

[54] **PASSIVELY COOLED FLUID STORAGE APPARATUS**

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62/530; 62/239

[51] Int. Cl. **F25d 3/12**

[58] Field of Search 62/384, 385, 438, 530

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[57] **ABSTRACT**

An improved food storage assembly and the like includes a housing having a cavity which opens from the housing along the side thereof. Door means are engageable with the housing across the side of the cavity for closing the cavity opening. Thermal insulation material is carried by the housing and the door means for essentially fully enclosing the cavity in the closed position of the door means. A receptacle is located in the housing for receiving a predetermined quantity of a latent heat of fusion cooling medium which is other than water ice. Means are intimately and thermally conductively associated with the receptacle for thermally coupling the receptacle with selected portions of the cavity; these means include a metal member which forms at least the floor of the receptacle and which also forms fin means disposed vertically in the selected portions of the cavity. The predetermined quantity of cooling medium and the dimensions of the metal member are defined with relation to the type and quantity of the insulation material, to the geometry of the cavity and to the thermal conductivity of the metal member for maintaining the selected portions of the cavity and the contents thereof at substantially predetermined temperatures throughout a predetermined period under predetermined ambient temperature conditions.

9 Claims, 9 Drawing Figures

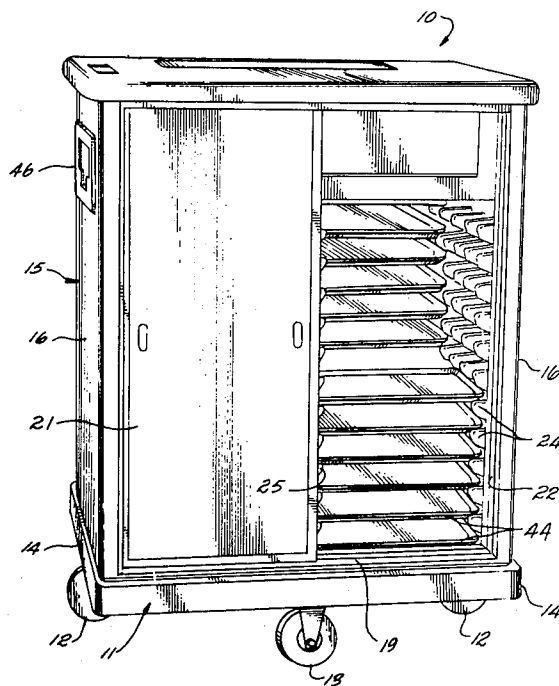
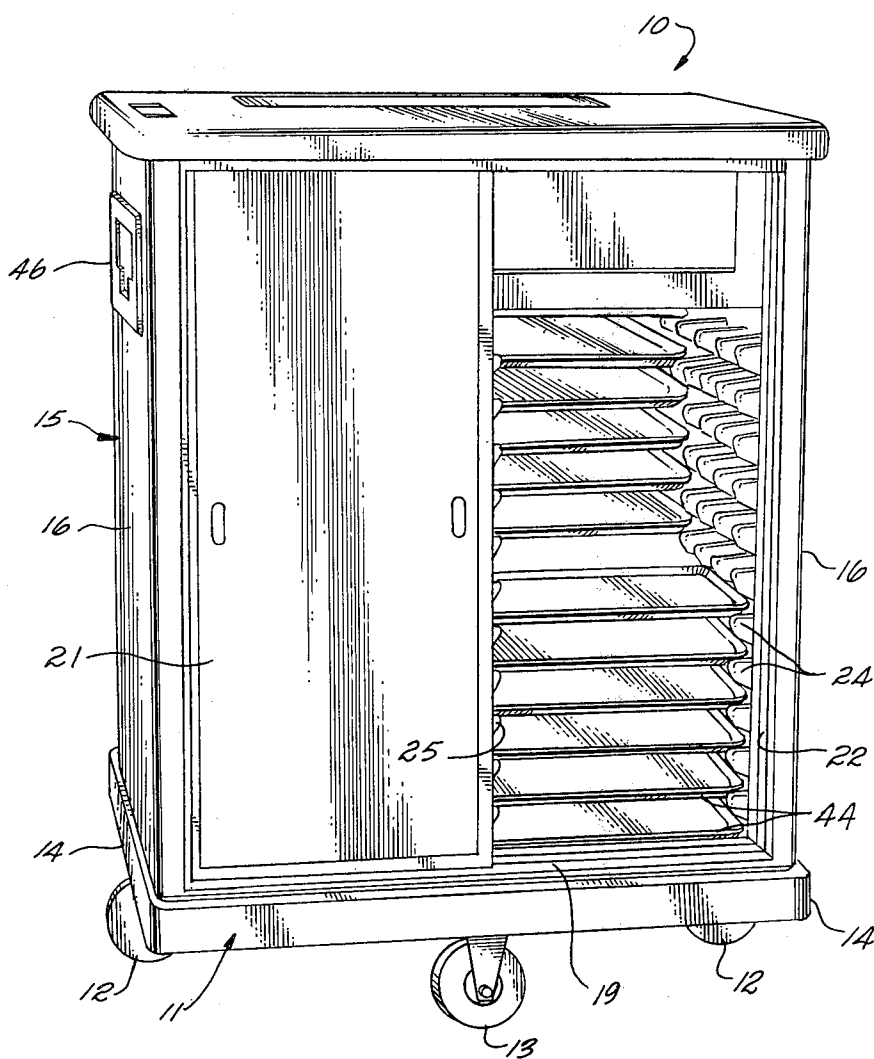


