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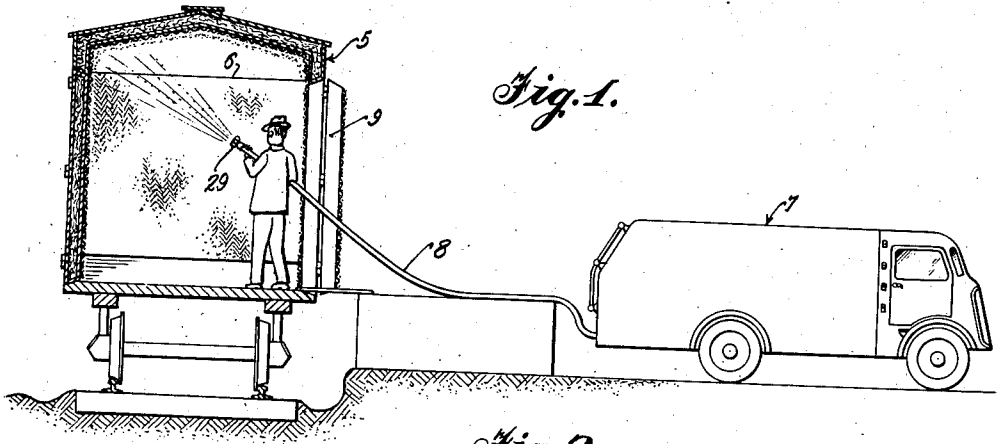
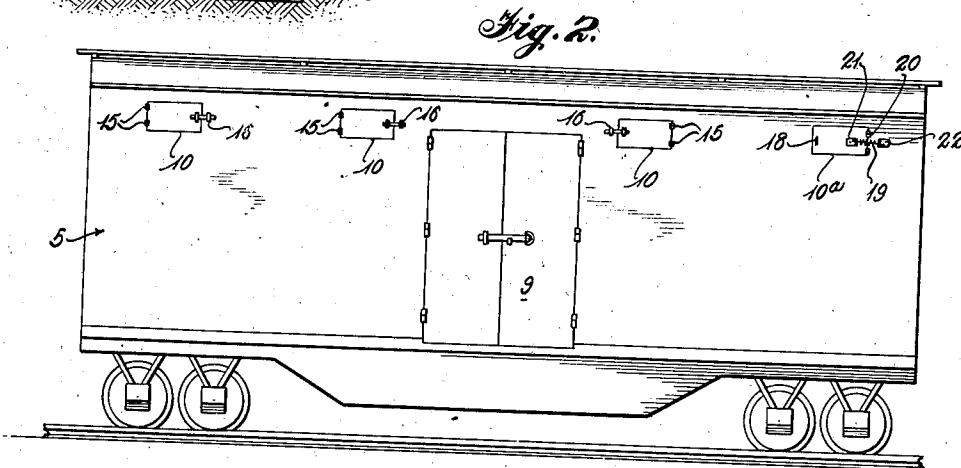
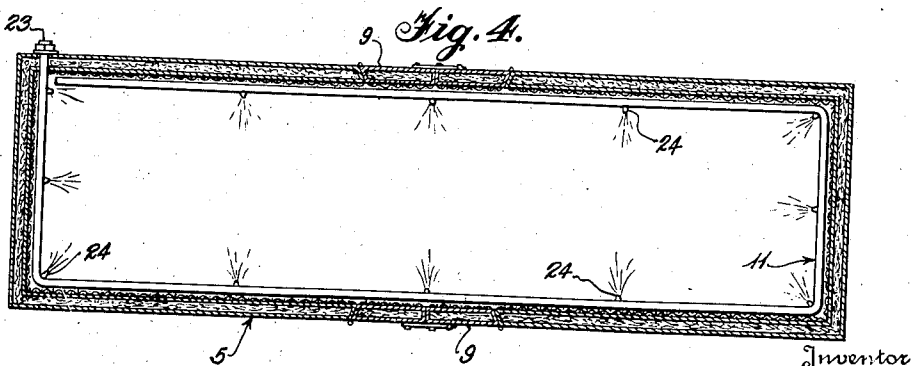
A. HARRIS

