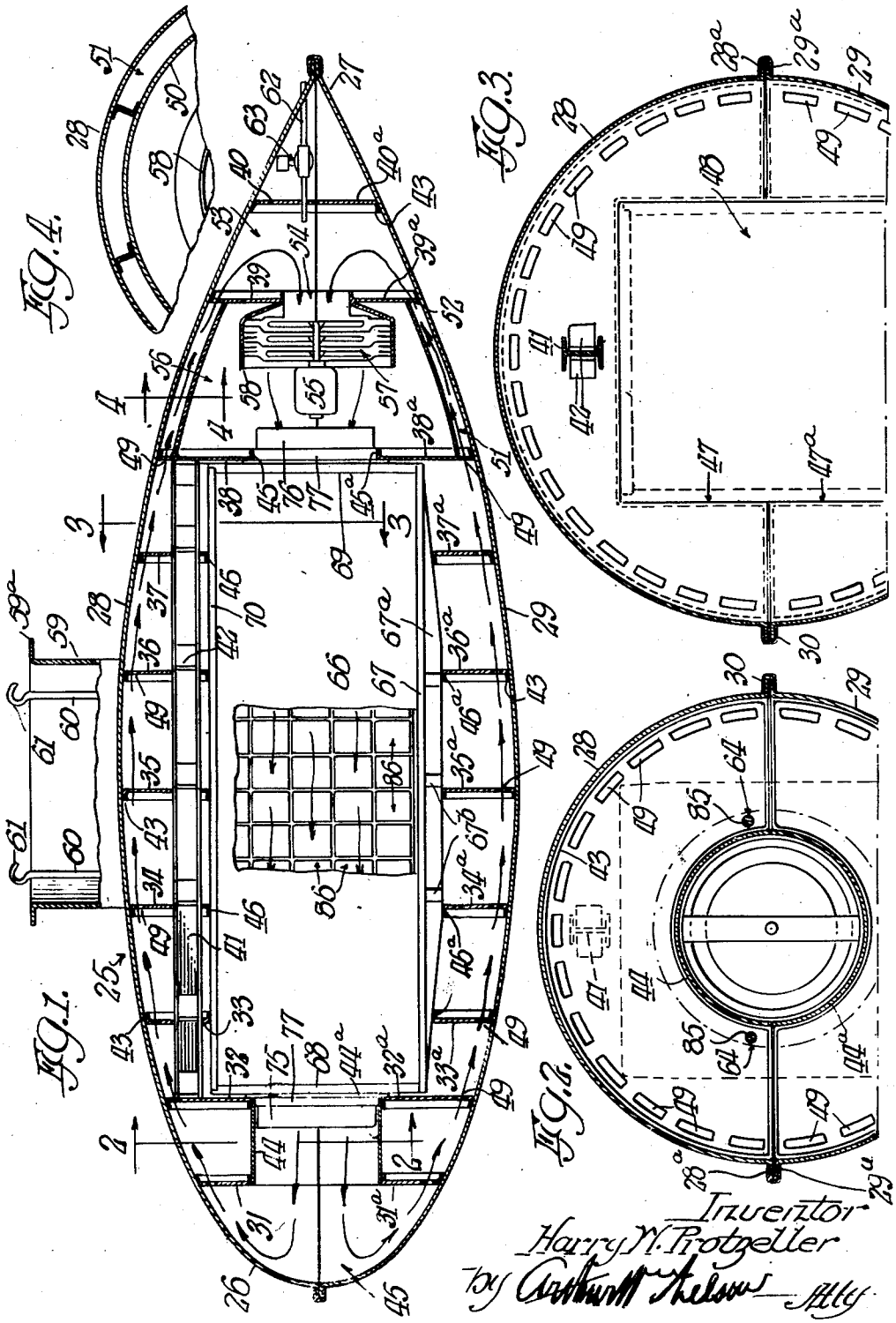
June 20, 1950 H. W. PROTZELLER 2,511,876

REFRIGERATING MEANS WITH AIR PUMP CIRCUIT

Filed Nov. 18, 1943 5 Sheets-Sheet 1



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REFRIGERATING MEANS WITH AIR PUMP CIRCUIT

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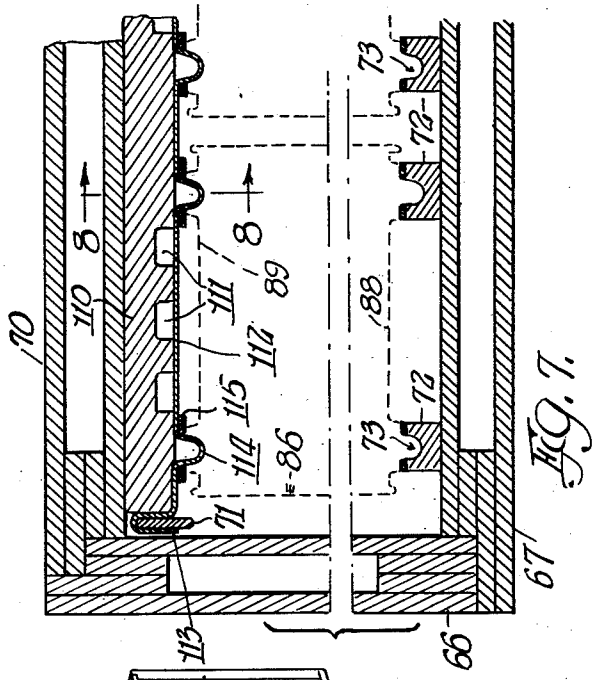



FIG. 1.