Fig. 1



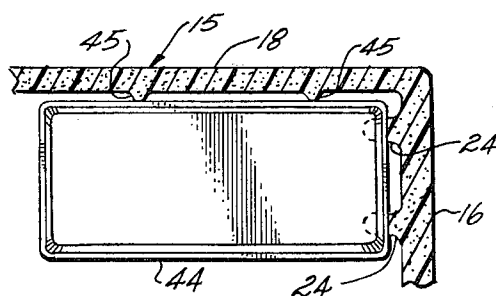
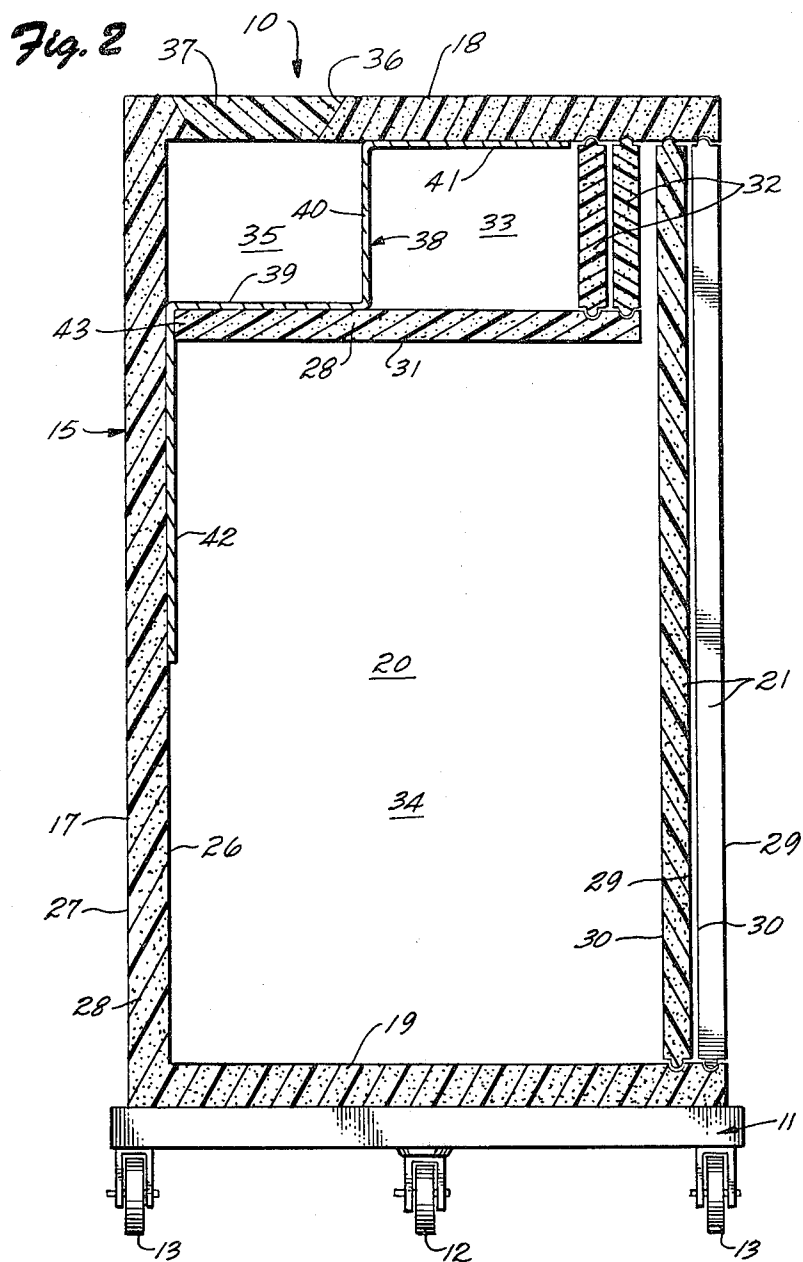