2,337,600

METHOD AND APPARATUS FOR REFRIGERATING TRANSPORTATION ENCLOSURES

Filed Nov. 8, 1940

2 Sheets-Sheet 1



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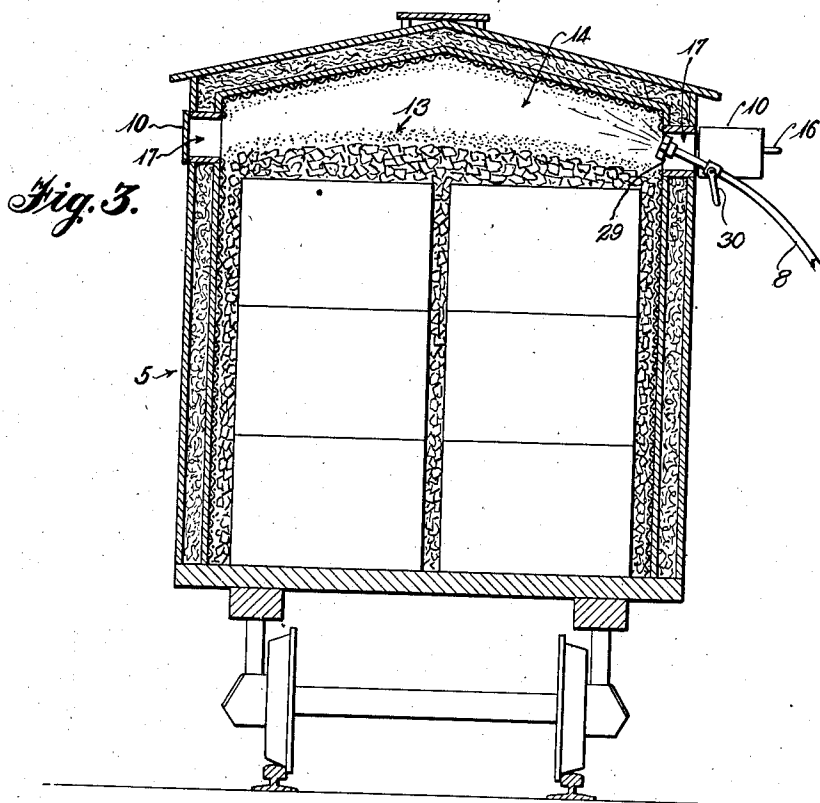
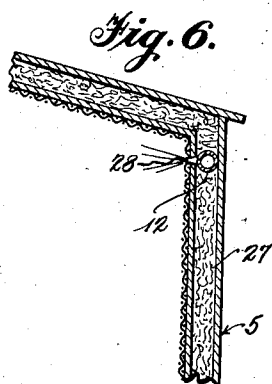
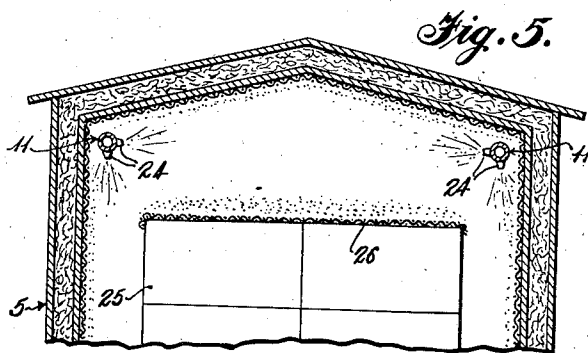
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METHOD AND APPARATUS FOR REFRIGERATING TRANSPORTATION ENCLOSURES

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2 Sheets-Sheet 2



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2,337,600

METHOD AND APPARATUS FOR REFRIGERATING TRANSPORTATION ENCLOSURES

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Application November 8, 1940, Serial No. 364,945

19 Claims. (Cl. 62—91.5)

This invention relates to new and useful improvements in methods and apparatus for refrigerating the load carrying spaces of either railway car or highway truck bodies employed for transporting perishable fruits, vegetables, and the like.

Water-ice is the medium most commonly employed at the present time for refrigerating perishable fruits and vegetables transported in railway cars and highway trucks. The water-ice usually is charged into the car or truck bodies after they are loaded and, if the transportation time is sufficiently long, the bodies are re-iced en route. While these bodies are standing empty, either awaiting transportation to loading points or awaiting loads at said points, and while they are actually being returned to the loading points, no attempt is made to control the temperature prevailing in the interiors of the body. Consequently, the temperatures oftentimes reach such high values that 24 to 48 hours of normal icing time is required before the interiors of the bodies can be lowered to a commodity preserving temperature.

If refrigeration is obtained by employing ice bunkers at the ends of the car or truck bodies, it is possible to precool the bodies before they are loaded so that the perishable commodities are not subjected to this high temperature. Of course, during such precooling periods the equipment is lost to both the owners and the shippers.

If only crushed or snow ice is to be used to "top ice" the commodities, loading must be accomplished before this refrigerating medium may be applied. Therefore, it is necessary to subject the perishable produce, which is warm to start with, to the overheated temperature of the enclosure during loading and to the gradual lowering of the temperature during the initial cooling period.

Attempts have been made to shorten the precooling period, where ice bunkers are employed, by first delivering to the bunkers a refrigerating medium which has a much higher rate of heat absorption than has water-ice. After the desired low temperature has been obtained with this special refrigerant, the usual charges of water-ice, in block form, are substituted in the bunkers for the special refrigerant. This type of procedure does reduce the time lost to a certain extent, but several hours still are needed because natural air circulation past the bunkers and throughout the load carrying enclosure is relied upon to accomplish the desired lowering of the temperature. Furthermore, the loading costs are increased to a considerable extent as a result of the necessity of handling these two refrigerants.

Another procedure which has been proposed is to create a forced circulation of air through the enclosure after the boxes and crates of warm produce have been loaded. The principal pur-

pose of this method is "conditioning" the commodity, and the treatment may consist of heating, cooling, hydrating, dehydrating, or cleaning. Any lowering of the temperature of the overheated transportation bodies which may occur, when the "conditioning" is that of cooling, is only incidental. If the procedure is carried on for a sufficient length of time to accomplish the desired cooling of the car or truck body in addition to "conditioning" the load, there is real danger that the treatment may be too severe for the perishable commodity.

It is the primary purpose of this invention to provide methods and apparatus for effectively precooling the interiors of transportation vehicles, employed for shipping refrigerated perishable commodities, without depriving the owners or shippers of the use of the vehicles for more than a very few minutes at the most. In fact, the loading of a series of vehicles may be carried out in quick succession, starting as soon as they are spotted at the loading platform, and the loss of time for precooling need only apply to the first one of the series. The time required to load the first will be ample to allow for precooling several of the succeeding bodies.

A further important object of the invention is to provide methods and apparatus for effecting precooling of refrigerator vehicles before placing loads of perishable commodities therein and for effecting initial refrigeration of the commodities during the loading period.

