Dec. 8, 1964 M. H. SCHACHNER 3,159,982

REFRIGERATED CONTAINER HAVING PRIMARY AND SECONDARY COOLING CIRCUITS

Filed March 28, 1962 3 Sheets-Sheet 1

Fig. 1

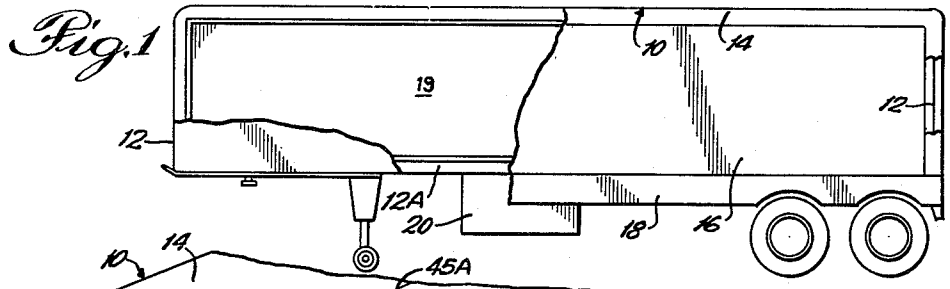


Fig. 2

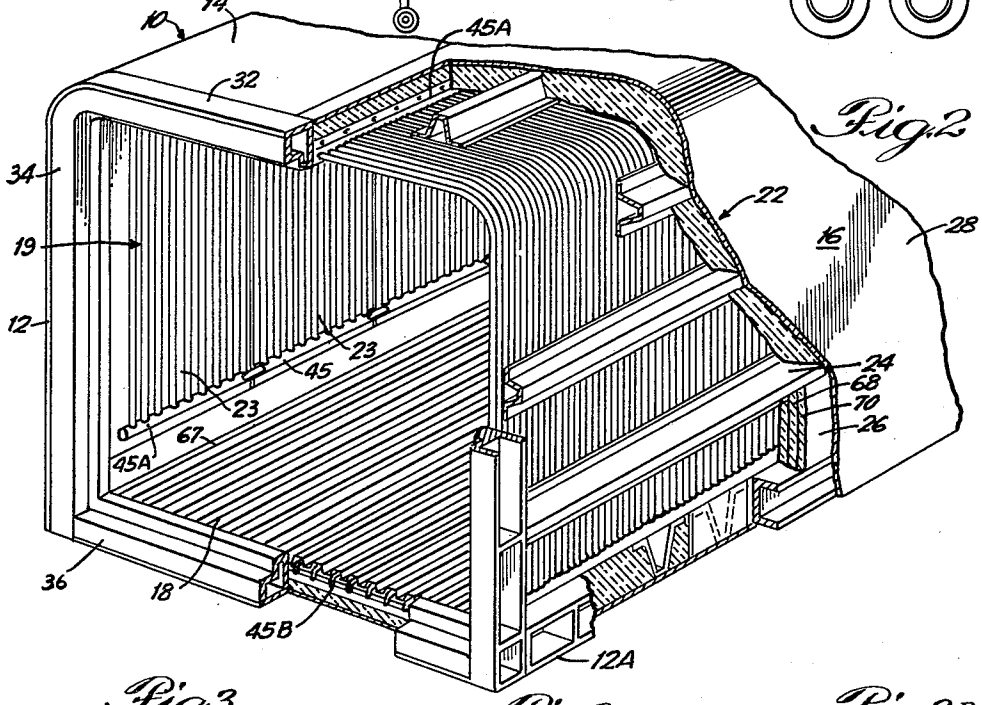


Fig. 3

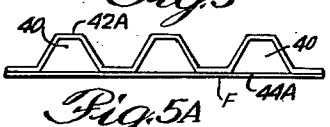


Fig. 3A

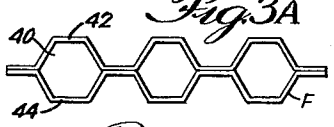


Fig. 3B

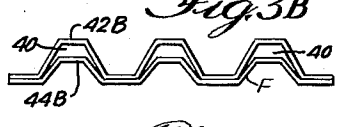


Fig. 5A



Fig. 4

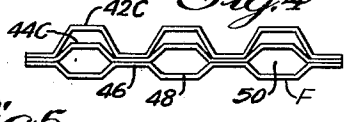


Fig. 4A

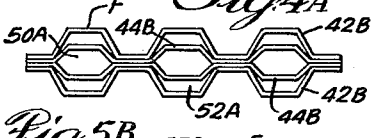


Fig. 5

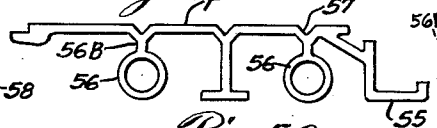


Fig. 5B



Fig. 5C



INVENTOR:
Max H. Schachner,
BY
Bair, Freeman & Molinare
ATTORNEYS.