Fig. 3

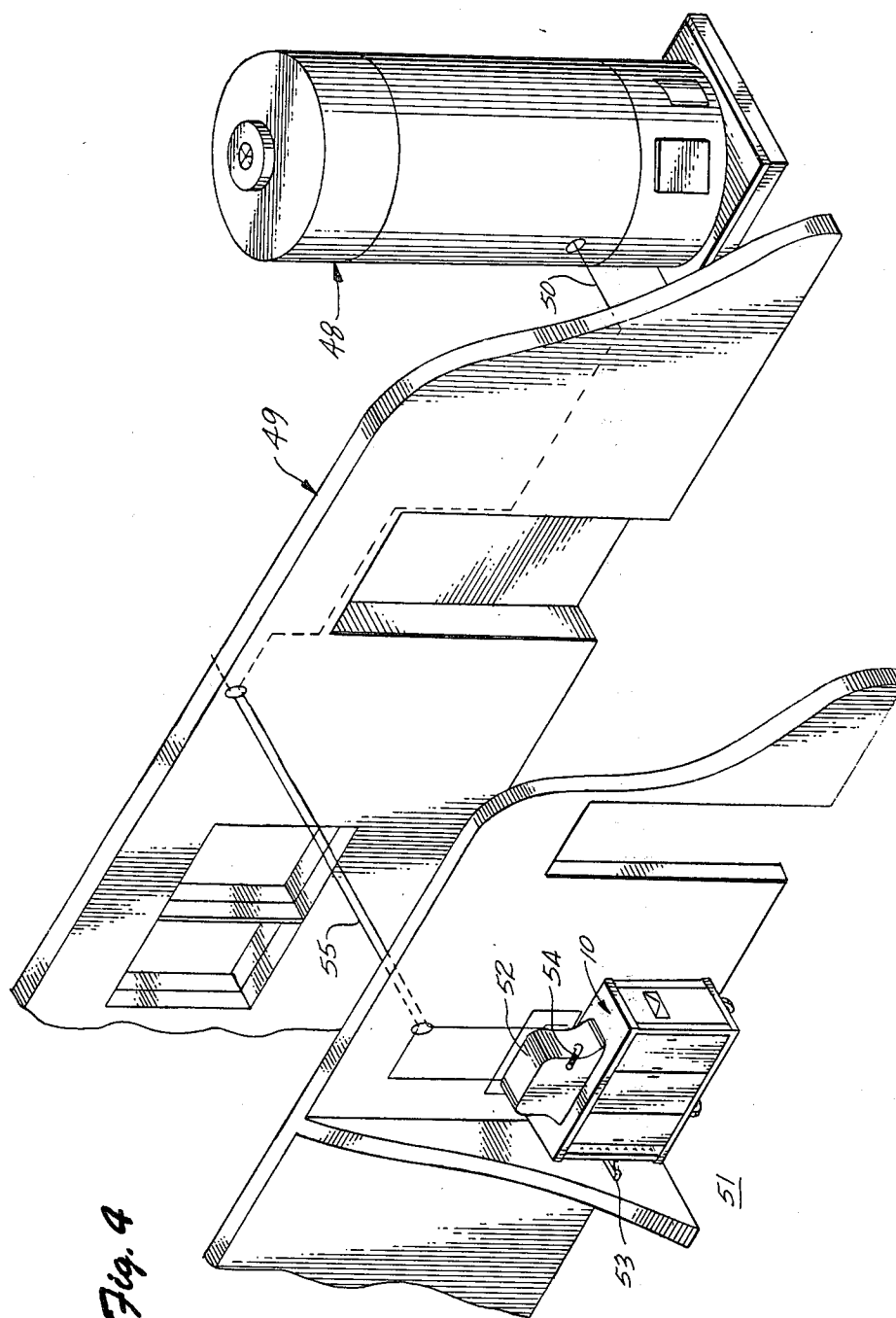


FIG. 6

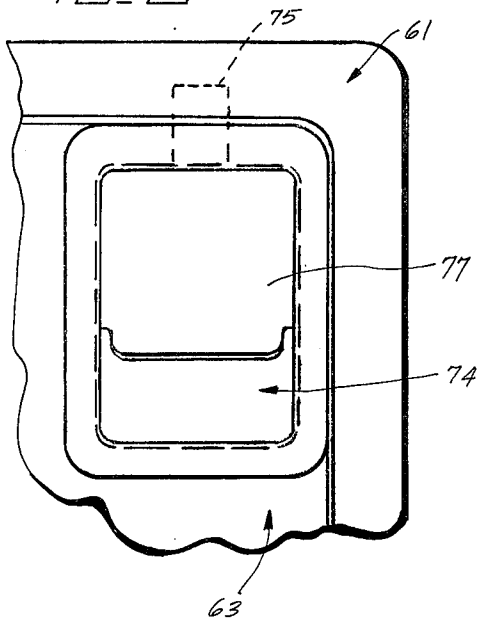


FIG. 7

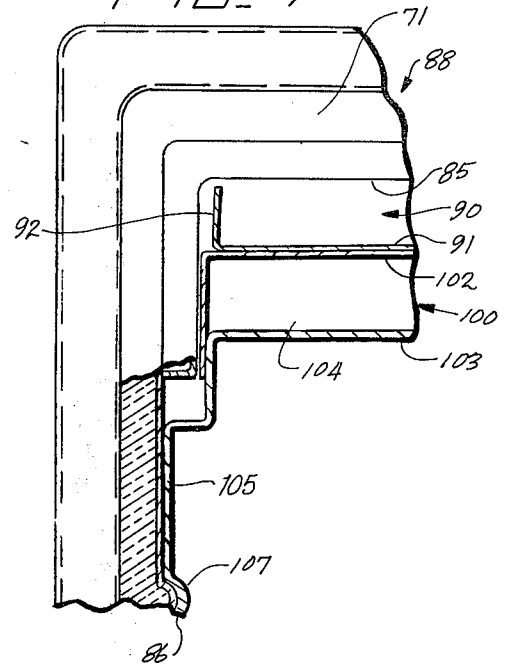


FIG. 8

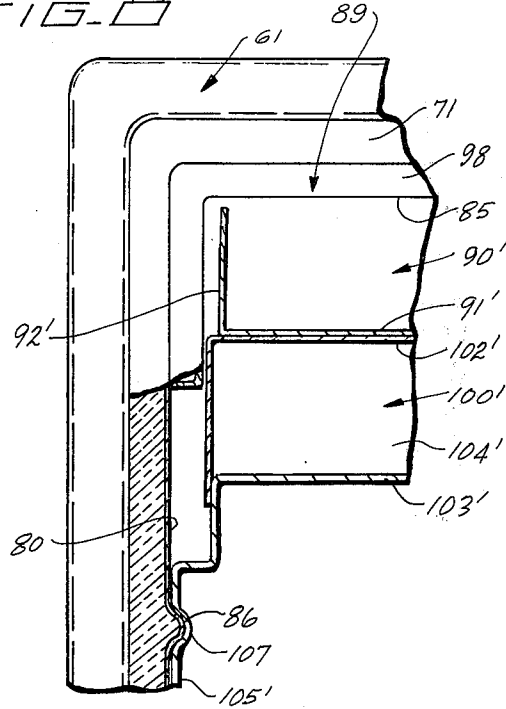
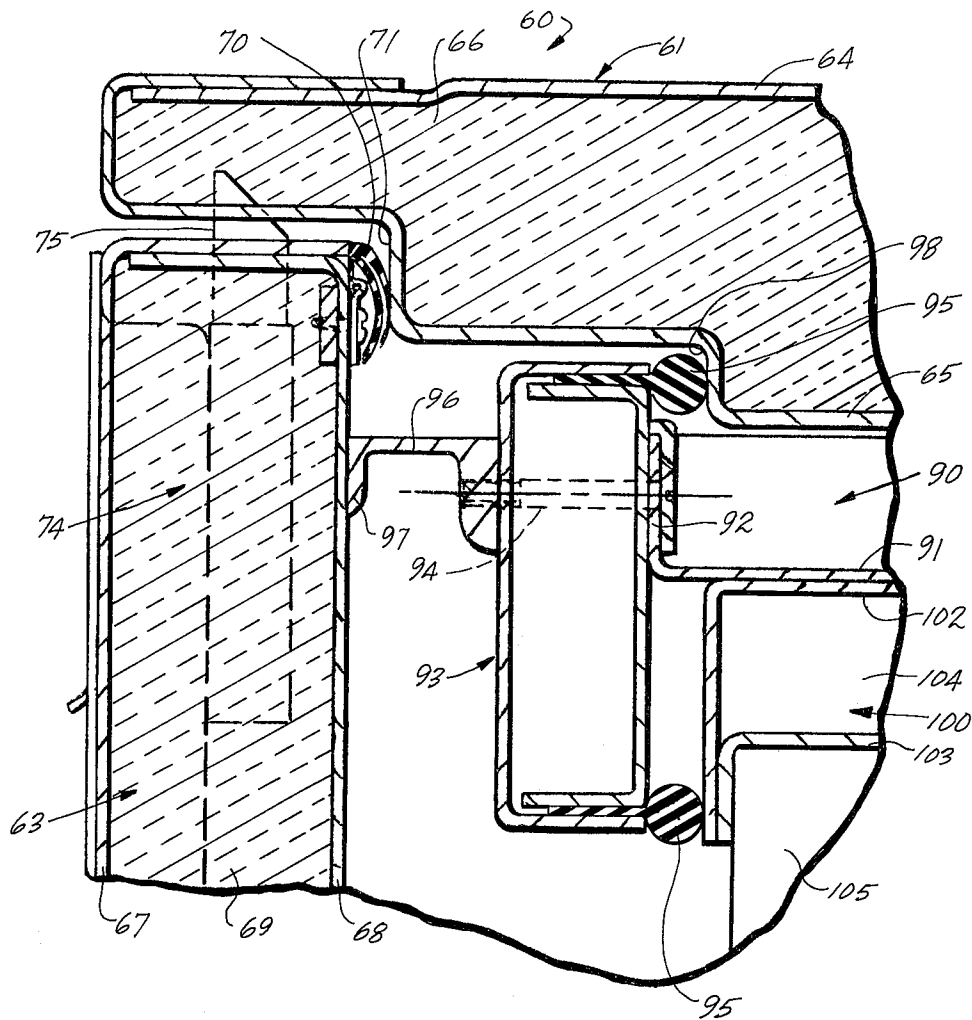


FIG. 9



PASSIVELY COOLED FLUID STORAGE APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of copending application Ser. No. 253,414 filed May 15, 1972, now matured into U.S. Pat. No. 3,800,554.