Still another object of the invention is to provide methods and apparatus for precooling refrigerator vehicles before loading, effecting initial refrigeration of the perishable commodities during loading, and refrigerating the commodities in a preserving, bacteria-destroying atmosphere during transportation.

Another object of the invention is to provide methods and apparatus for reducing the amount of crushed or snow ice employed initially in "top icing" perishable commodities transported in refrigerator vehicles and eliminating the need for re-icing en route.

Other objects and advantages of the invention will be apparent during the course of the following description.

In the accompanying drawings forming a part of this specification and in which like numerals are employed to designate like parts throughout the same,

Figure 1 is a schematic view, partly in vertical section and partly in side elevation of a railway refrigerator car and the apparatus required to carry out the precooling method embodying this invention.

Figure 2 is a side elevational view of a railway refrigerator car modified to adapt it for being

refrigerated by the method embodying this invention,

Figure 3 is a vertical sectional view taken through the refrigerator car disclosed in Fig. 2 and illustrates a method of refrigerating commodities transported in railway cars, or the like, by means of water-ice and a refrigerating fluid,

Figure 4 is a horizontal sectional view of a refrigerator car permanently equipped with apparatus for accomplishing precooling and refrigerating en route,

Figure 5 is a detail, vertical sectional view illustrating the use of the permanently installed equipment of Fig. 4 for accomplishing refrigeration en route, and

Figure 6 is a fragmentary, detail, vertical sectional view of a modified form of permanent precooling and refrigerating equipment for a transportation body.

In the drawings, wherein for the purpose of illustration are shown the preferred embodiments of this invention, and particularly referring to Fig. 1, the reference character 5 designates a railway refrigerator car in the process of being precooled after becoming overheated while being returned to a shipping point for some perishable commodity.

At this point, it will be stated that although the various figures of the drawings disclose only railway refrigerator cars, it is to be understood that refrigerator truck bodies and trailer bodies could just as well have been disclosed and the following description applied thereto. These disclosures of railway cars, therefore, are not to be considered as a limitation in construing the claims. For the purpose of illustrating the versatility of this invention, it will be assumed that the particular refrigerator body disclosed in Fig. 5 is intended to employ blocks of water-ice as the refrigerating medium en route. To receive these blocks of ice, the ends of the body 5 are provided with the conventional ice bunkers 6. These bunkers, of course, are constructed to permit air to circulate through the interior of the body with the interiors of the bunkers included in the path of air flow.

To adapt the body 5 for the precooling step embodying this invention, the various side walls and roof have had applied thereto a lining material to which carbon dioxide snow will adhere. Any fabric material will be suitable, and it is suggested that an inexpensive fabric, such as burlap, be employed. This lining may be permanently secured to the said walls of the body if the car is to be maintained in service, at least for a substantial portion of its time, on runs or routes where facilities for precooling in accordance with this invention are provided. If certain refrigerator bodies are only intended to be temporarily employed as a part of this service, the snow retaining lining may be preformed as removable panels which may be readily detachably secured to the inner surfaces of the body walls.

It will be explained at this point that any fabric covered surface, or in fact any rough fibrous surface, when placed in the path of a stream of mixed carbon dioxide snow and vapor will accumulate a deposit of snow as a result of impingement of the snow against the surface. The rough, fabric or fibrous lining for the walls of the refrigerator body 5 are provided for this purpose.

To accomplish precooling of the body 5, this invention contemplates releasing into the interior of the body a sufficient quantity of a mixture

of carbon dioxide snow and vapor, at a sufficiently rapid rate, to completely flood the internal space of the body with the vapor and to apply an appropriate layer of snow to the exposed surfaces of the lining. To accomplish this result, an exteriorly positioned source of supply of carbon dioxide, in liquid form, is employed. One such source is designated by the reference character 7 and takes the form of a truck or trailer body that includes a tank completely enclosed in a suitable insulating material. Trucks suitable for this purpose are now available for handling a full load of approximately $3\frac{1}{2}$ tons of liquid carbon dioxide. Larger trailer bodies are available for transporting six, seven, and eight ton loads. If, at certain shipping points, this precooling method is to be restricted to railway refrigerator cars, there are available insulated railway tank cars, each having a capacity suitable for storing 24 tons of liquid carbon dioxide.

As a further modification, shipping centers for large quantities of perishable commodities may have installed fixed storage tanks which may be serviced by a truck of the type designated by the reference character 7 in Fig. 1. Fixed storage tanks may be of any desired capacity. The largest insulated, fixed tank for the storage of liquid carbon dioxide so far constructed has a 125 ton capacity. Larger tanks may be provided if desired.

Although it is possible to carry out this precooling method with liquid carbon dioxide stored in uninsulated tanks, such as commercial cylinders, which are subjected to the temperature of the surrounding atmosphere, the process may be more efficiently and economically carried out by employing liquid carbon dioxide which is maintained at a substantially constant subatmospheric temperature, and its corresponding vapor pressure.

When employed in its broad sense, the term "subatmospheric temperature" is intended to cover all temperatures falling below a normal atmospheric temperature of 70° F. However, it has been determined that extremely low temperatures are more desirable and provide greater efficiency and economy of operation. The most satisfactory temperature range is from 32° F. to -40° F. At this time, liquid carbon dioxide is most frequently stored in such insulated tanks at a constant temperature of approximately 0° F. Liquid carbon dioxide stored at this temperature has a vapor pressure of approximately 305 pounds per square inch, absolute. When stored at 32° F., the vapor pressure of the liquid will be approximately 505 pounds per square inch, absolute, while at -40° F., the vapor pressure will be approximately 145 pounds per square inch, absolute.