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REFRIGERATED CONTAINER HAVING PRIMARY AND SECONDARY COOLING CIRCUITS

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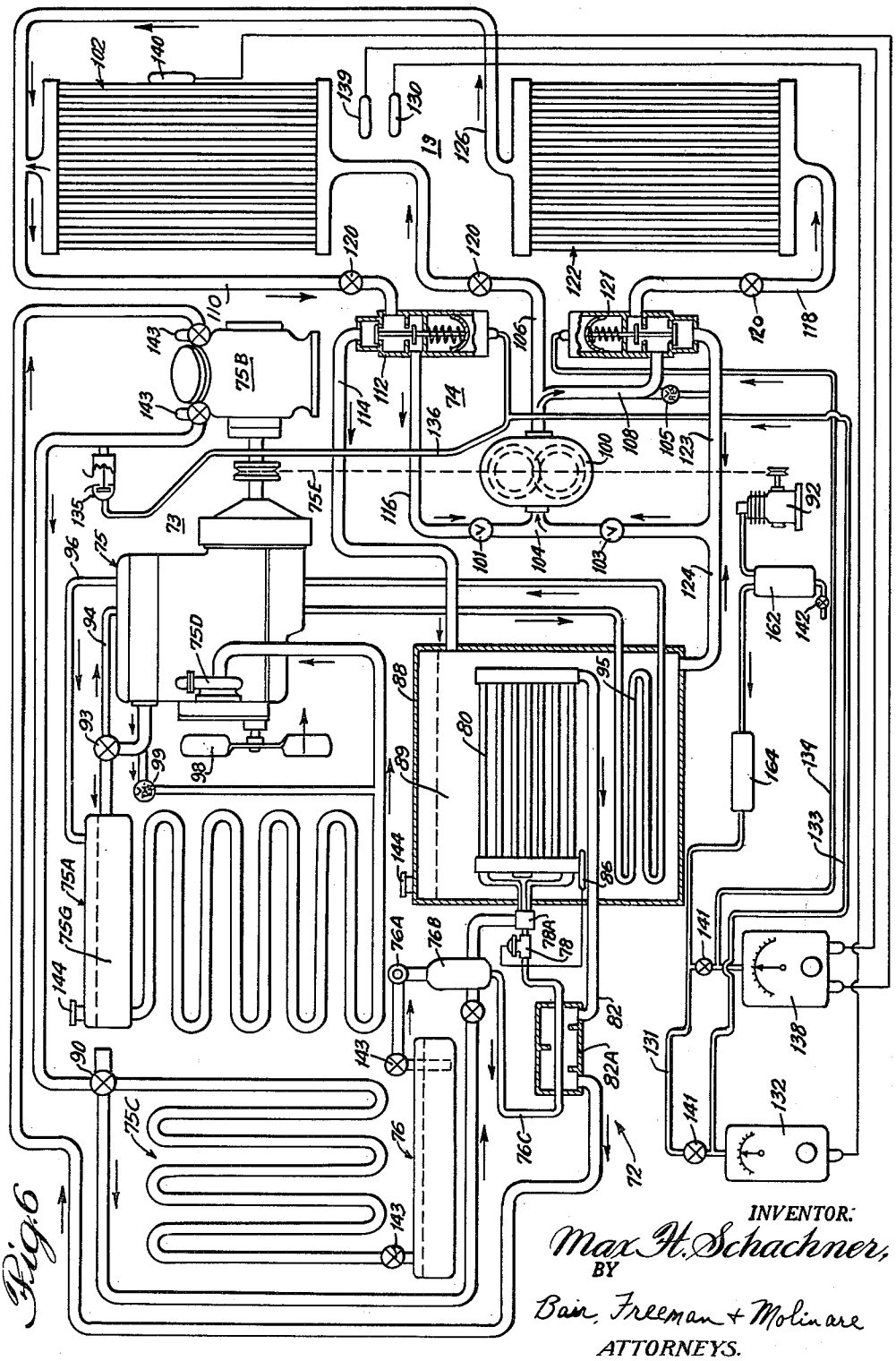


Fig. 6

INVENTOR:
Max H. Schachner,
BY
Bair, Freeman + Molinare
ATTORNEYS.