FIELD OF THE INVENTION

This invention pertains to food storage apparatus, and more particularly to such apparatus using passive resistance and latent heat control mechanisms for preserving frozen and refrigerated foodstuffs and the like.

BACKGROUND OF THE INVENTION

Description of the Prior Art: So-called "convenience foods" are increasingly being used by hospitals and other institutions for the preparation and serving of individual meals. In a typical convenience food system, food is cooked completely, or essentially completely, in a centralized kitchen which may be on the premises of the serving institution, but which more commonly is separate from the institution so as to serve several institutions, such as hospitals and the like, on a contract basis. After it has been prepared in a centralized kitchen, the food may be shipped in bulk or in individual dispensed portions to the serving institution in either a frozen or refrigerated state. Upon receipt by the serving institution, the food is maintained in a central commissary or the like until it is required. The commissary is a food receiving and processing facility, and does not have the extensive cooking and heating equipment of a conventional institutional kitchen. If the convenience foods are received in bulk by the serving institution, the foods are dispensed into individual portions in the commissary.

The basic objective of the convenience food industry is to enable the preparation of food of enhanced quality at reasonable cost by personnel working with efficient equipment during normal working hours. This concept makes it possible to employ competent people and to pay them reasonable wages without increasing the cost of the foods so prepared. A subsidiary object of the convenience food industry is to centralize the food preparation equipment. Hospitals which have adopted the convenience food concept no longer require a full-scale kitchen and its staff. The central commissary is supported by individual food preparation stations on the various floors of the hospital close to the individual patients who are to be fed. A typical final preparation station may include one or more electronic or microwave ovens and dispensing apparatus for hot and cold beverages.

Typically, in a hospital which has adopted a convenience food program, individually prepared trays of food for specified patients are assembled in the commissary and transported to the proximity of the patients in refrigerated food service carts. Immediately prior to serving of the food, the hot dishes on the tray are placed in the electronic oven where the food is brought up to the desired temperature, which may include the last stages of cooking of partially cooked foods such as meats. Upon emerging from the electronic oven, the hot dishes are placed on the tray with the refrigerated foods, such as salads, and frozen foods, such as ice

cream desserts or the like, are also placed on the tray and the tray is delivered promptly to the patient.

The individual food service carts may be loaded several hours or a few days prior to the time at which the individual trays and the food contained thereon are to be served to the patients.

Several food service carts are known for receiving trays loaded with convenience foods in the centralized commissary of hospitals and the like, and for transporting these trays to the individual food preparation stations. All of these products are single temperature devices designed specifically for refrigerated, as opposed to frozen, foods. These products include service carts which incorporate conventional electrical powered refrigeration systems, whereas other products use forced-air circulation over dry ice banks contained within the cart. To the extent that forced-air circulation systems are involved, fans and the like are also required. In all of these products, the insulative capacity of the cart is relied upon, during movement of the cart from the commissary to the individual preparation stations, to maintain food at the desired temperature. Because these products rely upon electrical mechanisms, they are expensive and heavy, and therefore are difficult for the usual hospital attendant or the like to manipulate through the sometimes crowded hallways of the hospital.

A need exists for an improved food service cart which is not dependent upon electrical power to generate and maintain the desired temperature levels within the food storage areas of the cart. A need also exists for a food service cart which is capable of generating different temperature for long-term holding of both refrigerated and frozen foods so that ice cream or sherbet, for example, can be served in a fully frozen condition to a patient at the same time the patient is served with hot and refrigerated foods according to the procedures reviewed above.

SUMMARY OF THE INVENTION

This invention provides improved food service carts and the like which meet the needs identified above. The food service cart according to this invention uses passive cooling processes which are not dependent upon the use of forced-air circulation or other electrically powered refrigeration systems. These passive cooling mechanisms are arranged so that the cart is capable of holding frozen and refrigerated foods in respective sections of the cart for long periods of time, including during movement of the cart from a central commissary to the individual preparation stations proximate the patient. Because they do not incorporate electrical apparatus, the present service carts are substantially lighter in weight than similar products known heretofore and are conveniently moved about the hospital or other serving institution.

Generally speaking, this invention provides an improved food storage assembly, such as a hospital food service cart for receiving and transporting convenience foods. The assembly includes a housing which defines a cavity opening from the housing along one side thereof. Door means are engageable with the housing across one side of the cavity to close the cavity opening. Thermal insulation material is carried by the housing and by the door means for essentially fully enclosing the cavity in the closed position of the door means. A receptacle is located in the housing for receiving a

predetermined quantity of a latent heat of fusion cooling medium which is other than water ice. Means are intimately and thermally conductively associated with the receptacle for thermally coupling the receptacle with selected portions of the cavity, and these coupling means include a metal member which forms at least the floor of the receptacle and which also forms fin means disposed vertically in the selected portions of the cavity. The predetermined quantity of cooling medium and the dimensions of the metal member are defined with relation to the type and quantity of the insulation material, to the geometry of the cavity and to the thermal conductivity of the metal member so that the cooling means are effective to maintain selected portions of the cavity and contents thereof at substantially predetermined temperatures through a predetermined period under predetermined ambient temperature conditions. In the embodiment of this invention typified by a hospital food service cart and the like, the latent heat of fusion medium is solidified carbon dioxide, also commonly known as "dry ice".

Another embodiment of this invention is useful for maintaining quantities of refrigerated or frozen food in refrigerated or frozen states for long periods of time as required, for example, in food handling systems for passenger airlines. In this embodiment, the latent heat of fusion cooling medium preferably is a eutectic gel material which is so formulated to have its freezing point at a predetermined temperature.