When the liquid carbon dioxide to be used in carrying out this invention is stored in fixed tanks, the desired constant temperature may be maintained by employing a commercial refrigerating machine which has its cooling coil located in the vapor space of the tank. When the liquid carbon dioxide is to be obtained from a mobile unit, the tank of the unit will be charged at a suitable source of supply with liquid carbon dioxide at a desired low temperature. This mobile unit will be provided with one or more bleed off valves which will be set for operation at a somewhat higher pressure. When the vapor pressure of the liquid stored in the tank of this unit reaches the pressure for which the bleed off valve is set, carbon dioxide vapor will be released

to the atmosphere and self-cooling or self-refrigerating of the remaining liquids will be accomplished as a result of vaporization of additional liquid to take the place of the vapors released through the valve. For example, if liquid carbon dioxide at a maximum pressure of 300 pounds per square inch is to be used in carrying out this method, the mobile unit may be charged with liquid carbon dioxide at, say, 200 pounds per square inch. During transit from the source of supply to the shipping center serviced by the unit, the pressure of the stored carbon dioxide will rise as a result of normal input of heat through the insulation surrounding the tank. The pressure of the stored liquid may rise until 300 pounds is reached. At this maximum pressure, a sufficient amount of carbon dioxide vapors will be slowly bled from the tank to lower the pressure of the liquid. The closing pressure for the valve may be set at 275 pounds per square inch. From the time the pressure first reaches the maximum value of 300 pounds, the pressure within the tank of the mobile unit will be maintained between the opening and closing pressures for which the bleed off valve has been set.

By confining the liquid carbon dioxide to be used in carrying out this process in bulk storage tanks of the types referred to above, the liquid may be discharged at almost any desired rate. Liquid carbon dioxide has been discharged from such storage tanks through pipe lines varying from one inch to six inches in diameter. Discharge rates up to six tons a minute have been used commercially up to the present time. Discharge lines measuring from one inch to one and one-half inches have been found to be entirely adequate for carrying out this method.

It is the purpose of this invention to totally flood the interior of refrigerator car or truck bodies with a sufficient amount of mixed carbon dioxide vapors and snow to accomplish the desired cooling of the interior of the body and its walls to the desired low temperature and to apply an appropriate coating of carbon dioxide snow to the exposed surfaces of the car lining in a fraction of a minute's time. This rapid pre-cooling may be accomplished by delivering the liquid carbon dioxide to the vehicle body through either a one inch or a one and one-half inch discharge line having applied to its extremity a single discharge device.

To accomplish this precooling operation with the mobile unit 7 and the hose line 8, the operator will merely step just inside the body 5 through the conventional loading doorway 9 and will release the carbon dioxide into the car body. During the fraction of a minute that the liquid carbon dioxide is being discharged, the hose line should be manipulated so that the stream will impinge against all of the exposed surfaces of the snow accumulating lining. By quickly swinging the discharge end of the hose line around so that the discharge will be directed against all the walls of the interior of the body 5, this snow deposit may be provided.

To indicate the ability of this type of carbon dioxide discharge to quickly cool heated spaces, it will be stated that the temperature of the discharged mixture is approximately -110°F . and enclosed spaces heated to a temperature in the neighborhood of 1000°F . have been cooled to sub-zero temperatures as a result of a carbon dioxide discharge of the illustrated character lasting approximately one minute.

Of course, flooding the interior of a trans-

portable refrigerator body of the illustrated character with carbon dioxide vapor expels from the space the heated air. It also creates an atmosphere in which it would be dangerous to work. With the loading door 9 wide open, however, the vapors will be permitted to escape rapidly. In the course of two or three minutes, an observer will note that the whitish vapors have settled within the space, as a result of this escape, and the top of the vapor blanket or mass within the space will be well defined and will be visible through the door opening 9. In approximately five minutes, the vapors charged into the refrigerator space will have dissipated to a sufficient extent to enable workmen to safely enter the vehicle body for loading purposes.

The deposit of carbon dioxide snow on the lined walls of the enclosure is still present after the vapors have escaped through the loading doorway. This carbon dioxide snow sublimates at a temperature of -110°F . and will continue to refrigerate the interior of the vehicle body while it sublimates. This prolonging of the refrigerating action during the loading period effects an initial refrigerating of the warm commodities. Because the carbon dioxide vapors liberated as a result of sublimation of the snow are more dense than air, these vapors will move downwardly along the sides of the body walls and after reaching the floor level they will flow outwardly of the enclosure through the loading opening. In observing this action, it will be noted that the walls of the enclosure are covered with a fabric lining which has applied thereto the deposit of snow and a film or layer of vapors, traveling downwardly, will overlie the snow deposit. This combination of fabric, solid carbon dioxide, and vapor layers will very effectively insulate the interior of the enclosure against the input of heat through the walls of the refrigerator body.

After the refrigerator vehicle has been properly loaded, it is necessary to provide the enclosure with the refrigerant which is to be relied upon to preserve the commodities while in transit. The vehicle of Fig. 1 is provided with the conventional ice bunkers 6 which are to be charged with blocks of ice for this purpose. Another method of refrigerating the commodities en route would be to "top ice" the same by discharging crushed or snow ice into the car for the purpose of filling the spaces between the boxes, crates, or the like which contain the commodities and for applying a blanket or layer of the ice particles over the top of the load. This top icing method is illustrated in Fig. 3. If top icing is to be relied upon as the sole refrigerant en route, the entire space between the top of the load and the inner surface of the roof should be filled with the ice particles.