Dec. 8, 1964 M. H. SCHACHNER 3,159,982

REFRIGERATED CONTAINER HAVING PRIMARY AND SECONDARY COOLING CIRCUITS

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Fig. 7

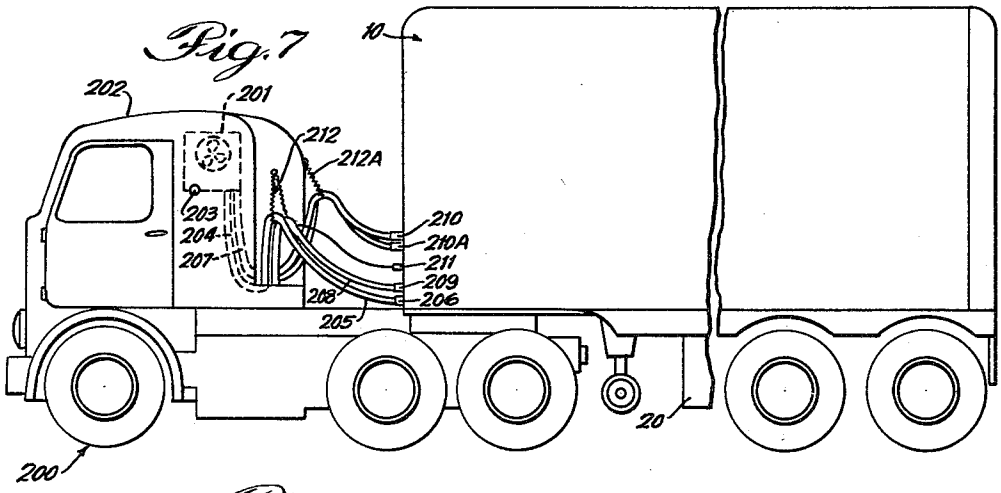
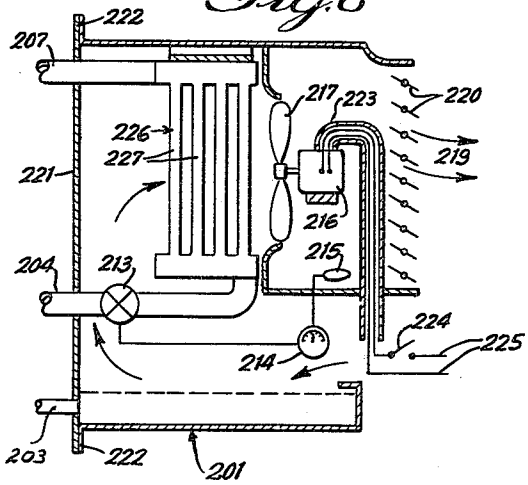


Fig. 8



INVENTOR:
Max H. Schachner,
BY
Bair, Freeman & Molinare
ATTORNEYS.

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3,159,982

REFRIGERATED CONTAINER HAVING PRIMARY AND SECONDARY COOLING CIRCUITS

Max H. Schachner, 10134 Kentucky St., Whittier, Calif.

Filed Mar. 28, 1962, Ser. No. 183,189
9 Claims. (Cl. 62—175)

This invention relates in general to mechanically refrigerated transport containers (such as constructed for vehicle bodies, truck trailer vans, and shipping containers) and, more particularly, to an improved cold wall refrigerating construction and to a refrigerating system adapted for use with such cold wall construction to meet the need for better protection, in transit, of perishable vegetables, meat, and other products against dehydration, shrinkage, and withering as now experienced with refrigerated forced air systems.

One object of this invention is to provide a refrigerated container having a cold wall structure with an improved refrigerating system having a primary cooling circuit and a secondary cooling circuit for controlling the relative humidity conditions in such refrigerated container.

Another object of the present invention is the provision of an improved cold wall refrigerating structure in which a refrigerating solution is circulated through the walls, floor and ceiling in place of air for refrigerating perishables.

A further object of the invention is to provide a refrigerated cold wall compartment which may be easily connected in tandem with other such compartments for refrigeration of the contents of each at various selected temperature and humidity conditions from a common primary refrigerant source.

It is another object of the present invention to provide a refrigerated cold wall container with a refrigeration system having two circuits, such system including an arrangement for rapid cooling (pull down) of the container being put into service at the maximum safe capacity rate of the primary refrigerating system.

It is another object of this invention to employ a special finish on the interior metal surfaces to increase radiation and improve circulation of air by natural convection.

A further object of this invention is to provide novel extruded floor, wall, and ceiling panels containing passages for the flow of a refrigerant to be used to line the interior of a conventional insulated container for construction of or conversion to a cold wall system.

It is a further object of this invention to provide a monocoque type refrigerated container utilizing to best advantage highly efficient foam type insulation ingeniously incorporated with support beams (as isolator and structural members) all combined with the inner coil panels of a cold wall refrigeration system.

Yet another object of the present invention is to provide a cold wall refrigerating construction in which the effects of wall expansion and contraction are minimized.

It is another object of the present invention to provide a cold wall refrigerating construction in which the amount of refrigerant fluid in the passages can be held to a minimum without affecting the structural strength of the wall panel,

A further object is to provide a cold wall refrigerating construction in which the refrigerating wall is inherently of a stable reinforced nature capable of withstanding considerable stress and carrying the refrigerant and cargo without the need of intermediate support braces.

It is another object of this invention to provide a wall construction for a refrigerated container in which the wall construction serves to seal against infiltration of vapor or moisture through the walls and into the refrigerated chamber.

Yet another object of this invention is to utilize in connection with the secondary refrigerant system, a means of separately utilizing the refrigerant for air-conditioning the cab and/or sleeping compartment of a truck or truck-tractor when such is used in conjunction with the refrigerated container.

I propose to improve the art of transport refrigeration by the use of a cold wall system and incorporating a means of controlling the temperature differential between the refrigerant and the cargo so as to maintain the desired humidity condition in addition to separately maintaining the proper temperature condition.

Temperature of the product is controlled by blending into the circulation system super chilled brine through a three way thermostatically controlled valve in a cascade type system.

