Feb. 26, 1952 L. L. WESTLING 2,586,893

METHOD AND APPARATUS FOR TRANSPORTING AND STORING FROZEN COMESTIBLES

Filed Feb. 23, 1949 2 SHEETS—SHEET 1

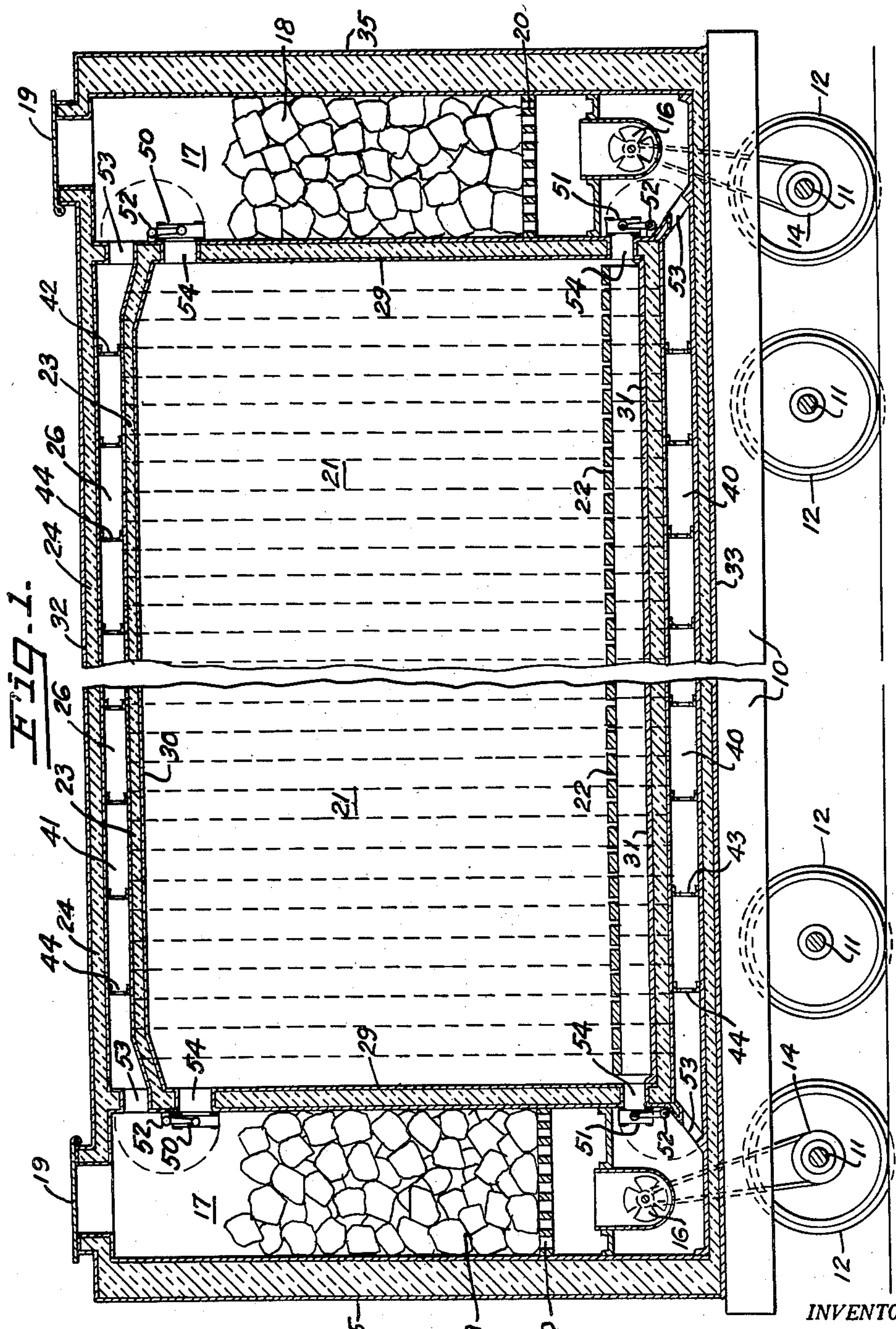


Fig. 1.

INVENTOR.