In addition to the aforementioned conventional ways of refrigerating the load while in transit, the present invention involves two entirely new methods. The first of these new methods consists of entirely closing up the refrigerator body by shutting the door or doors for the loading doorway and then discharging a second charge of carbon dioxide snow and vapors into the interior of the body either through one or more of the special charging doors 10 or 10a of Figs. 2 and 3, or by means of the permanent piping 11 and 12 disclosed in Figs. 4 to 6, inclusive. This second flooding of the sealed up enclosure provides a refrigerating temperature which will last for many hours. If the distance to be traveled will require several days, it will be necessary to

re-flood the enclosure at designated points along the route. This re-flooding may be accomplished in the same manner as the initial flooding, i. e., through the special doors or through the permanent piping. It will be appreciated that this method of refrigerating will not only maintain the perishable commodities at the desired low preserving temperature but will also provide the enclosure with a carbon dioxide atmosphere that has a very definite beneficial effect in preserving the commodities and preventing the growth of bacteria.

The second new method of refrigerating the load while in transit is fully illustrated in Fig. 3 and involves the combination of "top icing" and carbon dioxide flooding. In carrying out this method, the crushed or snow ice 13 is discharged into the interior of the body in the conventional way but the space between the top of the load and the inner surface of the car roof is not entirely filled with the layer or blanket of ice. A chamber is left between the top of the ice blanket and the inner surface of the roof.

After the enclosure is iced in this manner, the loading doors are closed and the remaining chamber, which is designated by the reference character 14 in Fig. 3, is flooded either through one of the doors 10 or by means of the permanent piping 11 or 12, shown in Figs. 4 to 6, inclusive. This flooding of the chamber 14 with a mixture of carbon dioxide snow and vapor, having a temperature of approximately -110°F ., will operate very effectively to retard melting of the water-ice. The carbon dioxide snow of the mixture, of course, will be deposited on the surfaces that form the chamber 14. This snow deposit will sublime in the course of time and will liberate additional vapors. The original vapors of the flooding mixture will not remain static in the chamber 14 but will find its way into the voids between the particles of water-ice and will provide the desired carbon dioxide preserving atmosphere for the commodities. If, as a result of unusually high temperature conditions and/or unusually long transportation time, it becomes necessary to reflood the enclosure, this may be accomplished in the same manner as the original flooding.

To return to the modified car structures shown in the several figures, it will be pointed out that the car of Figs. 2 and 3 is provided with doors 10 which are hinged to the side walls of the body, as at 15, and are adapted to be retained closed by means of suitable latches 16. Fig. 3 discloses these doors 10 as closing ports 17 which extend entirely through the walls of the car body and open into the upper portion of the enclosure.

The door 10a of Fig. 2 is of special construction and will function to relieve excessive pressure within the enclosure. This excessive pressure may be created as a result of sublimation of the carbon dioxide snow. This door 10a is provided with a suitable handle 18 for swinging it about its hinges 20. A spring 19 is interposed between end brackets 21 and 22, carried by the door and the car body, respectively. This spring will function to retain the door 10a closed at all times except when an excessive vapor pressure exists in the enclosure. When such an excessive vapor pressure does exist, the door will open to let out sufficient vapor to reduce the pressure to a desired lower value.

In Figs. 4 and 5, the car body is illustrated as being provided with a pipe line 11 which extends

through one side wall of the car body and is provided with a coupling 23 to which a hose line, such as that designated by the reference character 8 in Fig. 1, may be connected for supplying the line 11 with carbon dioxide from a bulk storage source. This pipe line extends around the interior of the car body, adjacent the roof, and is provided at suitable intervals with discharge nozzles 24. These discharge nozzles are illustrated in Fig. 5 as pointing both horizontally and vertically to deliver the released carbon dioxide snow and vapor mixture both transversely of the enclosure and downwardly. These discharged jets or streams of snow and vapor will sweep the side walls and the top wall or ceiling of the enclosure and will deposit carbon dioxide snow on these lined surfaces. The nozzles 24 are of suitable design to create a back pressure in the line 11 which will prevent the pressure of the carbon dioxide flowing through this line from dropping to a value which will permit snow to form either in the line or in the nozzles. Discharge devices of this type are very common in the prior art and are readily available on the open market. The majority of such devices operate on the principle of permitting the carbon dioxide to be discharged through a constricted orifice. This relatively small opening creates the desired back pressure, and liberation of the liquid carbon dioxide on the atmospheric side of the aperture permits sudden expansion which converts the liquid to vapor and snow.

The percentage of snow produced as a result of sudden expansion of liquid carbon dioxide depends on the temperature of the liquid. Theoretically, liquid carbon dioxide stored at a temperature of 70°F . produces a discharge mixture which contains 29% snow, while liquid carbon dioxide stored and released at 0°F . produces 60% snow. The percentage of snow continues to increase as the temperature of the stored liquid decreases. The latent heat of vaporization of carbon dioxide at different temperatures has a very important bearing on the ability of this medium to quickly cool the involved spaces. For example, at 87.8°F ., the latent heat of vaporization is 0 B. t. u. per pound of carbon dioxide; at -4.0°F ., it is 122 B. t. u. per pound, and at -69.9°F ., it is 149.6 B. t. u. per pound. It is apparent, therefore, that the use of low temperature, low pressure liquid carbon dioxide to carry out the steps of either pre-cooling or refrigerating during transit is much more effective than the use of uncontrolled, high temperature carbon dioxide.