I propose to control the refrigeration compartment humidity by controlling the temperature differential between the refrigerant and the product, by the use of a differential control valve (actuated by two sensing bulbs with variable regulator with pneumatic control and with a range of 2° to 20° F. temperature differential. The desired operating range is 10° to 15° F. for 90 to 80% relative humidity). This valve will control the flow of the refrigerant being circulated within a portion of an oversize refrigerating surface. Such control acts to increase or reduce the effective size of the total refrigerating surface. For example, to reduce the humidity, the total effective surface would be reduced. In order to maintain temperature the remaining surface would become colder to a point when the dew point would be reached. Moisture would collect on the cold surface and become frost and thus dehydrate the air in the container until the desired humidity was attained.

For over-the-road application of the refrigerated container, I propose to air condition truck driver's cabs or sleeping compartments by circulating liquid refrigerant from the secondary refrigeration system through a conventional type fan coil unit. This will permit performing a necessary function with very low additional investment. The unit may be permanently or temporarily installed. Connecting lines between the unit and the container would employ quick disconnect valves which may be of a type readily available on the market. These permit immediate disconnection of lines without loss of refrigerant fluid when the unit and the container are separated.

These and other objects, advantages, and functions of the invention will be apparent upon reference to the following specification and claims together with the drawings.

FIG. 1 is a schematic side illustration of a wheel-mounted refrigerated container.

FIG. 2 is a diagrammatic perspective view illustrating the manner in which the container is constructed.

FIGS. 3–3*b* illustrate various wall panel arrangements of embossed and seam welded sheets in section.

FIGS. 4–4*a* illustrate various panel arrangements used for special refrigerating purposes of embossed and seam welded sheets in section.

FIGS. 5–5*a* illustrate special extruded aluminum floor and wall panels.

FIGS. 5*b*–5*c* are longitudinal views of FIGS. 5 and 5*a*, respectively.

FIG. 6 is a schematic illustration of a refrigerating system incorporating the principles of the present invention.

FIG. 7 illustrates the connection of an air conditioning fan coil unit in the driver's compartment of a truck-tractor to the refrigeration system in a container type trailer.

FIG. 8 is a schematic illustration of the air conditioning fan coil unit for installation in the driver's compartment of a truck-tractor.

Referring to FIG. 1, a wheeled-chassis supported refrigerated container is indicated by the reference character **10**. It may be, for example, a shipping container, a truck trailer, a truck body or railroad car, and it comprises end frames **12** and side sills **12***a* to which are mounted a roof **14**, side walls **16** and a floor or bottom wall **18** to define a cooling chamber **19**. A housing **20**, suspended, for example, beneath the container may contain the apparatus for refrigerating the container.

Referring now to FIG. 2, the top, side and bottom walls **14**, **16** and **18** each comprise a sandwich or monocoque construction **22** in which a series of panels **23** face the interior of the trailer to form chamber **19**. Rails **24** are provided on the outside of the panels and they are embedded in an insulating material of polyurethane **26**. The insulating material **26** is covered with an outer layer of fibre glass reinforced plastic **28** or aluminum sheet to form the outer protective skin of the trailer.

The walls **14**, **16** and **18** are mounted between the end frames **12** which comprise a top member **32**, side members **34** and bottom member **36**. As many frames such as **12**, as desired, may be used intermediate the two end frames, however, for an ordinary 35–40 foot trailer length, the panels **23** and attendant structure are sufficiently self supporting to avoid the need. The space defined by the end frame **12** is of course filled by panels such as **23** together with attendant structure and is made removable to serve as a door although other positions may be used for this purpose. The chamber **19** may of course be easily subdivided by the erection of corresponding walls therein.

The panels **23** are generally about three feet wide and on their inner surfaces F are anodized or painted a non-metallic finish for improved radiation. As best seen in FIG. 3 each panel may comprise a series of parallel liquid conducting channels **40**. These channels are formed by a sheet of embossed or ridged metal **42** joined to a second sheet **44** of similar construction so that the space between the embossings forms the channel. Liquid circuits to the channels may be completed by simple interconnectors indicated at **45** (FIG. 2) and supply and return manifolds **45***a* may be embossed at the channel ends or on extruded panels they can be externally connected **45***b*. Thus the channels may be easily connected to a source of refrigerating liquid and in turn the channels of several vehicles may be easily interconnected. The sides of the panels may be fastened by a lap or a butt joint.

Various configurations and arrangements are possible, as shown in FIGS. 3, 3*a* or 3*b*. Thus, in FIG. 3, one sheet **42***a* is formed in a manner similar to sheet **42**, but the second sheet **44***a* is flat so that the channels formed by the embossings are smaller than those in FIG. 3*a*. FIGS. 3 and 3*a* are conventional types. In FIG. 3*b* the channels are made smaller yet by providing small embossings on one sheet **44***b* and nesting them in the space formed by the embossings in sheet **42***b*. Thus, with the embossings facing chamber **19**, considerable radiation area is provided in the chamber, while at the same time by increasing the comparative radiation area at the rear, the amount of refrigerant carried by the channels may be reduced. The panel embossings, of course, considerably reduce the problem of expansion and contraction of the walls.