LESTER L. WESTLING

BY

Stephen S. Townsend

ATTORNEY

Fig. 2

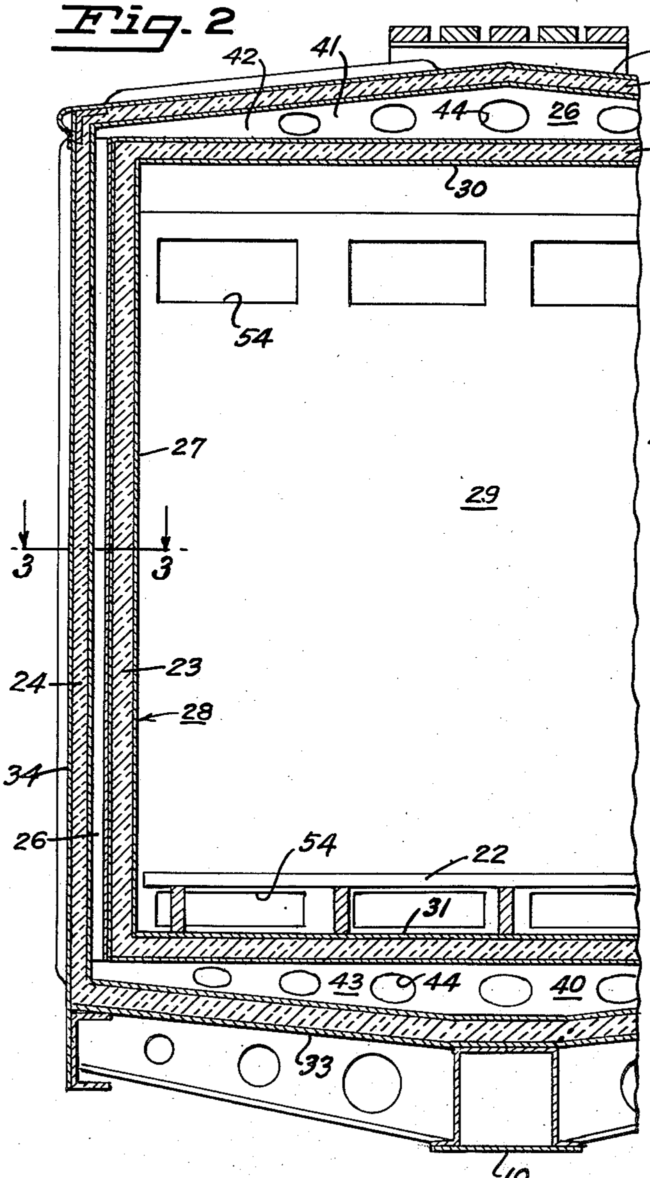


Fig. 4.

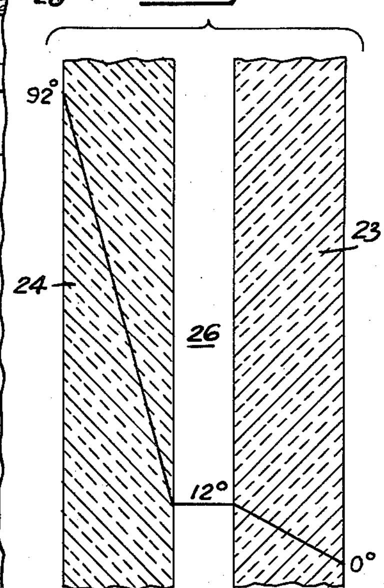


Fig. 5.

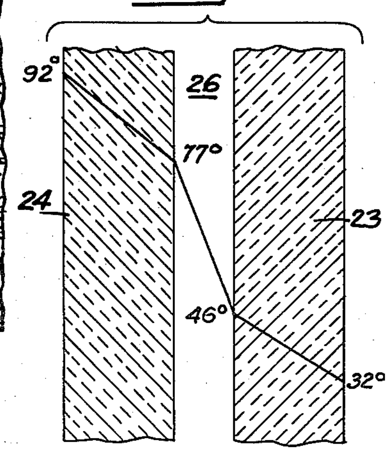
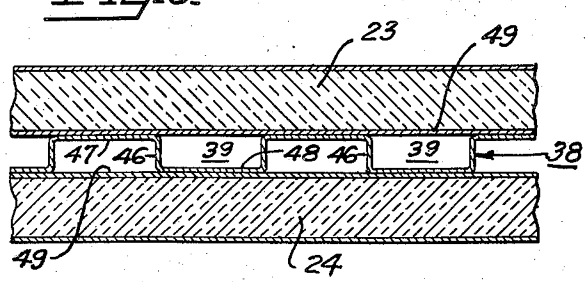


Fig. 3.



INVENTOR.
LESTER L. WESTLING
BY
Stephen S. Townsend
ATTORNEY

Patented Feb. 26, 1952 2,586,893

UNITED STATES PATENT OFFICE

2,586,893

METHOD AND APPARATUS FOR TRANSPORTING AND STORING FROZEN COMESTIBLES

Lester L. Westling, Oakland, Calif.

