves or collars **21** having a gas-tight fit within the hollow cover.

The box B and the cover C are clamped together by a skeleton frame work consisting of angle iron uprights **23** at the corners of the box connected by T bar horizontal frames **23** at the top and bottom of the box, the T bars being suitably secured at their inner faces to the angle irons with the legs of the T's affording rectangular horizontal inwardly presented flanges, which hold the felt wrapped cover tightly clamped against the felt-like box. A suitable wooden base **24** may be secured against the under face of the horizontal frame defined by the legs of the lower T bars and a wooden top **25** rests upon and is secured to the frames defined by the legs of the upper T bars.

The cabinet is completed by attaching metal plates **25** which form sheathing S to the outer faces of the angle iron uprights and then concealing the edges of these plates and trimming them by outer angle iron uprights **26**, the construction being further strengthened by reinforcing corner pieces 27 at the lower corners of the cabinet.

A steel plate 29 fixed upon the wooden top 25 carries flanges 30 which overlap and conceal the upper edges of the plates 25. Where the openings O and O' occur, the wooden top piece is preferably provided with liner sleeves 31 adapted to snugly receive the covers D and E.

Before proceeding with a description of the self-contained and self-regulating refrigerating unit, it may be observed that a refrigerating chamber constructed as above described, finds a wide field of usefulness regardless of the type of refrigerator unit or the type of refrigerating medium utilized. The relatively light gauge multiple walled inner portion of the box is effectively cushioned and protected and further insulated by the felt, and the frame structure with its outer shielding lends great ruggedness and rigidity to the completed unit. While the inert gas which fills the walls of the box adds to its heat insulating qualities, the use of a plurality of spaced, shiny surfaced sheets of material provides a heat reflecting effect of great value as an insulator, as more fully disclosed in my prior application above referred to.

It may also be observed that the refrigerator unit which I am about to describe is capable of usefulness in connection with various types of apparatus and may be made up in all sizes.

An enlarged view of this refrigerator unit is shown in Fig. 4. It consists of a hollow metal casting 40 of any suitable cross sectional shape illustratively rectangular. Casting 40 near its lower end is provided with an integral cross web 41 which divides it into an upper ice compartment 42 and a lower control compartment 43. The side walls of the ice compartment are internally insulated against direct heat exchange relationship with the block of solid carbon dioxide 44, which is used as a refrigerant. In the present case this insulation has been illustrated as a relatively thick rectangular open ended wooden box member 45 resting on the web and protruding some distance above the casting so that it fits within the opening O' of the ice cream cabinet and locks the refrigerator unit against lateral displacement with respect to the cabinet.

Preferably the box fits the casting with comparative looseness so that the carbon dioxide gas evolving upon the sublimation of the solidified refrigerant may escape into the cabinet through the space between the box 45 and the wall of the casting. Numeral 46 illustrates a conventional pad of Kapok dropped upon the block of refrigerant.

A flat plate form 47 is laid upon the cross web 41 and serves as the true support for the ice block. Means is provided in the control chamber for automatically lifting this platform and moving the ice out of direct heat exchange relationship with the casting web, after predetermined low temperatures have been reached.

Secured upon the end face of the partition 41 by any suitable number of brackets 48 is a bellows type thermostat 49 which at its lower end carries a spider structure 50 having screw threaded openings 51 therein receiving the threaded ends of screws 52 which extend through the web and have heads 53 normally lying in undercut recesses in the upper face of the partition or web 41 so that the screw heads lie flush with the partition and the platform 47 lies directly against the partition. Expansion of the bellows tends to draw the screw heads into their recesses and contraction of the bellows tends to move the screws upwardly, thereby lifting the platform 47 and lifting the ice block. The lower end of the casting may, if desired, be closed by plate 79 secured as at 80 to a casting flange 81 and leakage of gas around the lower end of the casting is prevented by a gasket 82 interposed between the plate and the flange. The heavier than air carbon dioxide gas which is generated in the chamber 42 finds its way into the lower control chamber 43 through one or more openings 52 in the web 41.

The operation of this apparatus is as follows:—When the ice is deposited on the platform 47, its intense cold is imparted to the web 41 and to the integral upstanding side members of the casting, the cabinet being cooled by direct heat exchange relationship with the cold plates 40. As the temperature reaches a predetermined minimum however, the bellows 49 will contract, thereby elevating the platform 47, lifting the block 44 out of heat exchange relationship with the casting and since the block is insulated on all sides by insulating material as well as by the gases which it has generated, there will be very little sublimation until such time as the temperature in the cabinet again rises, the bellows expands and the elevated platform 47 comes back into contact with the web 41.