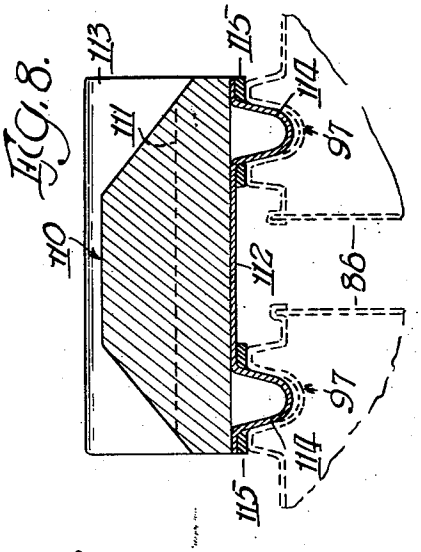



FIG. 8.

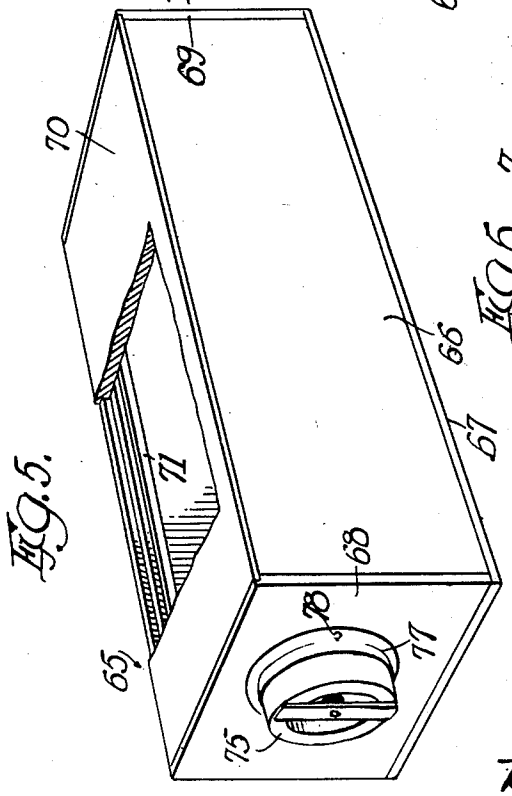



FIG. 5.

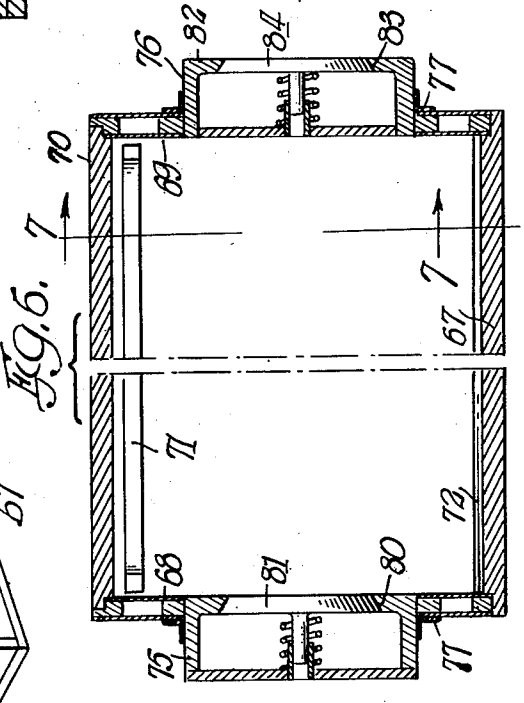



FIG. 6.

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REFRIGERATING MEANS WITH AIR PUMP CIRCUIT

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FIG. 11.

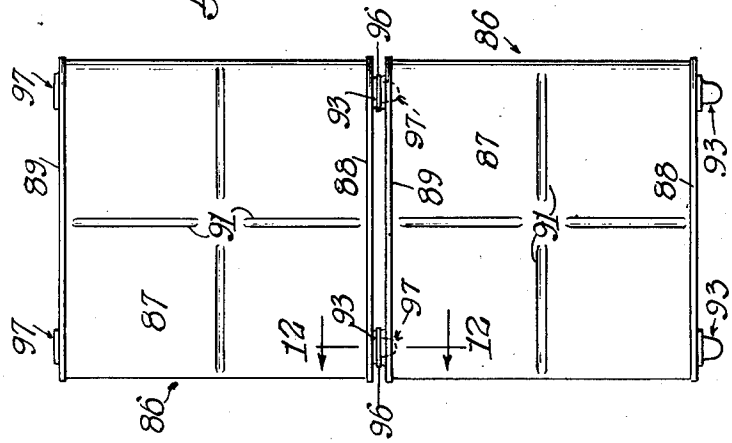



FIG. 12.