Application February 23, 1949, Serial No. 77,734

10 Claims. (Cl. 62—24)

1

This invention relates to refrigeration compartment and method of refrigeration and has particular adaptation to the refrigeration of comestibles which are quick-frozen and are most advantageously maintained at or below plus 5° F. The invention is particularly adaptable for use in connection with railway refrigerator cars and the like which utilize a refrigerant consisting of a mixture of ice and chemical salt. The invention will be described with particular reference to its use in a railway refrigerator car, it being understood that the invention may be applied to other installations.

One obstacle to continued expansion of the quick-frozen fruit, vegetable, meat, fish and poultry industry is the difficulty of transportation over long distances with existing equipment. The present invention is designed to decrease the expense of transportation of such goods, increase the range over which they may be transported and improve the properties of the foods transported, particularly with reference to weight, palatableness, appearance and nutritional value. Such goods are best preserved at a constant temperature of plus 5° F. or lower and with the moisture content of the surrounding atmosphere at or near saturation so that moisture is not removed from the food and transmitted to the refrigerating medium. If the temperature fluctuates, various elements in the food which, by reason of the quick-freezing process, exist in the form of small crystals, may melt and upon refreezing reform into larger crystals with consequent breaking down of the cell structure of the food and damage to the appearance, palatableness, and nutritional value thereof. Normal railroad transportation occasions cyclic rises and falls in temperature by reason of melting of the ice and re-icing of the cars and for other reasons such as weather changes, changes in altitude and differences in night and day conditions. Such cyclic changes in temperature have a particularly disadvantageous effect on frozen foods in that they promote the gradual building up of larger ice crystals.

Evaporation of moisture from the food diminishes the weight and also damages the comestibles both from the standpoint of appearance, palatableness and nutritional value. Existing methods of transporting or storing quick-frozen foods for long periods tend to cause considerable evaporation of moisture from the foods, as well as raising of the temperature above the desirable maximum and further result in cyclic elevations of temperature above the desired maximum. The almost universal means of refrigerating railway cars is by the deposit of salt and ice mixtures in bunkers at either end of the cars. A common mixture employs 30% sodium chloride and the remainder ice and results in a summer minimum car temperature of approximately 12° F. Air is circulated through the bunkers filled with salt and ice mixture and into the central compartment of the car either by means or fans or by natural draft. The railway industry has a considerable investment in car icing facilities, and it is one of the features of the present invention to make use of such facilities and not to require the investment of capital in new or different facilities.

2

The use of a 30% mixture of salt and ice results in a minimum refrigerating temperature of about 12° F. which is higher than the desired maximum temperature for maintaining quick-frozen foods. Thus existing facilities tend to bring into equilibrium the temperature of the quick-frozen food and the salt and ice mixture, and it is necessary initially to lower the temperature of the food considerably below 0° F. so that its temperature during transit will not rise too high, and even this expedient is successful only for relatively short periods of time before equilibrium is reached at a higher temperature than is desired. The necessity of re-icing refrigerating cars under present conditions to keep the temperature down results in an elapsed time of five to twelve days for a transcontinental trip, and during such period of time the temperature of the frozen foods is raised above the desired maximum with consequent deleterious effect. Among the objects of the present invention are the provision of facilities for increasing the range over which frozen foods may be transported at suitable temperatures and improvement of the quality of food from the standpoint of weight, moisture content, appearance, palatableness and nutritional value.

It is another principal object of the present invention to provide a refrigerating compartment which will maintain a satisfactory environment for the transportation or storage of such goods as frozen foods and preserve the moisture content of the goods and maintain the temperature thereof at a substantially uniform level lower than that now possible by the use of conventional salt and ice mixture refrigeration methods.

Another principal object of the present invention is the attainment of the foregoing objects by means of the novel construction of a refrigeration compartment in which there are two layers of insulating material interposed between the outside atmosphere and the compartment in which the goods are stored, with a space between the two layers of insulation through which a refrigerating medium, such as chilled air, may be circulated. Thus heat leaking from the outside is largely removed by the chilled air which circulates through the space between the layers at about 12° F. Since the space between the layers of insulation is maintained at a temperature greatly less than that of the atmosphere outside the refrigerating car, the temperature differential between the interior of the car and the space between the layers of insulation is relatively small, and the leakage between such space and the interior of the car is consequently small.