In practice, I have found that a cabinet of the type here illustrated, containing 50 gallons of ice cream may be maintained at a temperature of zero degrees F., without variation of more than one degree either way, for a period of twenty-four hours by the use of about ten pounds of solid carbon dioxide, this under conditions where the covers of the ice cream compartment are being frequently removed and ice cream dispensed. The solid carbon dioxide is very efficiently utilized not only because very little sublimation occurs when the elevator is raised, but because there is an automatic gravity feed of the solid carbon dioxide on to its bottom support, so that there will be no appreciable increase in temperature as long as even a few ounces of the ice remain in the chamber.

Difficulty has been found with many types of refrigerant apparatus using an intensely cold refrigerant due to the fact that frost forms on the heat exchange surfaces and so insulates the refrigerant, with the production of temperatures much below 32 degrees F. as above. In the present instance, however, no frost will form either on the bellows or on the screws or the heat exchange surface of the casting, due to the fact that all of them are bathed in the extremely dry carbon dioxide gas. In actual practice, I have found that in spite of the moist contents of the cabinet, all of the elements described above will be free of frost in use.

In Fig. 5 I have illustrated a modified type of construction in which some of the material to be cooled is not in close proximity to the refrigerating unit and cooling by direct heat transfer is not practicable. A typical instance is the case of an ice cream cabinet which is very long and narrow accommodating say ten or twelve cans of ice cream in a row.

Such a cabinet is indicated at 70 in Fig. 5 and 71 represents the hatches through which access is had to the cans (not shown) within the cabinet. Here the ice compartment 72 consists of a box or the like 73 of insulating material extending all the way to the bottom of the cabinet and enclosed by the hood 54. The block of solid CO_2 55 is supported upon a pipe coil 56. This pipe coil forms part of a continuous brine circulating system including circulating pipes 57, 58 and 59 arranged along the top, bottom and sides of the box. Brine circulation is maintained by a pump 60 operated by an electric motor 61 controlled by a thermostatic switch 16 disposed at any convenient location within the cabinet.

It will be observed that in this case again the pump and motor are bathed in carbon dioxide so that they are kept free of frost.

When the pump is stopped and no brine circulation is occurring there will be very little sublimation of the solid CO_2 since this refrigerant is insulated on all sides and can only transfer heat through the piping system. When the box temperatures rise however the thermostatic switch will start the motor which in turn will run the pump, maintaining a continuous brine circulation, the brine giving up its heat at the coil 56 and becoming colder and colder until such time as the thermostatic switch again cuts off the motor and causes cessation of brine circulation.

It will thus be seen that there is herein described apparatus in which the several features of this invention are embodied, and which apparatus in its action attains the various objects of the invention and is well suited to meet the requirements of practical use.

As many changes could be made in the above construction, and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. In a refrigerating apparatus of the character described, a refrigerant container insulated at its top, bottom and sides, and having a heat conductive bottom, a platform constituting a vertically movable part of said bottom, and upon which a mass of solid refrigerant is adapted to rest, and thermostatically controlled means arranged exteriorly of the container operable to raise the platform and shift the solid refrigerant out of direct heat exchange relationship with the bottom of the chamber.

2. In a refrigerating apparatus of the character described, a refrigerant container insulated at its top, bottom and sides, and having a heat conductive bottom, a platform constituting a vertically movable part of said bottom, and upon which a mass of solid refrigerant is adapted to rest, and thermostatically controlled means arranged exteriorly of the container operable to raise the platform and shift the solid refrigerant out of direct heat exchange relationship with the bottom of the chamber and means for bathing said thermostatically controlled operating mechanism in gas evolved from the sublimation of the refrigerant whereby to prevent frosting of the control apparatus.

3. An automatically acting self-contained refrigerating unit of the character described including a vertically disposed open-ended casting having a transverse partition therein, an insulating liner for the upper end of the casting supported on said partition, and an insulating cover, an elevator plate lying against the top surface of the partition, a thermostatic bellows secured to the underside of the partition, and means actuated by the bellows for lifting the elevator plate.

4. An automatically acting self-contained refrigerating unit of the character described, including a vertically disposed open-ended casting having a transverse partition therein, an insulating liner for the upper end of the casting supported on said partition, and an insulating cover, an elevator plate lying against the top surface of the partition, a thermostatic bellows secured to the underside of the partition, and means actuated by the bellows for lifting the elevator plate, and a gas passage through the partition adapted to insure continuous bathing of the bellows in gas evolved from the refrigerant on the elevator.

5. An ice cream cabinet of heat insulating material having a plurality of covered openings therein through which cans of ice cream are adapted to be introduced, a refrigerating unit including a container for solid CO_2, said refrigerating unit being disposed in immediate proximity to all of said cans and a cover in the top of the cabinet through which said unit is charged, said unit presenting a plurality of metallic heat exchange surfaces cooled directly by conduction from the refrigerant in said unit, automatic means for preventing direct conduction between the refrigerant and the heat exchange surface when the temperature of the cabinet reaches a predetermined minimum.