In FIGS. 4–4*a*, various other panel constructions are illustrated for special or unique refrigerating techniques. In the arrangement shown in FIG. 4, a panel construction utilizing sheets **42***c* and **44***c* similar to sheets **42***b* and **44***b* in FIG. 3*b* is illustrated. However, a third sheet **46** having embossings **48** aligned with the space between embossings of sheet **44***c* provide additional channels **50**.

Similarly, in FIG. 4*a*, a double arrangement similar to FIG. 3*b* is illustrated so that channels **50***a* and **52***a* are also formed. These added channels such as **50**, **50***a* and **52***a* may carry a secondary eutectic mixture or refrigerant for holdover control with separate freezing and control

circuits. The corrugated plates may have ridges shaped as shown in FIGS. 3, 3*a*, 3*b*, 4 and 4*a*, or the corrugations may be curvilinear in cross section.

FIG. 5 shows a cross section of an extruded aluminum floor panel with longitudinal sectional interlock **55** and with formed longitudinal refrigerant passages **56** and drain trough **57**.

FIG. 5*a* shows a cross section of an extruded aluminum wall or ceiling panel with formed longitudinal refrigerant passage **56***a*. These panels are used in place of panels **23** when installing the cold wall system in an ordinary refrigeration container, instead of the special container herein described. The flat side **58** faces chamber **19**. The configurations **59** are for a special plastic mounting attachment.

FIG. 5*b* shows a longitudinal view of FIG. 5. The dotted section shows a method of trimming back an end of the panel leaving round tubes **56** for ready attachment as liquid conduits by means of a hose with clamps or tube fittings, using compressed rubber ferrules for a seal. Trimming of the metal is accomplished by employing a hollow end mill (around the tubes) to remove the webs **56***b*. The flat surface section **57***a* is removed by a saw cut. FIG. 5*c* is trimmed similar to 5*b* to provide connection to tube **56***a*, by removing web **56***c* and surface **58***a*.

The panels **23** are arranged so that the channels **40** and **50**, for example, extend vertically in the case of the side walls **16** and as may be appreciated this arrangement offers considerable strength against flexure about a horizontal axis but allows flexure quite easily about a vertical axis. In other words, the panels flex only with difficulty about an axis perpendicular to the channels so that the structure is rigid to a stress about that axis. The panels may be formed, however, so that they approach the ceiling in a gradual curvature until they are horizontal so that the ceiling is actually a continuation of the side walls and is formed integral therewith to provide a simplified construction. Further, this permits any moisture which accumulates on the ceiling to run down the side walls instead of dropping onto the perishables in chamber **19**. It is accumulated in a runoff channel **67** provided in the floor panels. The conduits created by the embossed channels of the panels joined together, as for example, by seam welding, serve as inherent ribs of the formed enclosure. Thus the wall and ceiling construction permits side posts and ceiling ribs to be eliminated with consequent weight and labor saving.

The bottom wall or floor **18** has an extruded aluminum panel construction with integral passages for the refrigerant. It is heavily constructed to carry the weight of the cargo. Behind the panels **23** on the sides and top and bottom walls, the stringers or rails **24** of generally V-shaped construction are arranged in a direction perpendicularly to the longitudinal axis of the channels. The rails may be of fibre glass and they strengthen the panels against flexure along an axis parallel to the channels and insure rigidity to a stress acting in either direction. The panels are mounted and secured to each other in sections and to the end frames **12** in any well known manner.

A number of layers such as **68** and **70** of an insulation, such as polyurethane foam is then foamed in place onto the back surface of the panels with a spray foam gun to form the insulation layer **26**. The insulation thickness may be easily regulated from the height of the rails **24**. The thickness of the layers and densities may be varied as desired to provide the required resiliency for the composite structure. Spray foaming the insulation from the outside instead of pouring or injecting as conventionally done, is recommended as far more rapid and eliminates the formation of voids while at the same time aiding uniform drying and foaming. It also eliminates the need for maintaining extremely close temperature control of the elements being foamed and the need for special ventilation devices. Closer mixture regulation can thus be maintained for controlling the resilience of the material to

provide desired adherence, resiliency, and mechanical strength with acceptable insulation in one layer. The foam insulation layer is then covered with the glass matte panel or aluminum sheet to form the outer skin 28 so that a secure strong ideally insulated wall or floor construction is provided.

A system 72 for supplying a cooled refrigerant, such as ethylene glycol, to the channels 40, 56 and 56*a* is illustrated schematically in FIG. 6. If desired, liquid carbon dioxide, nitrogen, or other material may be expanded as a gas into the channels 40 as a separate method of refrigeration. The system 72 comprises a primary system 73 and a secondary system 74. The primary system includes a conventional engine 75, radiator 75*a*, Freon compressor 75*b* and condenser 75*c* having a receiver 76, liquid sight 76*a*, drier filter 76*b*, and a liquid line 76*c* extending to an expansion valve 78 with distributor 78*a*. The valve is connected to an evaporator 80 which has a suction line 82 for returning vapor through heat exchanger 82*a* (to cool liquid line 76*c*) to the compressor 75*b*. A refrigerant, such as freon, is moved through the system by the compressor 75*b*. The expansion valve 78 is of conventional design and meters the refrigerant flow between the condensing unit and evaporator in accordance with the requirements regulated by a conventional bulb element 86, for example. The evaporator coil 80 is located in a cooling tank 88 within which a solution 89 such as ethylene glycol is chilled and passed for use in the secondary cold wall system 74.