In Fig. 5, the loaded perishables are diagrammatically designated by the reference character 25. A fabric cover 26 is applied to the top of this load. This fabric covering will function to accumulate a blanket or layer of carbon dioxide snow which will sublime in transit and, of course, absorb heat from the load and from the interior of the car body as a result of this change of state.

Fig. 6 discloses a modification of the fixed piping idea illustrated in Figs. 4 and 5. In this Fig. 6, the pipe line 12 is located in the space 27 between the inner and outer walls of the side of the car body, which space usually receives the insulating material employed in the construction of the body. This piping 12 is provided with a suitable number of discharge nozzles or jets 28 that extend from the piping into the interior of the car body. The principal advantage in assembling the piping within the side wall struc-

ture of the car is to protect the piping from damage as a result of rough handling of the freight and to avoid obstructing any portion of the space provided by the car for transporting a pay load.

Fig. 3 discloses the refrigerator car structure of Fig. 2 when used for carrying out the combined "top icing" and carbon dioxide flooding method for refrigerating the perishable commodities en route. This figure additionally discloses the discharge nozzle 29, to be used on the hose line 8 and a control valve 30 by means of which the operator is permitted to start and stop the discharge of carbon dioxide snow and vapor through the nozzle.

It is to be understood that the forms of this invention herewith shown and described are to be taken as preferred examples of the same, and that various changes in the shape, size, and arrangement of parts may be resorted to without departing from the spirit of the invention or the scope of the subjoined claims.

Having thus described the invention, I claim:

1. A method of refrigerating perishable commodities and precooling the vehicles employed for transporting the same, comprising applying to the walls of the commodity transporting space of each of such vehicles a material to which carbon dioxide snow will adhere, releasing into the space liquid carbon dioxide to form a mixture of carbon dioxide snow and vapor at a sufficiently rapid rate to quickly lower the temperature of the space to that desired for loading, controlling the direction of release so that the mixture will strike said walls and, as a result of such impingement, deposit a layer of snow on the covering material which will prolong the refrigerating action beyond the period of discharge while subliming, and loading the vehicle with the perishable commodities to be transported while the temperature in the space is still at a desired low value.

2. A method of refrigerating perishable commodities and precooling the vehicles employed for transporting the same, comprising maintaining in bulk storage a supply of liquid carbon dioxide at a substantially constant subatmospheric temperature and its corresponding vapor pressure, conducting the carbon dioxide to each one of the vehicles to be refrigerated through a relatively large diametered confining flow path as a liquid and at substantially the stored temperature and pressure, effecting sudden expansion of the liquid into the commodity transporting space of the vehicle to quickly flood the same with a mixture of carbon dioxide snow and vapor whereby the subzero temperature of the discharge will effect refrigeration of the vehicle, prolonging the refrigerating action beyond the period of discharge by accumulating a substantial layer of carbon dioxide snow on certain walls of the space of the vehicle, and loading the vehicle with the perishable commodities to be transported while the temperature in the space is still at a desired low value.

3. A method of refrigerating perishable commodities and precooling the vehicles employed for transporting the same, comprising applying to the walls of the commodity transporting space of each of such vehicles a material to which carbon dioxide snow will adhere, maintaining in bulk storage a supply of liquid carbon dioxide at a substantially constant subatmospheric temperature and its corresponding vapor pressure, conducting the carbon dioxide liquid to each vehicle

to be refrigerated through a relatively large diametered confining flow path, and at substantially the stored temperature and pressure, effecting sudden expansion of the liquid into the said space of the vehicle to quickly flood the same with a mixture of carbon dioxide snow and vapor and in such a manner that a layer of snow will be deposited on the wall covering, and loading the vehicle with the perishable commodities to be transported while the temperature in the space is still at a desired low value.

4. A method of refrigerating perishable commodities and precooling the vehicles employed for transporting the same, comprising applying to the walls of the commodity transporting space of each one of such vehicles a material to which carbon dioxide snow will adhere, releasing into the space liquid carbon dioxide to form a mixture of carbon dioxide snow and vapor at a sufficiently rapid rate to quickly lower the temperature of the space to that desired for loading, controlling the direction of release so that the mixture will strike said walls and, as a result of such impingement, deposit a layer of snow on the covering material which will prolong the refrigerating action beyond the period of release while subliming, loading the space of the vehicle during the sublimation period of the carbon dioxide snow, and, after closing the loading door of the vehicle, charging a refrigerant into the vehicle space to maintain the desired refrigerating temperature en route.

5. A method of refrigerating perishable commodities and precooling the vehicles employed for transporting the same, comprising releasing into the commodity transporting space of each one of such vehicles liquid carbon dioxide to form a mixture of snow and vapor, the rate of release being sufficient to quickly lower the temperature of the space to the value desired for loading, prolonging the refrigerating action beyond the period of release by accumulating a substantial layer of carbon dioxide snow on certain walls of the space, loading the vehicle space during the sublimation period of the carbon dioxide snow, and, after the vehicle has been loaded, charging a refrigerant into the vehicle space to maintain the desired refrigerating temperature en route.