6. An ice cream cabinet of heat insulating material having a plurality of covered openings therein through which cans of ice cream are adapted to be introduced, a refrigerating unit including a container for solid CO_2, said refrigerating unit being disposed in immediate proximity to all of said cans and a cover in the top of the cabinet through which said unit is charged, said unit presenting a plurality of metallic heat exchange surfaces cooled directly by conduction from the refrigerant in said unit, and automatic means for preventing direct conduction between the refrigerant and the heat exchange surface when the temperature of the cabinet reaches a predetermined minimum and automatic means for reestablishing direct conduction between said surface and the refrigerant when the temperature in the cabinet exceeds a predetermined maximum.

7. In a refrigerating unit of the class described adapted to be mounted in a compartment to be refrigerated, said unit including a hollow casting having a horizontal partition extending thereacross and dividing the casting into an upper refrigerant chamber and a lower control chamber, means for insulating refrigerant in the upper chamber against direct contact with the side walls of the casting and thermostatic means in the control chamber for lifting the refrigerant out of contact with the partition when certain temperature conditions prevail in the chamber to be refrigerated.

8. In a refrigerating unit of the class described adapted to be mounted in a compartment to be refrigerated, said unit including a hollow casting having a horizontal partition extending thereacross and dividing the casting into an upper refrigerant chamber and a lower control chamber, means for insulating refrigerant in the upper chamber against direct contact with the side walls of the casting and thermostatic means in the control chamber for lifting the refrigerant out of contact with the partition when certain temperature conditions prevail in the chamber to be refrigerated, means affording free communication between the refrigerant chamber and the control chamber whereby the control mechanism

is bathed in gases evolved from the refrigerant and prevented from frosting.

9. In a refrigerating unit of the class described adapted to be mounted in a compartment to be refrigerated, said unit including a hollow casting having a horizontal partition extending thereacross and dividing the casting into an upper refrigerant chamber and a lower control chamber, means for insulating refrigerant in the upper chamber against direct contact with the side walls of the casting and thermostatic means in the control chamber for lifting the refrigerant out of contact with the partition when certain temperature conditions prevail in the chamber to be refrigerated, an elevator plate normally resting upon the top of the partition and supporting the solid sublimating refrigerant, a thermostatic bellows arranged in the control chamber and operative to raise said elevator.

10. In a refrigerating unit of the class described adapted to be mounted in a compartment to be refrigerated, said unit including a hollow casting having a horizontal partition extending thereacross and dividing the casting into an upper refrigerant chamber and a lower control chamber, means for insulating refrigerant in the upper chamber against direct contact with the side walls of the casting and thermostatic means in the control chamber for lifting the refrigerant out of contact with the partition when certain temperature conditions prevail in the chamber to be refrigerated, an elevator plate normally resting upon the top of the partition and supporting the solid sublimating refrigerant, a thermostatic bellows arranged in the control chamber and operative to raise said elevator, said bellows being anchored at one end of the underface of the partition and screws carried by the movable end of the bellows working through the partition to lift said elevator.

11. In a refrigerating unit of the class described adapted to be mounted in a compartment to be refrigerated, said unit including a hollow casting having a horizontal partition extending thereacross and dividing the casting into an upper refrigerant chamber and a lower control chamber, means for insulating refrigerant in the upper chamber against direct contact with the side walls of the casting and thermostatic means in the control chamber for lifting the refrigerant out of contact with the partition when certain temperature conditions prevail in the chamber to be refrigerated, an elevator plate normally resting upon the top of the partition and supporting the solid sublimating refrigerant, a thermostatic bellows arranged in the control chamber and operative to raise said elevator, said bellows being anchored at one end of the underface of the partition and screws carried by the movable end of the bellows working through the partition to lift said elevator, said elevator being of heat conducting material and the upper face of the partition being counter-sunk to receive the heads of the screws and permit the elevator to rest primarily on the partition when the bellows is expanded.

12. A refrigerating unit including a hollow open-ended casting having a transverse horizontal partition therein, a hollow box of insulating material loosely lining the upper end of the casting and adapted to insulate a sublimating refrigerant from contact with the side walls thereof and a cover for the refrigerant chamber fitting into the top of said box, a flat plate resting on the top of the partition and adapted to support the solid sublimating refrigerant in the chamber and thermostatic means disposed in the partition for raising and lowering the plate.

13. A refrigerating unit including a hollow open-ended casting having a transverse horizontal partition therein, a hollow box of insulating material loosely lining the upper end of the casting and adapted to insulate a sublimating refrigerant from contact with the side walls thereof and a cover for the refrigerant chamber fitting into the top of said box, a flat plate resting on the top of the partition and adapted to support the solid sublimating refrigerant in the chamber and thermostatic means disposed in the partition for raising and lowering the plate, comprising a thermostatic bellows anchored at one end of the partition and at its free end carrying elevator rods working through the partition whereby the plate is lifted as the bellows contracts.

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