The solution 89 is normally cooled by the evaporator 80 but it may also be heated for defrosting purposes. To heat the solution, the valve 90 may be controlled to bypass the operation of the condenser 75*c*, receiver 76, and expansion valve 78 so that hot compressed Freon gas passes through the distributor 78*a* into the evaporator coil 80 to warm the solution 89. An alternate circuit, not portrayed here, could be circuited so that the unit becomes a heat pump by transposing the functions of the evaporator and condenser coils. In addition, advantage is taken of the engine 75 used for powering the refrigeration unit. The hot ethylene glycol solution 75*g* circulated by pump 75*d* in the engine radiator cooling system 75*a* is diverted by means of the valve 93 in the conduits 94 to the heat exchanger 95 in the tank 88, returning through conduit 96 for recirculation. The tank 88 thus receives additional heat to augment the heating cycle. Thermostatically controlled bypass valve 99 protects the engine from operating at too cold a temperature.

The fan 98 cools the condenser 75*c* and the radiator 75*a*. The fan 98, compressor 75*b*, air compressor 92 and pump 100 are powered by the engine 75 by direct or belt drive 75*e*. Ordinarily, however, the solution 89 is maintained at about —22° F. and it may be used to control the condition of several compartments such as 19*a* and 19*b*.

The pump 100 moves the solution from respective branches of a conduit 104 through conduits 106 and 108 respectively. The conduit 106 extends to the primary cold wall circuit 102 in the refrigerated container, and a return conduit 110 therefor is provided from the cold wall circuit 102. The return conduit 110 extends to three-way valve 112, which diverts the flow to either conduit 114 and the tank 88 or to conduit 116 for return through conduit 104 to pump 100. (Disconnect valves 120 may be located in conduits 110, 106 and 118, to permit the container to be separated from the refrigerating system.)

The output of pump 100 connects through conduit 108 to three-way valve 121, which proportions the flow of solution to conduits 118 and 123. Solution passes through conduit 118 to the secondary circuit 122 of the secondary refrigeration circuit 74 in the cold wall refrigerated container. Solution may be diverted through conduit 123 for return to pump 100 via conduit 104. Conduit 126 returns the solution from the secondary circuit 122 into conduit 110 for reassignment by valve 112. Solution may be recirculated from tank 88 to the pump 100 through conduits 124 and 104. Regulating valves 101 and 103 in conduit 104 are used to balance the fluid pressure head in their respective systems. Disconnect valves 120 may be located in conduits 110, 106 and 118 to permit the container to be separated from the refrigeration system.

Variable temperature regulator 132 actuated by a capillary sensing element 130 responds to the chamber temperature for controlling three-way valve 112 by a pneumatic system consisting of air compressor 92, preferably driven by engine 75 through belt drive 75*c*, and air storage tank 162, an air filter-drier 164, all connected so as to supply air through air supply line 131 for a one-pipe bleed-type proportional action control. Regulator 132 (which can be set at any temperature between —20° F. and +50° F.) will modulate a supply of air through line 133 to valve 112 so as to properly meter the flow of recirculated fluid from conduit 110 through either conduit 114 to tank 88 or conduits 116 and 104 to the pump 100 for circulation in the secondary cold wall circuits 102 and 122 for maintaining the desired temperature in chamber 19. Temperature differential thermostat 138 (which can be set at any desired temperature differential from 2° F. to 20° F.) is likewise supplied with air from line 131. Its control is derived from the difference in temperature between the air temperature sensing element 139 in chamber 19 and the liquid temperature sensing element 140 sensing the temperature of the refrigerant in the primary cold wall circuit 102. Differential thermostat 138 will modulate a supply of air through line 134 to the three-way valve 121 so as to proportion the flow of refrigerant from conduit 108 between conduits 118 and 123. A humidistat may be substituted for the differential thermostat. Conduit 118 supplies refrigerant to the secondary cold wall circuit 122. Conduit 123 acts as a bypass to conduct the refrigerant back to the pump. Throttling the supply of refrigerant through conduit 118 to cold wall circuit 122 decreases the effective coil surface, causing coil circuit 102 to become colder in order to maintain temperature. The temperature differential between the chamber 19 and the refrigerant is thus increased, causing the humidity to be lowered until the requirement is satisfied.

For example, produce at 40° F. requires a 10° F. temperature differential between the coolant and the box temperature in order to maintain 90% relative humidity, while fresh meat transported at nearly the same temperature as produce requires a temperature differential of 15° F. so as to have an 80% to 83% humidity condition.

Pressure relief valve 105 protects the system from over pressure from the positive displacement pump 100 by bypassing fluid from conduit 108 to conduit 123.