DESCRIPTION OF THE DRAWINGS

The above-mentioned and other features of this invention are more fully set forth in the following description of presently preferred embodiments of this invention, which description is presented with reference to the accompanying drawings wherein:

FIG. 1 is a perspective view of a food service cart for transporting refrigerated and frozen foodstuffs;

FIG. 2 is a cross-section elevation view of the cart shown in FIG. 1;

FIG. 3 is a fragmentary cross-sectional plan view of a portion of the cart shown in FIG. 1;

FIG. 4 is a fragmentary perspective view of a station in a hospital for loading dry ice into the cart of FIG. 1;

FIG. 5 is a cross-sectional elevation view of a food transport container according to this invention;

FIG. 6 is a fragmentary elevation view of a door latch mechanism in the structure shown in FIG. 5;

FIG. 7 is a fragmentary elevation view of a portion of the structure shown in FIG. 5, such structure being arranged for the keeping of unfrozen perishable foodstuffs;

FIG. 8 is a view similar to FIG. 7 of a modification of the structure shown in FIG. 5 adapted for keeping frozen foodstuffs; and

FIG. 9 is an enlarged fragmentary elevation view of the structure shown in the upper left-hand portion of FIG. 5.

DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

A passively cooled food service cart 10, shown in FIGS. 1 and 2, includes a pallet-like base 11 supported on two castered wheels 12 and two uncastered wheels 13. The castered wheels are disposed at the middle of each of the opposite ends 14 of the base, and the uncastered wheels are each mounted at the center of the

opposite sides of the base. An insulated food storage housing 15 is mounted on the base and defines opposite vertical end surfaces 16, a vertical rear surface 17, a horizontal top 18, and an insulated floor 19 which enclose five of the six sides of a cubical cavity 20 within the housing. The cavity is open across its entire front side from the housing but is closable by a pair of sliding doors 21 which are engaged in suitable tongue-and-groove guideways cooperating between the upper and lower edges of the doors and the adjacent boundary of a front opening 22 from the cavity. The fit of doors 21 within the perimeter of the cavity opening and between themselves is sufficiently tight that when the doors are fully closed across the front of the housing, cavity 20 is essentially sealed from the exterior of the housing.

The interior side walls of the housing define a plurality of protuberances 24 which cooperate with similar protuberances 25 on a central vertical partition within the cavity for supporting a plurality of food service trays 44 in spaced relation within the cavity. In the particular embodiment of the invention illustrated in FIG. 1, the interior structure of the housing is arranged to receive forty-eight 14 × 18 inch food service trays in four stacks of twelve trays each. The overall dimensions of this exemplary food service cart are 58 inches high by 37½ inches deep by 45 inches wide, and the cart, empty of food and dry ice, weighs approximately 230 pounds.

As shown best in FIG. 2, the top, bottom, rear and side walls of housing 15 are defined by an inner shell 26 and an outer shell 27, which preferably are fabricated of suitably formed thermoplastic material or fiberglass-reinforced synthetic resin material. The inner and outer shells over these surfaces of the housing, are spaced substantially uniformly from each other to define a space between them which is filled with a quantity of a thermal insulation material 28. Preferably the spacing between the inner and outer shells is on the order of 1½ inches, and the insulation material preferably is a Freon-blown polyurethane resin foam material having a density of about 2 pounds per cubic foot. The inner and outer shells are interconnected to each other about the periphery of cavity opening 22 by suitable bonding agents to define a hermetic seal around the thermal insulation material. As shown in FIG. 2, each of doors 21 has an outer face member 29 and an inner face member 30 which are suitably mated to each other to define a space between them which is filled with a quantity of thermal insulation material 28.

A horizontal shelf or partition 31 is disposed in the upper portion of cavity 20, as shown in FIG. 2. The shelf is constructed in a manner similar to each of doors 21 and extends from side to side of the cavity and also from closely proximate the inner rear wall of the cavity to just inwardly of the inner surface of the inner one of front doors 21. Because the partition is fabricated in a manner similar to that of doors 21, it is fully insulated across its entire extent by being filled with a quantity of insulation material 28 contained within the space defined by a pair of mating shell elements similar to the door shell elements. A pair of insulated sliding doors 32, generally similar to doors 21 except for their size, cooperate between the upper front portions of the partition and the top of the housing for separate closure of a freezing chamber 33 defined in the uppermost front portion of cavity 20 above partition 31. The partition subdivides cavity 20 into the aforementioned freezing

chamber 33 and a lower, larger refrigerating chamber 34.

Freezing chamber 33 occupies only a portion of the volume of cavity 20 lying above partition 31. The remainder of this volume of the cavity comprises a receptacle 35 for a quantity of dry ice which may be loaded into the receptacle through a filling port 36 in the top of the housing and closable by a manually removable plug closure 37 which is arranged to lie flush with the outer surfaces of the housing in its closed position.

A metal plate 38, preferably formed of aluminum or some other metal of high thermal conductivity, is bent as shown in FIG. 2 to define the floor 39 and front wall 40 of dry ice receptacle 35. Plate 38 has an extension portion 41 which projects forwardly from the upper edge of the receptacle front wall along the bottom surface of housing top 18 to just inwardly from the inner one of freezing chamber doors 32 so as to define the ceiling of the freezing chamber. Plate 38 has a second extension portion 42 which is formed by suitably bending the plate at the rear of receptacle floor 39 so that the plate extends through a mating aperture 43, formed between the rear of partition 31 and the inner face of housing rear wall 17, so that plate extension portion 42 is disposed vertically in the upper rear portion of refrigerating chamber 34 against the adjacent face of housing shell 26. The aperture 43 is sealed around the plate.

Plate portions 40, 41 and 42 define thermal fin means for the freezing and refrigerating chambers, respectively, and thermally couple the dry ice receptacle to these chambers. The extent of thermal coupling provided between the dry ice receptacle 35 and the freezing and refrigerating chambers respectively is determined by the temperature to be maintained in the respective chamber. In this context, it is well known that the sublimation temperature of dry ice, i.e., solidified carbon dioxide, at atmospheric pressure is -109°F . The coupling fin means defined in chambers 33 and 34 by the plate are vertical in the case of refrigerating chamber 34 and are both vertical and horizontal in the case of freezing chamber 33. This disposition of the fin means within these chambers facilitates the generation of convection currents within the chambers, which currents assure that the desired temperature will be established and maintained at all locations throughout the respective chamber during use of cart 10. It is apparent, therefore, that the cooling mechanisms at work during use of cart 10 in freezing chamber 33 and in refrigerating chamber 34 are principally conduction mechanisms in which heat is conducted from the chamber to the heat sink afforded by dry ice disposed in receptacle 35, and secondarily, by induced convection within the respective chambers.