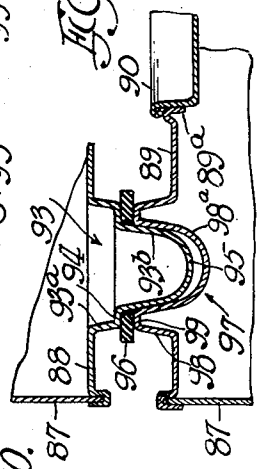



FIG. 10.

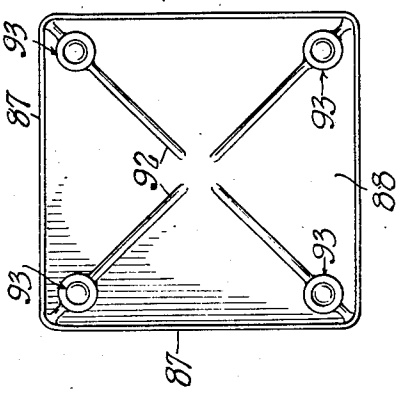
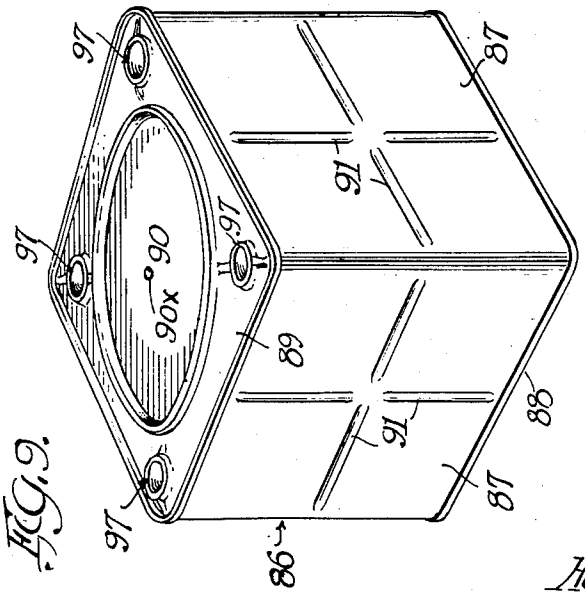



FIG. 9.




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REFRIGERATING MEANS WITH AIR PUMP CIRCUIT

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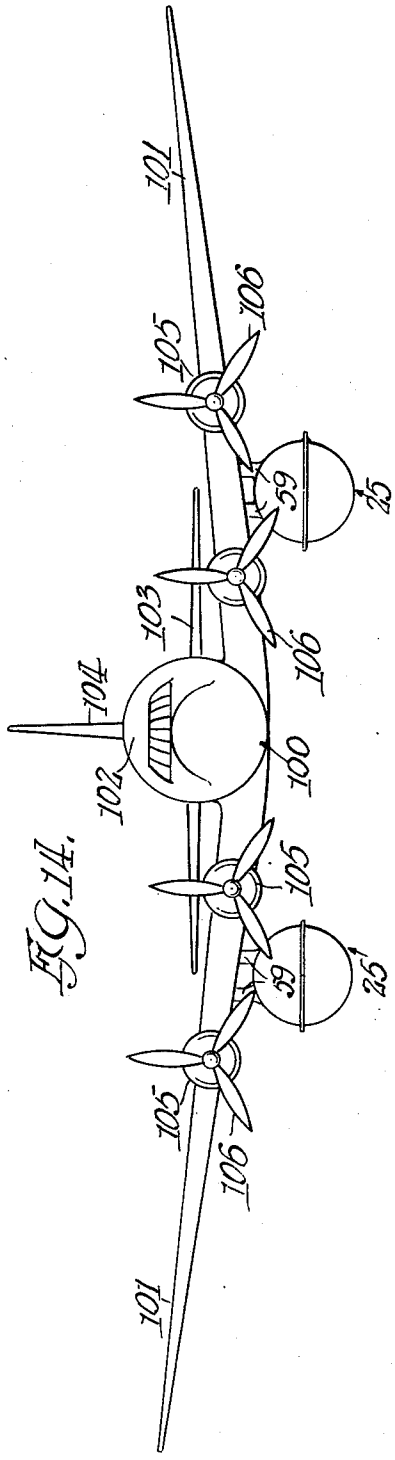



FIG. 14.

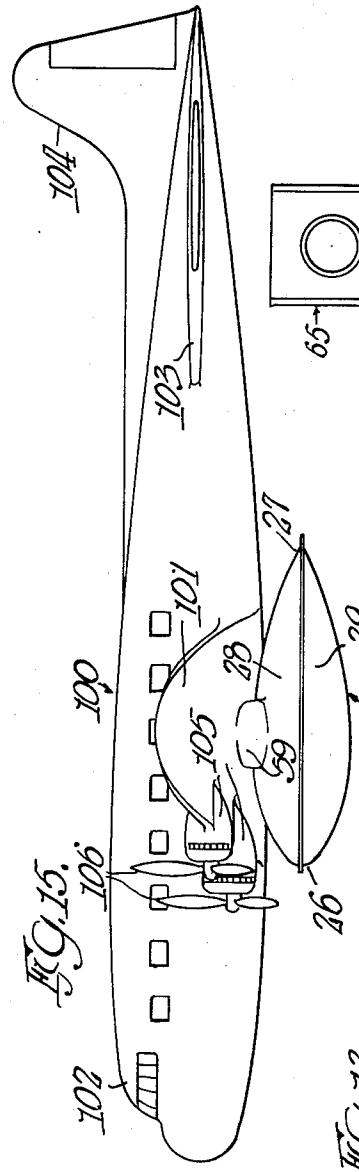



FIG. 15.