Another object of the invention is to eliminate the intimate contact of the circulating refrigerating medium, such as chilled air, with the goods being refrigerated, and hence to eliminate the removal of moisture from the goods.

A further object of the invention is to absorb or cushion major atmospheric temperature changes so that the temperature of the cargo is affected only slightly, if at all. The temperature fluctuation is largely absorbed by the air jacket between the layers of insulation and the proportionate difference between the temperature of the jacket and that of the cargo is less than that between the atmosphere and the cargo.

Another object of the invention is to decrease the time required to chill a car in preparation for loading.

Still another object of the invention is the provision of means which may be used to convert the refrigerating car to a refrigeration system similar to that used in conventional cars at the present time, but with certain advantageous features which increase the insulation of the interior from the atmosphere.

Further objects of the present invention will become apparent upon reading the following specification and referring to the accompanying drawings in which similar characters of reference represent corresponding parts in each of the several views.

In the drawings:

Fig. 1 is a longitudinal vertical section through a car.

Fig. 2 is a transverse vertical section of a half of a car.

Fig. 3 is a fragmentary horizontal sectional view through a side wall taken along the line 3—3 of Fig. 2.

Fig. 4 is a schematic view illustrating the drop in temperature from the outside atmosphere assumed to be at 92° F. to an interior compartment at 0° F. wherein the space between two layers of insulation is cooled by air at 12° F.

Fig. 5 is a view similar to Fig. 4 wherein the space between the two layers of insulation is closed off and constitutes a dead air space.

As has been stated, the present invention is described by reference to its installation in a railway car, but it will be understood that the invention is capable of use in other media.

In the accompanying drawings there is shown a railway car having frame **10** supported above axles **11** having wheels **12** which run on tracks. Rotation of the axles **11** as the car moves turns pulleys **13** mounted thereupon and by means of belts, chains or other transmission means **14** causes rotation of air circulating fans **16** which move air through bunkers **17** positioned at either end of the car. The bunkers may be filled with

a refrigerating medium, such as a mixture of ice and salt **18**, which is deposited in the bunkers through a plurality of doors **19** in the roof of the car communicating with the bunkers and is supported upon horizontal bunker grates **20** which permit circulation of air through the bunker and refrigerant. It will be understood that various means of driving the fans could be employed when the car is stationary, as at a loading platform or when the invention is put to use other than in connection with rolling stock.

The use of a mixture of 30% salt and 70% ice results in a plenum temperature of about 12° F., and consequently, as the air is forced or through natural means circulates through the mixture, the temperature of the plenum air is reduced to, at or about 12° F. In conventional refrigeration, this chilled air is caused to circulate through the contents of the car, and thus removes part of the heat leaking into the car from the atmosphere and also tends to bring the temperature of the contents into equilibrium with the temperature of the bunkers. Such temperature is too high for frozen foods for the reasons which have been explained, and the circulation of chilled air through quick-frozen foods tends to remove at least part of the moisture thereof and to raise the temperature thereof with the deleterious effects hereinbefore mentioned.

Where very cold outside temperatures are experienced it may be necessary to heat the cars by circulation of warm air through the space between layers of insulation, heating frequently being accomplished by combustion. In such instances, the gases resulting from combustion and/or the low humidity air do not reach the cargo but circulate in the space between layers of insulation.

In the present invention the chilled air passing through the bunkers **17** may be channeled so that it does not come into contact with the food being transported, and hence it cannot remove moisture from the food. In accordance with the present invention the food is stored inside a central compartment **21** to which access is afforded by side doors (not shown) suitably insulated. The goods may be stacked upon a floor rack or platform **22** spaced above the floor of the car. The compartment is insulated by two separate layers of insulation material **23** and **24** with a space **26** therebetween through which circulates chilled air from the bunkers **17** in an uninterrupted circuit around the roof, sides and floor of the car. The interior compartment **21** is provided with a lining **27** of plywood, fibre board, metal or other suitable substance on the sides **28**, ends **29**, roof **30** and floor **31** to reduce wear and so that the interior may easily be cleaned when necessary. The lining **27** is attached by adhesive or other suitable fastening means to interior insulation **23** which surrounds the compartment **21** and lining **27** on all sides thereof. Spaced from the interior insulation **23** is an exterior insulation **24** which may be attached by adhesive or other suitable fastening to the roof **32**, floor **33**, sides **34** and ends **35** of the car. The insulation may be of any suitable type but preferably has structural and compressive strength as well as high insulating efficiency.