Preferably, tray support protuberances 24 are defined by appropriate molding of housing inner shell 26. If desired, however, the function provided by protuberances 24 and 25 may be provided by appropriate wire rack assemblies secured to the inner side walls of the housing, and also substituted for the central vertical partition. In any event, the tray supporting mechanisms are arranged to prevent stratification of air within refrigerating chamber 34 by direct contact of the trays with the inner walls of the chamber. Thus, as shown in FIG. 3, protuberances 24 are formed locally of the inner side walls of the housing. Also, a plurality of vertical ribs 45 are defined by inner shell member 26 along the back surface of the refrigerating chamber. Accord-

ingly, the convection induced by cooling of fin projection 42 in the refrigerating chamber is not significantly impeded during use of the cart by direct contact of the tray perimeters with the walls of the chamber. Instead, the trays disposed in any given horizontal plane within the chamber are spaced from each other and from the walls of the chamber.

As shown in FIG. 1, a towing handle structure 46 preferably is molded into the outer shell of housing 15 in each housing end wall 16. The handle structure is essentially a recess molded into the outer shell into which a person desiring to move the cart may put his hand in order to conveniently grasp the structure of the cart.

In a presently preferred food service cart according to this invention, the predetermined temperature which is maintained in freezing compartment 33 is -10°F , $\pm 10^{\circ}\text{F}$. The predetermined temperature which is created and maintained in refrigerating compartment 34 is 40°F , $\pm 8^{\circ}\text{F}$. These predetermined temperatures are created and maintained efficiently when the ambient steady-state temperature outside the service cart is 75°F , $\pm 10^{\circ}\text{F}$. These temperatures are maintained by appropriate balancing of the cooling characteristics of dry ice loaded into receptacle 35 and the heat transfer characteristics provided between the receptacle and the freezing and refrigerating compartments, on the one hand, with respect to the insulation and heat transfer characteristics of the housing itself, on the other hand. In the abovementioned preferred embodiment of the invention, the usage rate of dry ice disposed in the dry ice receptacle is from 1 to 1.2 pounds per hour. Receptacle 35 has a capacity to receive approximately 35 pounds of solidified carbon dioxide in pellet or snow form. It has been found that, particularly where pre-chilling techniques are used to lower the temperature of the freezing and refrigerating temperatures prior to insertion of food therinto, frozen and refrigerated food may be maintained in the service cart at the desired temperatures for periods of up to 36 hours or so, depending upon the amount of dry ice disposed in the dry ice receptacle.

FIG. 4 is a fragmentary perspective view of a portion of a hospital 49 or the like in the vicinity of a food receiving and processing commissary with which a plurality of service carts 10 are used. A suitable tank 48 or other structure for storing liquid carbon dioxide is located outside building 49. A liquid carbon dioxide supply line 50 extends from tank 48 through the building into the vicinity of a cart loading area 51 to a dry ice dispensing mechanism 52 which preferably is located on the wall of the building adjacent to a cart pre-chilling mechanism 53 to which the liquid carbon dioxide supply line is also connected. The dry ice dispensing mechanism and the pre-chilling mechanism are so disposed relative to each other that, when the cart is brought into position with its dry ice filling port located directly below dispensing mechanism 52, the pre-chiller mechanism 53 is positioned to discharge a stream of supercooled CO_2 gas or the like into the interior of the cart through the open front of the cart as provided by partial retraction of one of doors 21. The dry ice dispensing mechanism 52 is arranged to discharge a metered amount of dry ice, in either pellet or snow form, into the dry ice receptacle of the adjacent cart upon operation of an activating lever 54. A carbon dioxide vapor vent line 55 is connected from the dry

ice dispenser and pre-chilling mechanisms to the exterior of building 49.

In the food storage assemblies according to this invention, namely, both those shown in FIGS. 1-4 as well as those shown in FIGS. 5-9, the cooling mechanisms involved rely upon the heat of fusion of a suitable cooling medium. The cooling medium is a medium other than water or water ice. In the context of food service cart 10, the latent heat of fusion cooling medium is solidified carbon dioxide. In the food storage assemblies shown in FIGS. 5-9, the latent heat of fusion cooling medium is a suitable eutectic gel material with which dry ice, in appropriate form, may be used.

FIG. 5 is a vertical cross-sectional elevation view of a food transport container 60 according to this invention. The food transport container is adapted for use in the galley or hold compartments of commercial passenger aircraft for maintaining frozen or unfrozen foodstuffs at a desired cooled state for desired periods of time under the ambient temperature conditions typical of a hot summer day, and also during an aircraft flight of desired duration. Container 60 is comprised in principal part by a generally cubical housing 61 defining a cavity 62 therein, and by a door 63 adapted to close the cavity; the cavity is openable across its entire front extent upon disengagement of the door from the housing. In a presently preferred embodiment of the container, the housing has external dimensions of about 39 inches high by about 27 inches deep by about 24½ inches wide. It will be appreciated, however, that food storage containers having other external dimensions are within the scope of this invention.

Housing 61 is comprised of an outer shell 64 and an inner shell 65 which preferably are fabricated of resin-impregnated fiberglass material or of a suitable molded thermoplastic resin. The inner shell is disposed within the outer shell and is connected to the outer shell only around the perimeter of the openable front of cavity 62. As so interconnected with each other, the inner and outer shells are spaced apart substantially uniformly over most of their area, and the spacing between opposed locations on the shells is approximately 1½ inches in the aforementioned embodiment. The space between the inner and outer shells of housing 61 is filled with a quantity of thermal insulation material 66, preferably Freon-blown polyurethane resin foam material having a density of about 2 pounds per cubic foot. The connection between the shells about the perimeter of the cavity opening preferably is a hermetic seal provided by a suitable bonding agent interposed between the mating surfaces of the shells.

Door 63 is of a construction similar to that of housing 61 and includes an outer face member 67 and an inner face member 68 which are mated with and bonded to each other about the perimeter of the door, as shown best in FIG. 9. The interior of the door is filled with a quantity of thermal insulation material 69 which preferably is of the same type as is provided in the space between the housing inner and outer shells. A strip of suitable resilient gasket material 70 is fixed to the inner surfaces of the door, i.e., to the outer surface of the door inner face plate, around the perimeter of the door to mate with a front-opening shoulder 71 defined by the housing inner shell around the perimeter of the opening of cavity 62. A half-round, upwardly-convex bead protuberance 72 is defined by the housing inner shell along the bottom of the container door opening to

mate with a downwardly-concave, semicircular recess 73 formed in the bottom edge of door 63 as shown in FIG. 5. Protuberance 72 and recess 73 cooperate to define a fully disengageable pivot fulcrum for hinging movement of the door relative to the housing as the door is moved into its closed position.