Pressure controller 135 in the hot gas line from compressor 75*b* protects the compressor from being overloaded by high head pressure during initial temperature pull down of a system being initially put into service. Controller 135 is set for the maximum permissible working pressure. When maximum pressures are approached a proportional amount of air will be bled from air line 136 to modulate valve 112 to restrict the flow of hot refrigerant through conduit 114 to cooling tank 88 and thus maintain the rate of heat flow to the tank 88 for absorption by the refrigeration system at a maximum for safety and efficiency.

Control valves 141 regulate the air flow from the air compressor to the temperature regulator 132 and the differential thermostat 138. Valve 142 on air storage tank 162 is for bleeding air and condensate from the pneumatic system. Valves 143 on the receiver 76 and compressor 75*b* are service valves.

Caps 144 on the radiator 75*a* and the cooling tank 88 are for filling and pressure venting.

In FIG. 7, a trailer-mounted refrigerated container, in-

dicated generally by reference numeral 10, is refrigerated by apparatus contained in chamber 20. Truck-tractor 200 is equipped with a fan coil unit type air conditioning unit 201 located inside sleeping compartment in rear of cab 202. Outlet 203 drains condensate to the outside. Air conditioning unit 201 is connected by refrigerant supply conduit 204 to supply hose 205, which connects through quick disconnect coupling valve 206 to conduit 106 of the refrigeration system in the container. Similarly, unit 201 is connected by refrigerant return conduit 207 to return hose 208 which connects through quick disconnect valve 209 to conduit 110 of the refrigeration system in the container. These connections to conduits 106 and 110 are not shown in FIG. 6. Connections 210 and 210*a* are for the usual brake system of the combined vehicles. Connection 211 is for the electrical system of the combined vehicles. Spring loop 212 takes up the slack in the refrigerant hoses 205 and 208 and similarly spring loop 212*a* suspends the slack in the brake hoses and electric cable connected to the trailer.

In FIG. 8 there is shown schematically the air conditioning unit 201. Such unit comprises a casing 221 supported by brackets 222. Within the casing is a coil 226 consisting of tubes through which liquid refrigerant is circulated from the supply conduit 204 to the return conduit 207. Flow of the refrigerant is regulated by valve 213 which is controlled by variable thermostat 214 which is actuated by sensing element 215.

Electric power from the vehicle system, supplied by leads 225 and controlled by switch 224, passes through cable 223 to operate the motor 216 driving the fan 217. Fan 217 induces air into casing 221 and over tubes 227. Heat is absorbed from the air by the refrigerant in the tubes 227.

Fan 217 then blows the cooled air 219 through the adjustable deflector 220 into the cab compartment space. The refrigerated air 219 absorbs heat of the compartment and returns for recirculation as 218. The temperature of the compartment is regulated by the thermostat 214 as previously mentioned.

While there has been shown and described a particular embodiment of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention. For example, electric or bellows controlled valves may be used in place of the pneumatic controlled valves described. A humidistat might be employed instead of a temperature differential controller. Again all valves might be eliminated by employing two electric motor operated pumps in the two circuits of the secondary system, one motor operated by a thermostat, the other by a humidistat. The refrigeration system disclosed herein is deemed to be the most accurate for modulating the required control and the most dependable for transport application. Therefore, it is intended in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What I claim as new, and desire to secure by Letters Patent of the United States, is:

1. In a refrigerated vehicle, a wall structure defining a chamber, said wall structure comprising an outer shell, a layer of insulation on one side of said outer shell, and corrugated inner metallic sheets joined to each other to form a plurality of liquid refrigerant conducting channels between said inner metallic sheets, a primary refrigerating system, a secondary refrigerating system including a liquid refrigerant cooled by said primary refrigerating system and conducted through said channels in dual circuits for refrigerating said chamber, and means in one circuit of said secondary system for controlling the temperature difference between the environs of a perishable carried in said chamber and the liquid refrigerant in said wall structure defining said chamber so as to control the humidity of said environs by changing the amount of effective radiation surface by controlling the flow of liquid refrigerant in one of said dual circuits while maintaining the required chamber temperature by varying the temperature of the liquid refrigerant flowing through the other of said dual circuits.

2. In a refrigerated container, means forming a storage space having a wall structure comprising an outer sheet, a layer of foamed polyurethane type insulation on one side of said outer sheet, corrugated metallic sheets bonded together to form liquid refrigerant conducting channels between said inner sheets, and plastic rail members arranged transverse to the longitudinal axis of said corrugations and embedded in said insulation for supporting said sheets, said insulation bonding said outer sheet, said metallic sheets and said rail members together.

3. In a refrigerated container, means forming a storage space having a wall structure comprising an outer sheet, an air sprayed layer of polyurethane type foam type insulation on one side of said outer sheet, and corrugated inner metallic sheets bonded together to form liquid refrigerant conducting channels between said inner sheets, said insulation comprising layers of different resilient qualities, the layers adjacent said outer sheet being more resilient than the layers remote from said outer sheet.

4. In a refrigerated vehicle, means forming a storage space having a wall structure comprising a monocoque structure of integrated and bonded components comprising an outer sheet, a layer of polyurethane foam type insulation on one side of said outer sheet, corrugated inner metallic sheets bonded together to form liquid refrigerant conducting channels between said inner sheets, said sheets being constructed and arranged to form both a side wall of said space and a top wall continuous with said side wall, and rail members arranged transverse to the longitudinal axis of said corrugations and bonded to said insulation for supporting said inner sheets.