Interposed between the interior and exterior insulations along the sides of the car are spacing means **38** attached to said respective insulations by adhesive or other fastening means and separating the two layers of insulation **23** and **24** from each other and establishing the space **26** therebetween. The spacers 38 shown in the preferred embodiment particularly with reference to Fig. 3 are corrugated so as to afford a plurality of vertical channels 39. These unobstructed channels provide a flue effect to enhance air circulation through space 26 when fans 16 are not operating. In conventional refrigerator cars, circulation of air through the cargo space by natural draft is obstructed by the cargo itself, particularly when the fans are stopped as, for example, during re-icing. The channels 39 augment natural draft circulation and hence tend to keep a constant cargo temperature even when the fans 16 are stopped.

The spaces between the two layers of insulation at the top and bottom of the car are somewhat greater in cross-sectional area than the spaces between the two layers of insulation at the sides. Further, the roof 32 of a freight car generally slopes downward from a central crown so that the space between the two layers of insulation is greater along the center than near the sides of the car. Similarly, the floor 33 may be sloped downward at the center to provide a greater space at the center of the bottom of the car than along the sides. The enlarged spaces constitute plenums 40 and 41 for movement of air longitudinally of the car. For the purpose of supporting the insulation and load along the top and bottom of the car, there are a plurality of transverse webs 42 and 43 at the top and bottom, respectively, and to permit free circulation of air through the plenums 41 and 40 across which these webs extend, holes 44 are spaced in the webs to provide longitudinal communication from one end bunker 17 to the other so that the air may circulate freely longitudinally of the car at the top and bottom plenums and be channeled downwardly or upwardly in the plurality of channels 39 formed by the spacers 38.

In Fig. 3 there is shown corrugated material interposed between the inner layer 23 and outer layer 24 of insulation, said corrugations consisting of risers 46 which hold the two layers apart a fixed distance, the risers being associated with parallel faces 47 and 48 transverse to risers 46 which are alternately on one side or the other of the two layers of insulating material. Optionally, sheets 49 extending across the faces 47 and 48 are joined to spacers 38 by welding or other suitable manner and affixed to insulation 23 and 24 by adhesive or other means. It will be understood that the construction of the spacers 38 is subject to wide modification. It will be observed, however, that the spacers shown in the preferred embodiment have considerable structural strength and tend to support the weight of the insulation and contents of the cargo. The channels provide convenient means for uniform distribution of chilled air longitudinally of the car.

Positioned adjacent the top and bottom of each of the bunkers 17 are insulated dampers 50 and 51, respectively, hingedly connected to the interior insulation at hinge pivot 52. The dampers are adjustable in three positions. In one position of adjustment each damper affords communication between the bunker 17 and the plenums 40 and 41 by opening ports 53 communicating between the bunkers and plenums and closing ports 54 communicating between the bunkers 17 and interior compartment 21. A second position of adjustment closes the ports 53 communicating from the bunker 17 to the plenums 40 and 41 and opens the ports 54 communicating between the bunkers 17 and the interior compartment 21 of the car. A third or intermediate adjustment is provided in which there is communication from the bunkers 17 through both ports 53 and 54 into both the compartment 21 and plenums 40 and 42. In the first position of adjustment of the dampers the car is available for use in connection with transportation of quick-frozen foods. In the second position of adjustment the car is adaptable for use similar to conventional refrigerating cars but with improved effect. In the third position of adjustment the car is adapted for rapid pre-cooling. A description of the use of the car in each of the three positions of adjustment follows.

In the first position of adjustment of dampers 50 and 51, as is shown in Fig. 1, air is circulated by the fans 16 through the bunker 17 and is cooled by the salt and ice mixture 18 to a temperature about 12° F. The ports 53 being open, the chilled air passes through said ports and through the longitudinal upper plenum 41 and branches out and travels down through the channels 39 in the spacers 38 between the layers of insulation 23 and 24 of the side walls, thence down to the lower plenum 40 and through the ports 53 and up through end bunker 17. By such air circulation the temperature of the space 26 between the two layers of insulation tends to reach a level of about 12° F. It will be understood that a reverse flow may be employed in which case the air is drawn through the bunker 17 by fan 16 thence through lower plenum 40, up through channels 39 and back to the bunker through upper plenum 41.