A pair of spring-loaded, commercially available latch assemblies 74, only one of which is shown, are carried in the upper corners of the door. Each latch assembly (see FIGS. 5, 6 and 9) includes a retractable latch member 75 which cooperates with a corresponding latch aperture 76 defined in housing 61 adjacent each upper corner of the door opening. The latch assemblies are arranged to cause the retractable latch member to be engaged with the latch aperture as the door is slammed into its closed position following engagement of protuberance 72 with recess 73. Such movement of the door into its closed position causes gasket 70 to be suitably deformed to provide an airtight seal between the door and the housing. The door is releasable from the housing by operation of trip levers 77 (see FIG. 6).

As shown in FIG. 5, it is preferred that housing shells 64 and 65 be of essentially uniform thickness, and similarly with the inner and outer face members of door 63. To impart the desired structural rigidity to the housing a plurality of dimples are defined in the housing inner shell, thereby to provide a plurality of vertically disposed spaced stiffening ribs 79 extending inwardly of cavity 62 from the sides 80 and rear 81 walls of the cavity. A similar plurality of parallel stiffening ribs 82 extend upwardly from the bottom surface 83 of the cavity in alignment with the front-to-back dimension (i.e., the depth) of the cavity. Door 63 is similarly stiffened by a plurality of vertical stiffening ribs 84 which extend outwardly from the inner surface of the door.

Each side wall 80 of container cavity 62 is dimpled inwardly of the cavity at a specified distance below the cavity top wall 85 to define a horizontal rib protuberance 86 which serves as a support ledge for either a refrigerator latent cooling assembly 88 (shown in FIGS. 5 and 7) or a freezer latent cooling assembly 89 (shown in FIG. 8). That is, the opposing side wall surfaces of container cavity 62 define a pair of parallel, opposed horizontal ribs 86 approximately midway between the top wall surface of the cavity and the upper ends of stiffening ribs 79; ribs 79 preferably have their upper ends disposed at about the midpoint of the vertical extent of cavity 62.

Regardless of whether the foodstuffs disposed within the transparent container are to be maintained in a frozen state or in a refrigerated but unfrozen state, the container housing and door structures are identical. Where the contents of cavity 62 are to be maintained in a refrigerated but unfrozen state, then the refrigerator latent cooling assembly 88, shown in FIGS. 5 and 7, is supported in the upper portion of the cavity on ribs 86. In cases where the contents of the container cavity are to be maintained in a frozen state, a freezer latent cooling assembly 89 (shown in fragmentary cross-sectional elevation view in FIG. 8) is supported in the upper portion of the cavity by ribs 86.

Refrigerator and freezer latent cooling assemblies 88 and 89 are similar in their basic structural organization. Each includes a dry ice container, a quantity of eutectic gel material having a specified freezing point, a hermetically sealed containment receptacle for the eutectic gel material, and a coupling skirt for thermodynam-

ically linking the gel receptacle and the dry ice container to cavity 62 as a thermodynamic "impedance matching" mechanism between the latent cooling assembly and the container cavity. These components of a freezer latent cooling assembly are larger than those of the refrigerator latent cooling assembly because of the greater heat sink requirements of the freezer assembly relative to the volume of cavity 62 and to the heat transfer characteristics from the cavity to the exterior of the container.

As shown best in FIGS. 5, 7 and 9, the refrigerator latent cooling assembly 88 includes a dry ice container pan 90 which preferably is defined of aluminum. The pan has a bottom 91 and circumferential side walls 92. A hollow box member 93 is connected by suitable fasteners 94 to the front of the pan. The box member carries suitable resilient gasket elements 95 along at least its upper and lower rear edges, as shown best in FIG. 5. The dry ice pan of the refrigerator latent cooling assembly for a presently preferred frozen food transport container is proportioned to have a volume sufficient to receive approximately eight pounds of dry ice.

A horizontal spacer member 96 (see FIG. 9) is secured to the front face of the box member by suitable fasteners 94. The spacer member has a vertical flange 97 along its forward extremity for abutting engagement with the inner surface of door 63 adjacent the top of the door when the door is disposed in its closed position. This cooperation between the spacer member and the door urges upper gasket member 95, carried by the box member, into intimate engagement with a forwardly-opening seating shoulder 98 defined by housing inner shell 65 inwardly of cavity 62 from seating shoulder 71 for door gasket 70. Such engagement of gasket 95 with seating shoulder 98 disposes dry ice container 90 in a predetermined position within cavity 62, in which position the bottom of the container is supported on the top of an enclosure 100 for a plurality of plastic bags 101 each filled with eutectic gel material.

The eutectic gel receptacle is an enclosure which preferably is defined by an upper member 102 which resembles an inverted pan, and by a lower member 103 which has downwardly extending flanges along its entire periphery. Lower enclosure member 103 is mated within the depending flanges of the upper enclosure member so that the portions of the enclosure members inwardly of their peripheral flanges define the top and bottom surfaces of a containment chamber 104 for bags 101. The gel-filled bags are disposed in intimate contact with the top and bottom surfaces of chamber 104 over the greatest area possible, as shown best in FIG. 5. As so engaged, the mating flanges of the upper and lower enclosure members are sealed together, as by the use of a silicon bonding agent or the like, to hermetically seal chamber 104.

Along the sides and rear of enclosure 100, the peripheral flanges of member 103 are extended away from chamber 104 to define side 105 and rear 106 fin portions of a coupling skirt for thermodynamically linking the eutectic gel receptacle, and the dry ice container, with cavity 62. As shown best in FIG. 7, side fins 105 are configured to register closely with the side wall surfaces 80 of cavity 62 above, across and below rib protuberances 86. That is, side fins 105 of refrigerator latent cooling assembly 88 are horizontally recessed to mate with rib protuberances 86 for removable support

of the cooling assembly within container 60 by the ribs.

The lower gasket 95 carried by box member 93 is forcibly engaged with the forward portion of eutectic gel enclosure 100 when door 63 is closed, thereby forcing the rear end of the gel receptacle into intimate engagement with the back wall of cavity 62 and to locate the receptacle and its integral thermodynamic coupling skirt in a predetermined fixed position within the container. It is preferred that eutectic gel receptacle 100 and fins 105, 106, for example, be defined of aluminum or some other metallic material having high thermal conductivity.