6. A method of refrigerating perishable commodities and precooling the vehicles employed for transporting the same, comprising maintaining in bulk storage a supply of liquid carbon dioxide at a substantially constant subatmospheric temperature and its corresponding vapor pressure, conducting the carbon dioxide to each one of such vehicles to be refrigerated through a relatively large diametered confining flow path as a liquid and at substantially the stored temperature and pressure, effecting sudden expansion of the liquid into the commodity transporting space of the vehicle to quickly flood the same with a mixture of carbon dioxide snow and vapor whereby the subzero temperature of the discharge will effect refrigeration of the vehicle space, prolonging the refrigerating action beyond the period of discharge by accumulating a substantial layer of carbon dioxide snow on certain walls of the space of the vehicle, loading the vehicle space during the sublimation period of the carbon dioxide snow, and, after the vehicle has been loaded, charging a refrigerant into the vehicle space to maintain the desired refrigerating temperature en route.

7. A method of refrigerating perishable commodities and precooling the vehicles employed

for transporting the same, comprising applying to the walls of the commodity transporting space of each one of such vehicles a material to which carbon dioxide snow will adhere, maintaining in bulk storage a supply of liquid carbon dioxide at a substantially constant subatmospheric temperature and its corresponding vapor pressure, conducting the carbon dioxide liquid to each vehicle to be refrigerated through a relatively large diametered confining flow path, and at substantially the stored temperature and pressure, effecting sudden expansion of the liquid into the space of the vehicle to quickly flood the same with a mixture of carbon dioxide snow and vapor and in such a manner that a layer of snow will be deposited on the wall covering, loading the vehicle space during the sublimation period of the carbon dioxide snow, and, after the vehicle has been loaded, charging a refrigerant into the vehicle space to maintain the desired refrigerating temperature en route.

8. A method of refrigerating perishable commodities and precooling the vehicles employed for transporting the same, comprising applying to the walls of the commodity transporting space of each one of such vehicles a material to which carbon dioxide snow will adhere, releasing into the said space liquid carbon dioxide to form a mixture of carbon dioxide snow and vapor at a sufficiently rapid rate to quickly lower the temperature of the space to that desired for loading, controlling the direction of release so that the mixture will strike said walls and, as a result of such impingement, deposit a layer of snow on the covering material which will prolong the refrigerating action beyond the period of release while subliming, loading the vehicle space during the sublimation period of the carbon dioxide snow, and, after closing the loading door of the vehicle, releasing into said space a second charge of carbon dioxide snow and vapor to maintain the desired refrigerating temperature en route and to create a preserving atmosphere for the transported commodities.

9. A method of refrigerating perishable commodities and precooling the vehicles employed for transporting the same, comprising releasing into the commodity transporting space of each one of such vehicles liquid carbon dioxide to form a mixture of snow and vapor, the rate of release being sufficient to quickly lower the temperature of the space to the value desired for loading, prolonging the refrigerating action beyond the period of release by accumulating a substantial layer of carbon dioxide snow on certain walls of the space, loading the vehicle space during the sublimation period of the carbon dioxide snow, and, after the vehicle has been loaded, releasing into the said space a second charge of carbon dioxide snow and vapor to maintain the desired refrigerating temperature en route and to create a preserving atmosphere for the transported commodity.

10. A method of refrigerating perishable commodities and precooling the vehicles employed for transporting the same, comprising maintaining in bulk storage a supply of liquid carbon dioxide at a substantially constant subatmospheric temperature and its corresponding vapor pressure, conducting the carbon dioxide to each one of such vehicles to be refrigerated through a relatively large diametered confining flow path as a liquid and at substantially the stored temperature and pressure, effecting sudden expansion of the liquid into the commodity transport-

ing space of the vehicle to quickly flood the same with a mixture of carbon dioxide snow and vapor whereby the subzero temperature of the discharge will effect refrigeration of the vehicle space, prolonging the refrigerating action beyond the period of discharge by accumulating a substantial layer of carbon dioxide snow on certain walls of the space of the vehicle, loading the vehicle space during the sublimation period of the carbon dioxide snow, and, after closing the loading door of the vehicle, releasing into said space a second charge of carbon dioxide snow and vapor to maintain the desired refrigerating temperature en route and to create a preserving atmosphere for the transported commodity.

11. A method of refrigerating perishable commodities and precooling the vehicles employed for transporting the same, comprising applying to the walls of the commodity transporting space of each one of such vehicles a material to which carbon dioxide snow will adhere, releasing into the said space liquid carbon dioxide to form a mixture of carbon dioxide snow and vapor at a sufficiently rapid rate to quickly lower the temperature of the space to that desired for loading, controlling the direction of release so that the mixture will strike said walls and, as a result of such impingement, deposit a layer of snow on the covering material which will prolong the refrigerating action beyond the period of release while subliming, loading the vehicle space with the packed containers of perishable commodities while leaving the space unoccupied between the tops of the containers and the roof of the vehicle, covering the tops of the uppermost containers with a layer of water-ice particles having a depth which will only partly fill the aforesaid unoccupied portion of the space, and, after closing the loading door of the vehicle, flooding the unoccupied portion of the space in the top portion of the vehicle with an additional discharge of carbon dioxide snow and vapor.

12. A method of refrigerating perishable commodities and precooling the vehicles employed for transporting the same, comprising releasing into the commodity transporting space of each one of such vehicles liquid carbon dioxide to form a mixture of snow and vapor, the rate of release being sufficient to quickly lower the temperature of the space to the value desired for loading, prolonging the refrigerating action beyond the period of release by accumulating a substantial layer of carbon dioxide snow on certain walls of the space, loading the vehicle space with the packed containers of perishable commodities while leaving the space unoccupied between the tops of the containers and the roof of the vehicle, covering the tops of the uppermost containers with a layer of water-ice particles having a depth which will only partly fill the aforesaid unoccupied portion of the space, and, after closing the loading door of the vehicle, flooding the unoccupied portion of the space in the vehicle with an additional discharge of carbon dioxide snow and vapor.