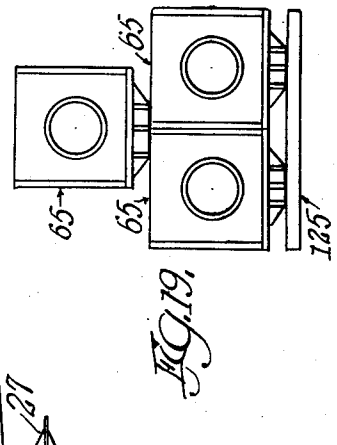



FIG. 19.

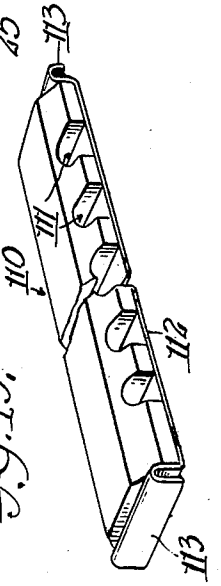



FIG. 13.

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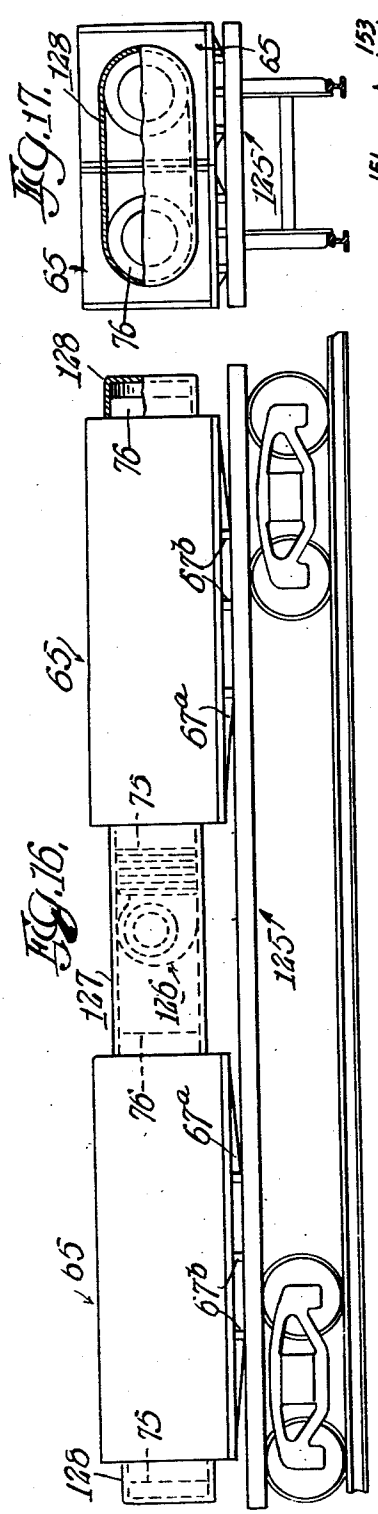



FIG. 16.

FIG. 17.

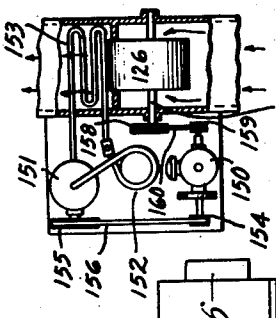



FIG. 20.