The advantages of the invention may be illustrated by example. Assuming that the temperature of the outside atmosphere is 92° F. and that the quick-frozen foods inside the compartment are at 0° F., as is shown by the temperature gradient diagram Fig. 4, the temperature drops from 92° F. on the exterior of the car through the outer insulation 24 to the temperature of 12° F. in the space 26 between the two layers of insulation 23 and 24 and then drops from 12° F. in said space to 0° F. in the interior compartment through the interior insulation 23. Hence the major portion of the heat which leaks into the car from the outside atmosphere is intercepted and removed in the space 26 between the insulation layers, and, therefore, the difference in temperature between the space 26 and the interior compartment 21 is relatively small as compared with the difference in temperature between the interior compartment 21 and external atmosphere. Accordingly, the leakage of heat into the interior compartment is relatively slight, for the heat leakage is a direct function of the temperature differential between the two sides of the layer of insulation. The reduction in heat leakage into the interior compartment prolongs the period of time during which frozen food is maintained at low temperature. Furthermore, since the air does not circulate through the interior compartment it does not remove moisture from the cargo.

The heat gained or lost through a thickness of insulation may be expressed by the formula:

$$H=A\frac{K}{t}(T_1-T_2)$$

wherein

H=heat gained or lost

A=surface area in sq. ft.

K=a constant dependent upon the type of insulation used expressed in B. t. u./hour/inch/thickness/deg. F. Diff.

t=thickness of insulation in inches
T_1=temperature on one side of insulation
T_2=temperature on opposite side of insulation

Referring now to Fig. 4 and computing H through insulation **24** and assuming

A=100 sq. ft.
t=3 in.
T_1=92° F.
T_2=12° F.
K=.28 for corkboard insulation

Then

$$H=100\times\frac{.28}{3}\times(92-12)=747 \text{ B. t. u. per hr.}$$

Computing H through insulation **23** and assuming

A=100 sq. ft.
t=3 in.
T_1=12° F.
T_2=0° F.
K=.28

Then

$$H=100\times\frac{.28}{3}\times(12-0)=112 \text{ B. t. u. per hr.}$$

Thus only 112 B. t. u. of heat per hour is absorbed by the cargo, whereas 747 B. t. u. is absorbed by the chilled air and goes to melt the ice in bunkers **17**.

The value of the present invention may be seen by computing the thickness of solid insulation required to produce a corresponding low heat absorption. Assume

H=112 B. t. u. per hour
A=100 sq. ft.
T_1=92° F.
T_2=0° F. (assuming a refrigerant were used to provide such a temperature, i. e., some refrigerant other than salt and ice)

Then

$$t=\frac{100\times.28\times(92°-0°)}{112}$$

$$t=23 \text{ in.}$$

Thus by the present invention a saving of 17 inches in thickness of insulation results with consequent reduction in cost, weight and time of precooling for like conditions.

The second position of adjustment of the dampers **50** and **51** provides communication from the bunkers **17** to the interior compartment **21**, through ports **54**, and thus permits circulation of air around the cargo much as in conventional refrigerator cars. In this position of adjustment the cars may be used normally for transportation of foods at a higher temperature than in the first position of adjustment. It will be observed that the space **26** between the layers of insulation is closed off by the dampers **50**, and hence there is a dead air space between the two layers of insulation **23** and **24** which enhances the insulation effect between the interior compartment **21** and the external atmosphere. As shown in Fig. 5 assuming a temperature of 92° F. in the exterior atmosphere, it will be seen that the dead air space **26** between the two layers of insulation **23** and **24** enhances the insulation effect and results in a lower interior temperature in compartment **21** than would be obtained were there no space between the two layers of insulation, or the required higher temperatures could be obtained by lower salt-to-ice ratios or at reduced expenditure of the same.

Referring to Fig. 5, assuming insulation **23** and **24** to be each three inches in thickness and the dead air space **26** to be one-and-one-half inches and K for a dead air space to be 1.2, thus it will be observed that considerably less heat is transferred to the interior compartment than would be the case were a solid wall of insulation six inches thick to be used.

The third position of adjustment—namely, when both the ports **53** and **54** are open—provides for rapid pre-cooling of the cars. It will be understood that when refrigeration cars are not in use and stand in freight yards the temperature of the interior compartment **21** and the temperature of the air entrained in the insulation layers **23** and **24** rises to about the temperature of the surrounding atmosphere or even higher by reason of solar radiation. In pre-cooling the cars, it is necessary to withdraw heat not only from the interior compartment **21** but also from the insulation layers **23** and **24**. In the third position of adjustment of the dampers **50**, the area of insulation subjected to chilled air is approximately trebled. Thus the air in the interior compartment **21** is refrigerated and also the layers of the insulation are subjected to refrigeration on three separate surfaces—namely, the surface of inner layer **23** which communicates with the interior compartment, the surface of inner layer **23** which communicates with space **26**, and the surface of exterior layer **24** which communicates with space **26**. Therefore, the time consumed in lowering the temperature of the insulation is materially decreased because a greater surface area is subjected to refrigeration. Although this position of adjustment is advantageous for rapid pre-cooling, it is also useful in certain situations where a temperature slightly below 12° F. is desired. It is possible by adjustment of dampers **50** and **51** to balance circulation through the space **26** and compartment **21** in any desired ratio.