13. A method of refrigerating perishable commodities and precooling the vehicles employed for transporting the same, comprising maintaining in bulk storage a supply of liquid carbon dioxide at a substantially constant subatmospheric temperature and its corresponding vapor pressure, conducting the carbon dioxide to each one of such vehicles to be refrigerated through a relatively large diametered confining flow path as a

liquid and at substantially the stored temperature and pressure, effecting sudden expansion of the liquid into the commodity transporting space of the vehicle to quickly flood the same with a mixture of carbon dioxide snow and vapor where-
 by the subzero temperature of the discharge will effect refrigeration of the vehicle space, prolonging the refrigerating action beyond the period of discharge by accumulating a substantial layer of carbon dioxide snow on certain walls of the said space of the vehicle, loading the vehicle with the packed containers of perishable commodities while leaving the space unoccupied between the tops of the containers and the roof of the vehicle, covering the tops of the uppermost containers with a layer of water-ice particles having a depth which will only partly fill the aforesaid unoccupied portion of the space, and, after closing the loading door of the vehicle, flooding the unoccupied portion of the space in the vehicle with an additional discharge of carbon dioxide snow and vapor.

14. A method of refrigerating perishable commodities and pre-cooling the vehicles employed for transporting the same, comprising applying to the walls of the commodity transporting space of each one of such vehicles a material to which carbon dioxide snow will adhere, maintaining in bulk storage a supply of liquid carbon dioxide at a substantially constant subatmospheric temperature and its corresponding vapor pressure, conducting each carbon dioxide liquid to the vehicle to be refrigerated through a relatively large diametered confining flow path, and at substantially the stored temperature and pressure, effecting sudden expansion of the liquid into the commodity transporting space of the vehicle to quickly flood the same with a mixture of carbon dioxide snow and vapor and in such a manner that a layer of snow will be deposited on the wall covering, loading the vehicle space with the packed containers of perishable commodities while leaving the space unoccupied between the tops of the containers and the roof of the vehicle, covering the tops of the uppermost containers with a layer of water-ice particles having a depth which will only partly fill the aforesaid unoccupied portion of the space, and, after closing the loading door of the vehicle, flooding the unoccupied portion of the space in the vehicle with an additional discharge of carbon dioxide snow and vapor.

15. A method of refrigerating perishable commodities in transit, comprising packing the commodities in a transportation vehicle while leaving a space between the top surface of said commodities and the roof of the vehicle, filling a part of the depth of said space with a layer of water-ice particles applied to the top of said commodities, and, after closing the loading door of the vehicle, flooding the interior of the vehicle and particularly the unoccupied space in the top portion of the vehicle with a mixture of carbon dioxide snow and vapor.

16. Means for refrigerating perishable commodities, comprising a transporting vehicle having a refrigerating space, a fabric lining applied to the walls of said space, a piping system installed in said vehicle and having a plurality of discharge devices opening into the said refrigerating space and directed relative to said lining so as to apply a coating of carbon dioxide snow

thereto, a storage unit for maintaining a supply of liquid carbon dioxide exteriorly of the vehicle and at a subatmospheric temperature and its corresponding vapor pressure, and means for connecting the storage unit to the piping system for conducting the liquid carbon dioxide to the interior of the vehicle and releasing it so as to form a mixture of vapor and snow in sufficient quantities to completely flood the space with vapors and to apply the said coating of snow to the exposed surface of the fabric lining.

17. A method of refrigerating perishable commodities and pre-cooling the vehicles employed for transporting the same, comprising releasing into the commodity transporting space of each one of such vehicles liquid carbon dioxide to form a mixture of snow and vapors, the rate of release being sufficient to quickly lower the temperature of the vehicle space to the value desired for loading, prolonging the refrigerating action beyond the period of release by accumulating a substantial layer of carbon dioxide snow on certain walls of the space, loading the vehicle space with the perishable commodities to be transported while the temperature in the space is still at a desired low value, and charging a refrigerant into the vehicle to maintain a desired refrigerating temperature en route.

18. A method of refrigerating perishable commodities and pre-cooling the vehicles employed for transporting the same, comprising maintaining in bulk storage exteriorly of all of the commodity transporting vehicles a supply of liquid carbon dioxide at a substantially constant subatmospheric temperature and its corresponding vapor pressure, successively conducting the liquid carbon dioxide to each one of such vehicles to be refrigerated through a flow path which will provide a relatively high volume of flow and at substantially the stored temperature and pressure, effecting sudden expansion of the liquid into the commodity transporting space of the vehicle to quickly flood the same with a mixture of carbon dioxide snow and vapors, loading the vehicle space with the perishable commodities to be transported while the temperature in the space is still at a desired low value, and charging a refrigerant into the vehicle space to maintain a desired refrigerating temperature en route.

19. A method of refrigerating perishable commodities and pre-cooling the vehicles employed for transporting the same, comprising releasing into the commodity transporting space of each one of such vehicles a mixture of snow and vapors resulting from the sudden expansion of liquid carbon dioxide, the rate of release being sufficient to quickly lower the temperature of the vehicle space to the value desired for loading, prolonging the refrigerating action beyond the period of release by accumulating a substantial layer of carbon dioxide snow on certain walls of the vehicle space, loading the vehicle space with the packed containers of perishable commodities while leaving the space unoccupied between the top of the pile of containers and the roof of the vehicle, and covering the top of the pile of containers with a layer of water-ice particles to a desired depth to effect refrigeration of the commodities en route.

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