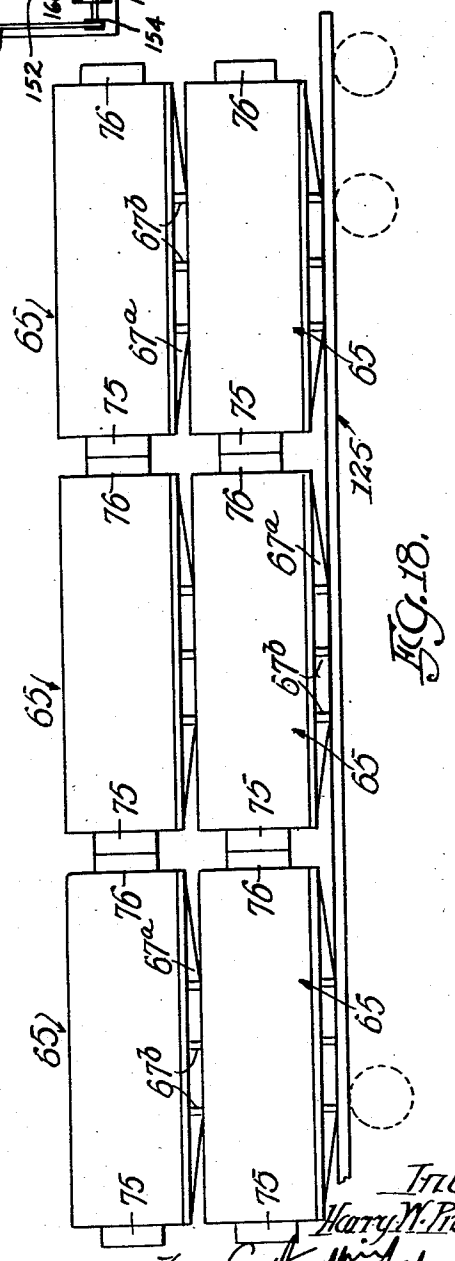



FIG. 18.

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Patented June 20, 1950 2,511,876

# UNITED STATES PATENT OFFICE

2,511,876

## REFRIGERATING MEANS WITH AIR PUMP CIRCUIT

Harry W. Protzeller, Fairmont, Minn., assignor of one-half to Arthur Wm. Nelson, Park Ridge, Ill.

Application November 18, 1943, Serial No. 510,747

13 Claims. (Cl. 62—102)

1

This invention relates to improvements in refrigerated food products, and means for and methods of refrigerating and distributing food products, and it consists of the matters hereinafter described and more particularly pointed out in the appended claims.

One of the objects of the invention is to provide a refrigerated food product and methods and means for processing and distributing the same wherewith there is retained in the food product, to a greater extent than heretofore, the flavor, color, essential minerals, vitamins and volume.

It is also an object of the present invention to provide improved means for refrigerating food products by methods which retain, to an extent greater than in prior commercial practice, the flavor, color, essential minerals, vitamins and volume of the food products.

A further object of the invention is to provide improved means for refrigerating products and which is adapted to be exteriorly carried by an aircraft into a low temperature high altitude air and wherein heat units are transmitted through the outer covering of container to atmosphere to thus accomplish the refrigerating operation.

Another object of the invention is to provide a food product container having improved features better adapting it to the reception of the product packages, and the utilization of the container during refrigerating and transporting operations.

Again, it is an object of the invention to provide an improved package for the product to be refrigerated which shall be adapted to be associated with others of similar construction to facilitate the refrigerating operation.

It is also an object of the invention to provide methods and means whereby vehicles not designed for the transportation of products requiring refrigeration may be readily used for such purposes without any substantial structural change in the vehicle itself.

The above mentioned objects of the invention, as well as others, together with the several advantages thereof will more fully appear as the specification proceeds.

In the drawings:

Fig. 1 is a longitudinal vertical sectional view through a pressure temperature chamber assembly by which a part of the improved method of refrigerating products may be carried out.

Fig. 2 is a transverse vertical sectional view through a part of the assembly shown in Fig. 1, on an enlarged scale, as taken on the line 2—2 of said Fig. 1.

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Fig. 3 is a transverse vertical sectional view through another part of the assembly shown in Fig. 1, as taken on the line 3—3 thereof, on the scale of Fig. 2.

Fig. 4 is a transverse vertical sectional view through still another part of the assembly shown in Fig. 1, as taken on the line 4—4 thereof, on the scale of Figs. 2 and 3.

Fig. 5 is a perspective view of one form of product container that may be used in connection with the assembly of Fig. 1 in carrying out the improved method of refrigerating food products.

Fig. 6 is a longitudinal vertical sectional view through end parts of the product container appearing in Fig. 5 and on a scale enlarged thereover.

Fig. 7 is a transverse vertical detail sectional view through top and bottom portions of the container shown in Figs. 5 and 6 as taken on the line 7—7 of Fig. 6 and on a scale enlarged thereover.

Fig. 8 is a detail vertical sectional view as taken on the line 8—8 of Fig. 7 and on a scale enlarged thereover.

Fig. 9 is a perspective view of a certain product package, a plurality of which are adapted to be associated together for use in the refrigerating operation.

Fig. 10 is a bottom view of the product package shown in Fig. 9 but on a somewhat smaller scale.

Fig. 11 is a view in side elevation of two of the product packages shown in Fig. 9, on the scale of Fig. 10, showing more particularly the manner in which such packages will stack vertically to provide an air circulating space between them.

Fig. 12 is a detail vertical sectional view through top and bottom interengaging parts of the packages shown in Fig. 11, as taken on the line 12—12 thereon, but on a considerably enlarged scale, better to show the interengagement of said parts.

Fig. 13 is a perspective view of a certain bar whereby the product packages of Fig. 9 are held in stacked relation, in the product container of Fig. 5.

Fig. 14 is a view in front elevation of an aircraft as in flight and carrying a pair of the pressure temperature chamber assemblies shown in Fig. 1.

Fig. 15 is a view in side elevation of the aircraft shown in Fig. 1, when carrying the improved pressure temperature assemblies.

Fig. 16 is a view in side elevation showing an arrangement in which a number of loaded product containers shown in Fig. 5 may be advantageously carried by a railroad car for distribu-

tion purposes, certain portions being broken away for illustrative purposes.