It is further apparent that the dampers at one end bunker may be in one position of adjustment and those at the other end at a different position. Thus flexibility is imparted to the system, which is desirable particularly if the two bunkers are at different temperatures by reason of different salt-and-ice ratios, and a compounded effect is desired for compartment **21**.

It will be understood that metallic surfaces, such as the spacers **38** and car exteriors **32** to **35**, inclusive, are preferably fashioned of bright metal or are painted or enameled white or a bright color so as to reduce heat absorption. Other enclosed metal should, preferably, be corrosion resistant.

The present invention is, therefore, particularly useful in connection with transportation of quick-frozen foods for relatively long distances where the refrigerant most economically employed is one such as a mixture of salt and ice, which produces a refrigerating temperature higher than the optimum for the goods being preserved. Specifically, the invention has application in connection with railway refrigerator cars in hauling quick-frozen foods which should be preserved at or below a temperature of 5° F. This result is accomplished by passing the chilled air from the bunker containing salt and ice mixture through the space between two layers of insulation surrounding the lading compartment and so channeling and thereby distributing the air as to provide a substantially uniform flow of air through the space between the insulation layers. By circulating the air through the space between the layers of insulation most of the heat leaking into the car from the atmosphere is carried off by the chilled air. Hence the temperature differential between the lading compartment and the space between the layers of insulation is considerably less than the temperature differential between the lading compartment and the atmosphere, and since the amount of heat absorbed through the insulation is proportional to the temperature differential between the two sides of the insulation layers, the heat leaking into the cargo is thereby reduced. This permits transportation of cargoes over longer distances because the quick-frozen food is not elevated in temperature as rapidly as would be the case if solid insulation were employed. It is also significant that the chilled air does not circulate through the cargo for otherwise, as in conventional installations, the air would remove moisture from the food, thereby reducing weight, damaging the appearance of the food, and decreasing nutritional value.

By making the dampers **50** and **51** adjustable, as has been indicated, the present invention may be used in two alternative ways—namely, as a means of quickly pre-cooling a car which has been standing in a yard with the result that the insulation has absorbed considerable heat, and as a conventional refrigerator car but with improvement in insulating quantities by reason of the dead air space provided when the ports **53** are closed.

Although the invention has been described as applied to a railway refrigerator car, it will be understood that with suitable modifications it may be used in other installations, either stationary or transportable. It will, further, be understood that the invention is adaptable to use with refrigerants other than salt and ice, and in fact if weather conditions necessitate, heated air may be circulated in the space between the layers of insulation.

Although I have described my invention in some detail by way of illustration for purposes of clarity of understanding, it is understood that certain changes and modifications may be made therein without departing from the spirit of the invention or scope of the appended claims.

I claim:

1. A refrigerating compartment comprising a cargo-accommodating walled enclosure, a first layer of insulation about said enclosure, a second layer of insulation about said first layer, spacing means for spacing said layers apart, a bunker for a refrigerating medium, a first port communicating between said bunker and said enclosure, a second port communicating between said bunker and said spacing means, damping means controlling circulation through said ports, and means for circulating air through said bunkers.

2. A refrigerating compartment comprising a cargo-accommodating walled enclosure, a first layer of insulation about said enclosure, a second layer of insulation about said first layer, spacing means for spacing said layers apart, a bunker for a refrigerating medium, a first port communicating between said bunker and said enclosure, a second port communicating between said bunker and said spacing means, damping means controlling circulation through said ports, and means for circulating air through said bunkers, said damping means being adjustable to at least three positions including, a first position establishing circulation between said bunker and said spacing means, a second position establishing circulation between said bunker and said enclosure, and a third position establishing circulation between said bunker and both said spacing means and said enclosure.

3. A refrigerating compartment comprising a cargo-accommodating walled enclosure, at least one wall thereof having a first layer of insulation, a second layer of insulation outside said first layer, and spacing means for spacing said layers apart, said spacing means including, webs in the space between said layers at the top and bottom of said enclosure extending transversely to the direction of movement of air through the space between said layers, said webs being apertured to permit movement of air and risers disposed between said layers at the sides of said enclosure to support structurally said layers and defining a plurality of vertical channels, the spaces at the top and bottom of said enclosure forming plenums for circulation of refrigerated air in a circuit from a source of refrigerated air out through the plenum in the space at the top of said enclosure, thence down through said vertical channels and back through the plenum at the space at the bottom of said enclosure to said source, and means for circulating air through said spacing means.