Inasmuch as the structure of freezer latent cooling assembly 89 is substantially identical to refrigerator latent cooling assembly 88, except for the individual components of the freezer latent cooling assembly being of greater capacity than the corresponding components of the refrigerator latent cooling assembly, the structure of the freezer latent cooling assembly is not described in detail; those components of the freezer latent cooling assembly which correspond to the components of the refrigerator latent cooling assembly are assigned prime reference numbers in FIG. 8. Accordingly, from a comparative examination of FIGS. 7 and 8, it is apparent that dry ice container 90', eutectic containment chamber 104', and fins 105' and 106' have vertical dimensions which are approximately twice those of the corresponding elements of the refrigerator latent cooling assembly. Thus, as shown best in FIG. 5, the thermodynamic coupling skirt of the freezer latent cooling assembly (shown in broken lines) extends approximately twice as far vertically into cavity 62 as does the coupling skirt of the refrigerator latent cooling assembly.

Preferably the volume of gel containment chamber 104 is sufficient to permit approximately 13 pounds of eutectic gel material to be disposed within the chamber in appropriate plastic bags. In the freezer latent cooling assembly, it is preferred that the volume of chamber 104' be sufficient to enable about 20 pounds of eutectic gel material to be disposed therein. Similarly, in the freezer latent cooling assembly, it is preferred that the capacity of dry ice container 90' be sufficient to accommodate approximately 28 pounds of dry ice.

In a food transport container according to this invention, regardless of whether it includes a refrigerator or freezer latent cooling assembly, temperature control within container cavity 62 is accomplished by the constant temperature heat of fusion associated with the pertinent eutectic gel. Locating the cold latent heat sink (comprised of the eutectic gel material) at the top of the cavity in intimate contact with the horizontal conductive members of the eutectic gel enclosure provides natural convection within the cavity due to the cooled air flowing downwardly in the cavity. Additional heat transfer capability from the latent heat sink to the container cavity is provided by the conductive coupling skirt depending from the sides and back of the eutectic gel enclosure. The large expanse of heat transfer surface provided by the coupling skirt minimizes the temperature gradient between the cooling surfaces and the interior of the container, thereby enhancing temperature control within cavity 62.

In a presently preferred container adapted for keeping refrigerated unfrozen foodstuffs, the eutectic gel disposed within containment chamber 104 is formulated so that its latent heat of fusion occurs at approxi-

mately 27° F. That is, where a refrigerator latent cooling assembly is arranged to include about 13 pounds of eutectic gel formulated to have the phase change between the solid and liquid states thereof at about 27° F., the contents of cavity 62 can be maintained at a temperature of 37° F., $\pm 3^\circ$ F., for a period of from four to eight hours under conditions in which the ambient temperature is from 50° to 78° F. average (nominally 72° F., $\pm 5^\circ$ F.), and for an additional four hours under conditions wherein the ambient temperature is 50° F., $\pm 5^\circ$ F. Similarly, where the freezer latent cooling assembly is constructed to contain 20 pounds of eutectic gel formulated to have its liquid-to-solid phase change occur at about -25° F., the contents of cavity 62 (following initial cool-down of the container) can be maintained at -5° F., $\pm 5^\circ$ F., for similar periods under similar ambient temperature conditions.

Initial cooling of the eutectic gel in the latent cooling assemblies, and of the containers in which they are disposed, is accomplished by using dry ice disposed in the corresponding dry ice receptacle to freeze the eutectic gel. The refrigerator dry ice receptacle 90 has a capacity of about 8 pounds of dry ice, and the freezer dry ice receptacle 90' has a capacity of about 28 pounds, both capacities being given with reference to the abovementioned presently preferred embodiments of the invention. If desired, however, the latent cooling assemblies may be placed in a suitable freezer or the like to produce solidification of the eutectic gel material. Where dry ice is used to produce solidification of the eutectic gel, the dry ice is essentially entirely consumed in freezing the gel from a liquid state at about room temperature. Thereafter, temperature control over the contents of container cavity 62 is provided by resort to the latent heat of fusion of the eutectic gel material. The abovementioned quantities of dry ice are effective to freeze the corresponding quantities of eutectic gel material, having the freezing points specified, in the container within a period of about 2 hours.

Workers skilled in the art to which this invention pertains will realize that the present invention has been described above with reference to specific presently preferred embodiments of the invention merely for the purposes of example and illustration. Such workers will appreciate that the organizational, geometric, dimensional and thermodynamic relationships described above may be varied without departing from the scope of this invention to produce food storage containers and the like tailored to other thermal and usage conditions. Accordingly, the foregoing description should not be considered as limiting the scope of this invention.

What is claimed is:

1. An improved food storage assembly and the like comprising a housing defining a cavity therein opening from the housing along one side thereof, door means engageable with the housing across the one side of the cavity for closing the cavity opening, thermal insulation

material carried by the housing and the door means for essentially fully enclosing the cavity in the closed position of the door means, a receptacle in the housing in an upper portion of the cavity for receiving a predetermined quantity of latent heat of fusion cooling medium which is other than water ice, a thermally insulated partition disposed horizontally in the cavity immediately below the receptacle subdividing the cavity into a first upper chamber above the partition and a second lower chamber below the partition, and means intimately and thermally conductively associated with the receptacle for thermally coupling the receptacle essentially only by thermal conduction with selected portions of the cavity and including a metal member forming at least the floor of the receptacle for contact directly by cooling medium disposed in the receptacle, the metal member further forming fin means disposed vertically in both the first and second chambers and forming an uninsulated wall common to the receptacle and to the first chamber, the predetermined quantity of cooling medium and the dimensions of the metal member being defined with relation to the type and quantity of the insulation material, to the geometry of the cavity and to the thermal conductivity of the metal member for maintaining the selected portions of the cavity and contents thereof at substantially predetermined temperatures throughout a predetermined period under predetermined ambient temperature conditions.

2. Apparatus according to claim 1 wherein said cooling medium is solidified carbon dioxide.

3. Apparatus according to claim 1 wherein the predetermined temperature maintained in the first chamber is about -10° F. and the ambient temperature is on the order of 70° F.

4. Apparatus according to claim 1 wherein the metal member extends through the partition to define a portion of a vertical wall of the second chamber.

5. Apparatus according to claim 4 wherein the predetermined temperature is about 40° F. and the ambient temperature is on the order of 70° F.

6. Apparatus according to claim 1 wherein the fin means include a portion of the metal member arranged to define at least a portion of a ceiling of the first chamber.

7. Apparatus according to claim 1 wherein the door means cooperate with a vertical boundary of the cavity to provide access to the first and second chambers, and thermally insulated second door means in the housing for separately closing the first chamber.

8. Apparatus according to claim 2 including closable access means to the receptacle through a top portion of the housing separate from the door means.

9. Apparatus according to claim 2 including means for supporting a plurality of food service trays and the like in the cavity in spaced relation to each other and to the walls of the cavity.

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