Fig. 17 is an end view of the parts shown in Fig. 16, certain portions being broken away for illustrative purposes.

Fig. 18 is a view in side elevation showing one manner in which empty containers, such as shown in Fig. 5, may be stacked on a railroad car for return shipment.

Fig. 19 is an end view of the parts shown in Fig. 18.

Fig. 20 is a schematic view in plan, with parts broken away, illustrating the refrigerating means and power source.

The apparatus illustrated in the drawings for carrying out the improved method of refrigerating products, such for example as food products, includes a pressure temperature chamber assembly, adapted to be quickly attached to and detached from an exterior part of a commercial aircraft, a product container adapted to be removably disposed in and carried by the pressure temperature chamber assembly and a plurality of product packages, adapted to be stacked vertically in spaced apart relation in the product container during the refrigerating period.

Each pressure temperature chamber assembly, which has a smooth surfaced aerodynamic contour or shape, is made up of top and bottom halves or shells having a thin sheet metal covering of good heat conductivity. These shells are braced internally for strength and are so matched at their meeting margins as to be substantially sealed against atmospheric leakage. Each assembly also includes means whereby the pressure of the gaseous-like atmosphere, usually air, can be regulated in accordance with the temperature thereof, as well as means whereby said atmosphere may be recirculated between and about the product packages carried in the product container.

The product container is adapted to be disposed within the pressure temperature chamber assembly and to hold a plurality of product carriers or packages in spaced relation. The body of the container, which is made of insulating material, is so correlated with respect to the pressure temperature chamber assembly as to be spaced from the ends and sides thereof. The ends of the container each includes a normally closed valve which, under a certain pressure condition, automatically opens to permit the gaseous-like atmosphere within the assembly to be circulated through the container in one direction from end to end and then into the other end of the assembly and back to the first mentioned end for recirculation.

The product packages or carriers are in the form of cubical containers made of good heat conducting material, such as thin sheet metal. They are so formed, complementally at the top and bottom, as to stack in spaced relation without lateral relative shifting, the bottom of the product container being so formed as to receive and hold the bottommost packages or carriers against displacement. When the container is loaded with the stacked product packages, locking means are applied to the topmost packages in a manner preventing shifting thereof in any direction.

*The sealed pressure temperature chamber assembly*

Each pressure temperature chamber assembly, which is indicated as a whole at **25**, is in the form of a streamline hollow, thin-walled body, having a rounded or partly spherical leading end **26** and a somewhat pointed trailing end **27**. The body of the assembly has its greatest diameter at substantially its mid portion and then gradually tapers toward said ends.

Preferably the assembly is made of top and bottom separable halves or shells **28** and **29** respectively of thin sheet metal having good heat conducting properties. Said shells have matched horizontal meeting margins or edges, each formed as an outwardly extending flange **28***a*—**29***a* respectively, best appearing in Figs. 2 and 3. These flanges are detachably secured together in tight relation by removable strips **30** of U-shaped cross section, which substantially enclose said flanges.

The shell parts **28** and **29** are each provided with a plurality of longitudinally spaced arch-like plates **31**—**31***a*, **32**—**32***a*, **33**—**33***a*, **34**—**34***a*, **35**—**35***a*, **36**—**36***a*, **37**—**37***a*, **38**—**38***a*, **39**—**39***a* and **40**—**40***a* respectively, beginning at the leading (left hand) end of the pressure temperature chamber assembly **25** and proceeding toward the trailing (right hand) end thereof as shown in Fig. 1. The plates **32**, **33**, **34**, **35**, **36**, **37** and **38** of the shell **28** are operatively connected together by means of a weight distributing beam **41** arranged in the longitudinal median line of the shell and fastened to the respective plates by angle brackets **42**—**42**.

Each of the plates from **31**—**31***a* to **40**—**40***a* inclusive, has an outer semicircular peripheral flange **43** that is engaged with and is fixed to the inner surface of the respective shell parts **28** and **29**. The pairs of plates **31**—**32** and **31***a*—**32***a* are each provided with a semicircular member **44**—**44***a* and these members coact, when the shell parts **28**—**29** are engaged with each other, to form a tubular duct that opens at one end into a space **45** in the leading or front end of the assembly **25**.

The plates **38**—**38***a* are each provided in the meeting edges thereof with a semicircular flange **45**—**45***a* and the flanges coact to provide an opening of the same size and coaxially with the duct provided by the members **44**—**44***a* above mentioned.

The pairs of plates **33**—**33***a*, **34**—**34***a*, **35**—**35***a*, **36**—**36***a*, and **37**—**37***a* respectively are each provided with a second flange **46**—**46***a* and these flanges bound a rectangular recess **47**—**47***a* respectively in each plate. Said recesses for the plates of each pair coact to define a rectangular opening **48** indicated only in Fig. 3. Each of the plates of the pairs just above mentioned is provided near its peripheral flange with openings **49**, the purpose of which will appear later.