4. A refrigerating compartment as defined in claim 1 and wherein one of said layers at the top of the compartment is positioned at an angle with respect to the other of said layers so that the distance between said layers is greater along the longitudinal center of the top of said compartment than along the sides thereof thereby forming a top plenum for circulation of air along the top of said spacing means, and one of said layers at the bottom of the compartment is positioned at an angle with respect to the other of said layers so that the distance between said layers is greater along the longitudinal center of the top of said compartment than along the sides thereof thereby forming a bottom plenum for circulation of air along the bottom of said spacing means.

5. A refrigerator car comprising a bunker, a lading chamber, a first layer of insulation enclosing said chamber, a second layer of insulation surrounding said first layer, spacing means separating said layers, a first port communicating between said bunker and said spacing means, a second port communicating between said bunker and said chamber, a damper controlling circulation through said ports, and a fan for circulating air through said bunker and selectively upon adjustment of said damper through said first port, through said second port and through both said ports.

6. A method of maintaining pre-chilled cargo at or near its pre-chilled temperature comprising, depositing an ice and salt mixture in a bunker, pre-cooling a compartment by circulating cooled air from said bunker through said compartment and through a space between plural layers of insulation enclosing and defining said compartment, and maintaining said cargo below the temperature of said cooled air by circulating cooled air only through the space between said plural layers of insulation.

7. A method of maintaining pre-chilled cargo at or near its pre-chilled temperature comprising, depositing an ice and salt mixture in a bunker, loading said compartment with a pre-chilled cargo below the temperature of said bunker-chilled air,

and then circulating bunker-chilled air through the space between plural layers of insulation surrounding and defining said compartment, said circulation following a closed circuit of travel including a horizontal stretch below said compartment, a horizontal stretch above said compartment, a vertical stretch in a plurality of relatively narrow streams outside the sides of said compartment and a vertical stretch through said bunker, said path of travel being insulated from said compartment thereby substantially maintaining the temperature of said pre-chilled cargo below the temperature of said bunker-cooled air.

8. A refrigerating compartment comprising a cargo-accommodating walled enclosure, a first layer of insulation about said enclosure, a second layer of insulation about said first layer, spacing means for spacing said layers apart, a source of refrigerated air, a first port communicating between said source and said enclosure, a second port communicating between said source and said spacing means, and damping means controlling circulation through said ports.

9. A refrigerating compartment comprising a cargo-accommodating walled enclosure, a first layer of insulation about the bottom, top, sides and an end of said enclosure, a second layer of insulation about said first layer, spacing means for spacing said layers apart and establishing spaces between layers of insulation at the top, sides, an end and the bottom of said compartment, said spacing means in the sides of said compartment being formed to establish a plurality of vertical channels communicating between the spaces at the top and bottom of said compartment, the space at the end of said compartment communicating with the spaces at the top and bottom of said compartment, and means establishing a flow of refrigerated air in a circuit through said spaces wherein portions of said circuit extend longitudinally of said compartment along the top thereof, vertically along the sides of said compartment, longitudinally along the bottom of said compartment and vertically at an end of said compartment.

10. A method of maintaining pre-chilled cargo at or near its pre-chilled temperature comprising, depositing an ice and salt mixture in a bunker, loading a compartment with a pre-chilled cargo below the temperature of said bunker-chilled air, and then circulating bunker-chilled air through a space between plural layers of insulation surrounding and defining said compartment, said circulation following a path of travel from said bunker longitudinally above said compartment above the top thereof, then vertically downward in a plurality of relatively narrow streams outside the sides of said compartment, and then longitudinally below said compartment back to said bunker, said path of travel being insulated from said compartment thereby substantially maintaining the temperature of said pre-chilled cargo below the temperature of said bunker-cooled air.

LESTER L. WESTLING.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,256,162	Patee	Feb. 12, 1918
2,138,885	Ross	Dec. 6, 1938
2,184,810	Crede	Dec. 26, 1939
2,184,819	Sisson	Dec. 26, 1939
2,202,635	Mandery	May 28, 1940
2,258,402	Baillie	Oct. 7, 1941
2,338,452	Munters	Jan. 4, 1944
2,381,796	Williams	Aug. 7, 1945
2,485,630	Munters	Oct. 25, 1949