5. In a refrigerated vehicle, the combination of a wall structure surrounding and defining a space to be refrigerated, said wall structure comprising an outer wall and an inner wall having channel means defined therebetween for conducting a liquid refrigerant, a primary refrigerating system comprising a compressor, a condenser, expansion means and an evaporator interconnected in refrigerant flow relationship; a secondary refrigeration system including a liquid refrigerant cooled by said primary refrigerating system and passing through said channel means in said wall structure to refrigerate the contents of said space to be refrigerated; means for circulating said liquid refrigerant through said channel means; and means sensitive to the head pressure of said compressor to reduce the cooling rate of the liquid refrigerant in said secondary refrigerating system during initial high temperature pull-down conditions so as to obtain maximum operating efficiency within a minimum time without exceeding safe pressure limits.

6. In a refrigerated vehicle, a wall structure defining a chamber, said wall structure comprising a monocoque structure of integrated and bonded components comprising an outer sheet, a layer of insulation, integral beams of reinforced plastic on one side of said outer sheet, and inner metallic sheets formed with rib corrugation means spaced from each other and seam welded to form a plurality of liquid refrigerant conducting channels between said inner metallic sheets, a primary refrigerating system, and a secondary refrigerating system, including a liquid refrigerant cooled by said primary refrigerating system and conducted through said channels in dual circuits, said liquid refrigerant absorbing heat transmitted from the outside by direct conduction, and refrigerating the contents of said chamber, said dual circuits being controlled to regulate the effective refrigerated surface within the chamber for temperature and humidity regulation, said rib corrugation means of said inner metallic walls constructed with sufficient contour to provide for integral expansion and contraction of the inner metallic sheets so as to reduce the effect of longitudinal changes in dimension of the monocoque wall structure.

7. In a refrigerated vehicle, a wall structure defining

a chamber to be refrigerated, said wall structure comprising an outer shell, a layer of insulation, a plurality of extruded aluminum panels having a plurality of liquid refrigerant conducting channels therein, a primary refrigerating system, a secondary refrigerating system including a liquid refrigerant cooled by said primary refrigerating system and conducted through said channels in dual circuits both of which absorb heat transmitted from the outside by direct conduction and refrigerate the contents of said chamber by conduction, radiation, and convection, and means in the dual circuits for controlling the temperature difference between environs of a perishable carried in said chamber and the liquid refrigerant in said conducting channels for controlling the humidity of said environs by changing the amount of effective radiation surface by controlling the flow of liquid refrigerant in one of said dual circuits while maintaining the required environs temperature by varying the temperature of the refrigerant flowing through the other circuit.

8. In a refrigerated container, a wall structure defining a chamber, said structure comprising an outer shell, an inner shell spaced inwardly from said outer shell by a layer of insulation with integrated longitudinal reinforced plastic beams, said inner shell formed with a plurality of liquid refrigerant conducting channels for perimeter cooling of said chamber, a primary refrigerating system, a secondary refrigerating system including a liquid refrigerant cooled by said primary refrigerating system and conducted through said channels in dual circuits for providing variable temperature with variable humidity control in said chamber, a first variable control means for regulating temperature conditions within said chamber, and a second variable control means for regulating humidity conditions within said chamber.

9. In a refrigerated container, a wall structure defining a chamber to be refrigerated, said wall structure comprising an outer shell, a layer of insulation, and a plurality

of extruded metallic panels having a plurality of liquid refrigerant conducting channels therein, a primary refrigerating system, a secondary refrigerating system including a liquid refrigerant cooled by said primary refrigerating system and conducted through said conducting channels in dual circuits both of which absorb heat transmitted from the outside by direct conduction and refrigerate the contents of said chamber, and means in the dual circuits for controlling the temperature difference between environs of a perishable carried in said chamber and the liquid refrigerant in said conducting channels for controlling the humidity of said environs by changing the amount of effective radiation surface by controlling the flow of liquid refrigerant in one of said dual circuits while maintaining the required environs temperature by varying the temperature of the refrigerant flowing through the other circuit.

References Cited by the Examiner

UNITED STATES PATENTS

1,880,245	10/32	Fourness et al.	62—435
2,143,171	1/39	Anderson	62—523
2,349,671	5/44	Newton	62—176 X
2,453,439	11/48	Hubbard	62—222
2,504,465	4/50	Sticelber	62—523 X
2,521,272	9/50	Williams	62—239
2,666,298	1/54	Jones	62—209
2,690,653	10/54	Kleist	62—430
2,814,186	11/57	Kleist	62—439
2,817,213	12/57	Miner	62—201
2,882,701	4/59	Nelson et al.	62—239
2,928,255	3/60	Harnish	62—81
2,931,192	4/60	Weinberg	62—434
3,059,449	10/62	Dilliner	62—239

ROBERT A. O'LEARY, *Primary Examiner.*

MEYER PERLIN, *Examiner.*