Spaced inwardly from each shell and extending between the pairs of plates **38**—**38***a* and **39**—**39***a* is a semicircular wall **50** that coacts with the shell parts in forming an annular passage **51** as appears in Figs. 1 and 4. The front end of this annular passage registers with the openings **49** in the plates **38**—**38***a* and the rear end of said passage registers with openings **52**—**52** in the plate parts **39**—**39***a* so as to communicate with a space **53** as formed in the assembly **25** by the plate parts **39**—**39***a* and **40**—**40***a* respectively. The plate parts **39**—**39***a* are each so formed in their central portions as to coact in defining an opening **54** therein.

The plate part **39** functions as a support for a variable speed electric motor **55** that is located in a space **56** formed by the annular wall **50** and plate parts **38**—**38***a* and **39**—**39***a*. This motor drives a turbo-compressor **57** disposed in a shroud

58 that communicates at its rear end with the opening 54 in the plate parts 39—39a and opens at its front end into the space 56. The purpose of said turbo compressor will appear later.

The shell part 28 is provided with a pair of upright laterally spaced hollow stream lined fairing struts 59—59 and in each of which is located a pair of upright rods 60—60, by which the chamber assembly 25 as a whole may be pendently attached to a support above the same. For this reason each rod terminates at its top end in a rearwardly opening hook 61 as best shown in Fig. 1. The top end of each strut is outwardly flanged as at 59a for engagement with the support above mentioned.

62 indicates a pressure relief tube that opens at one end through the trailing end of the shell part 28 to atmosphere and opens at its other end into the space 53. This tube is provided with an electromagnetic valve 63 which is designed for remote control. The arrangement is such that the valve 63 may be remotely controlled by the operator in the pressurized cabin of the airplane. There are gages in the cabin which indicate the pressure and temperature within the assembly 25 as well as the pressure and temperature of the external atmosphere. Suitable electrical plug connections to the pressure and temperature responsive devices within the assembly 25 are provided (but not shown) whereby such devices may be electrically connected to the gages in the operator's cabin.

It is pointed out that the shell part 28 is the weight supporting member of the chamber assembly 25 as a whole and that the shell part 29 functions only as a bottom closure therefor when the before-mentioned food product container is arranged in position in said assembly. Therefore the bottom portion of the wall parts 32—38 of the shell part 28 is provided with openings 64 for the passage of certain bolts by which said product container is supported in place. These openings appear only in Fig. 2.

*Food product container*

The food product container, which is indicated as a whole by the numeral 65, is best shown in Figs. 5, 6 and 7. It is in the form of a generally elongated rectangular box made of light weight, non-metallic, heat insulating material such as laminated wood. It has a length approximating the distance between the pairs of plates 32—32a and 38—38a of the assembly 25 and has a generally square cross section so that it fits in the squared openings 48 of the pairs of plates 33—33a, 34—34a, 35—35a, 36—36a and 37—37a.

The product container includes an open top body comprising side walls 66—66, a bottom 67 and end walls 68 and 69 respectively. Preferably said walls are made up of plywood, so that each one of them is substantially hollow or has an air space therein as best appears in Figs. 6 and 7. The side and end walls are rabbeted about their top edges of receive a removable cover 70 with a good fit. On the inner surface of each side wall 66 near its top edge is a rail 71. The mid part of each rail is offset from its associated side wall while its ends are secured directly to the associated wall.

The bottom wall 67 of the container is provided on its bottom side with longitudinal and transverse trusses 67a and 67b respectively to strengthen the same and the ends of said trusses are tapered as best shown in Figs. 1, 16, 17, 18 and 19 respectively. These trusses also function as skids for the respective container. Fixed to



the top surface of the bottom wall is a plurality of longitudinally extending pairs of strips 72—72 each having longitudinally spaced recesses 73 in the upper surface thereof. The strips 72 of each pair are spaced apart a distance greater than the distance between the strips of adjacent pairs of strips. These strips best appear in Fig. 7 and their function will soon appear.

The end walls 68 and 69 of the container 65 are each formed with a centrally arranged, outwardly extending tubular projection 75 and 76 respectively as best appears in Fig. 6 and each is surrounded near the associated end wall with an angle bar ring 77 whereby a good strong structure is afforded at this point. The horizontal flange of the ring 77 on the projection 75 is adapted to fit in the members 44—44a before mentioned and the like flange of the ring 77 for the projection 76 is adapted to fit in the opening as provided by the flange parts 45—45a of the plates 38—38a. The vertical flange of each ring 77 is provided with threaded openings 78 (only one of which appears in Fig. 5) which are so disposed as to register with the openings 64—64 in the plate parts 32—38 before mentioned when the container 65 is disposed within the assembly 25.

In the end wall 68 is a valve seat 80 to accommodate a normally closed spring-pressed valve 81 that opens outwardly from said end wall when pressure conditions in the product container are such as to cause the same to open. The tubular projection 76 has an end wall 82 (see Fig. 6) in which is a valve seat 83 to accommodate a normally closed spring pressed valve 84 that opens inwardly of the extension 76 when the pressure conditions in the compartment 56 of the chamber assembly 25 are such as to cause the same to open. Thus both valves 81—84 open in the same direction.

When the product container 65 is disposed in the chamber assembly 25, bolts 85 (see Fig. 2) are inserted through the openings 64 in the plates 32—38 to enter the openings 78 so as to hold the product container 65 in place in the chamber assembly 25. These bolts, of course, are applied before the shell part 29 is attached to the shell part 28 in the loading of a container 65 into the assembly 25. Conversely, in unloading the assembly 25, the bolts 85 are removed after the shell part 29 has been detached from the shell part 28.

*Product package*

As before mentioned, the product container is adapted to receive and hold a plurality of produce packages and this in such a relation that the sides and top and bottom of each package are separated from the sides and top and bottom of adjacent packages so that the gaseous atmosphere or air in the product container 65 may pass between, about and all around the packages therein.

One of such packages, which is indicated as a whole at 86, best appears in Figs. 9 to 12 inclusive. This package is in the form of a cubical container made of thin sheet material of good heat conductivity. It may be so-called tin can, if desired. Such a package comprises a body of thin sheet metal and includes four upright side walls 87—87, a bottom 88 and a top 89 having a centrally disposed flanged opening 89a therein (see Fig. 12). The side walls have a conventional seamed attachment with the top and bottom. A circular lid 90 has a friction fit within the flanged

opening 89a. The lid 90 is provided with a hole 90x to permit passage of sufficient air into or out of the package to equalize the pressure within the package with that in the space surrounding the package. After the product has been refrigerated or frozen this hole is sealed with paraffine or other suitable material. As the sides, top and bottom of the package are made of thin sheet metal, to stiffen the sides. I provide endwise and sidewise like inwardly depressed ribs 91 and to stiffen the bottom I provide the diagonally disposed pressed ribs 92.

In each corner of the bottom, I provide a hollow depressed boss 93 having upper and lower parts 93a and 93b respectively of relatively large and small diameter that are connected by a flange or shoulder 94 disposed somewhat below the plane of the bottom edge of the body as best appears in Fig. 12. The part 93b of smaller diameter has a rounded bottom 95 and is adapted to have applied thereto a non-metallic washer or ring 96 to take the wear from the shoulder 94.

In each corner of the top 89, coaxially with the depressed bosses 93 in the bottom 88 before mentioned, in a hollow boss 97 that includes an upwardly and inwardly directed side wall 98 and a downwardly extending cup 98a connected by a flange 99 to the wall 98, as appears in Fig. 12. The upper end of the cup 98a is open so as to receive the part 93b of the depressed boss 93 on the bottom of another package or container. It is to be noted from Fig. 10 that the depressed bosses mentioned 97 forms a "square" and this square has a width approximating the spacing between the two strips 72 of a pair of strips on the bottom of the container 65 and the spacing between certain of the recesses 73 in said strips.

With this arrangement of bosses, the packages may be stacked vertically as indicated in Figs. 1 and 11 and when so stacked there is an air space formed between the top and bottom of adjacent packages in each vertical stack and between the sides of the packages in one stack and the sides of the packages in a laterally adjacent stack.

When the container 65 is stacked full of the filled packages 86, the tops of the packages or cans in the top layer thereof are disposed substantially in the plane of the bottom edges of the strips 71 of the product carrier 65, and this is somewhat below the plane of the bottom of the cover 70 as obvious from Fig. 7. Therefore, to hold the stacks of packages against shifting and dislodgment and thus maintain the air space arrangement before mentioned between said packages I provide a plurality of hold down bars, one of which best appears in Fig. 13 bearing the numeral 110. It is preferably made of wood and has a length approximating the inside width of the product container 65. It is wider than it is thick and has a gabled top and transverse openings 111 in the bottom. This bar is reinforced on its bottom surface with a metallic strip 112. End portions of this strip follow up the end of the bar and are then turned downwardly as hooks 113 which are adapted for engagement with the bars 71 of the container 65, as best appears in Fig. 7.

The strip 112 for each bar is provided with depressed bosses 114—114 and these are spaced longitudinally and laterally of the bar so as to register with rows of pockets 97 in rows of packages 86 in the top layer of such packages. On each boss 114 is a wear taking washer 115. Thus, each bar spans the space between adjacent rows of packages in the top layer of packages so that each bar assists in holding down the packages in said rows. When the bars 110 are in place and the cover 70 is applied to the container 65, the bottom face of the cover exerts a hold down pressure on all of the bars in the container 65 (see Fig. 7).

*Supporting carriers for the chamber assembly 25*

Primarily one or more of the loaded chamber assemblies 25 is intended to be carried pendently from a support such as an exterior part of an aircraft so that the said assemblies may be transported to a high altitude where low temperature air exists. In Figs. 14 and 15 I have shown a four motor airplane that includes a fuselage 100, laterally extending wings 101—101, operator's cabin 102 and horizontal and vertical tail end rudders 103 and 104 respectively. Each wing carries a pair of nacelles 105 each including a motor or engine for driving a propeller 106.

In the present instance two of the pressure temperature chamber assemblies 25 are shown as carried by the aircraft. For the purpose of balance one assembly 25 is disposed under each wing so as to extend in a fore and aft direction and arranged in a plane between the two nacelles of the wing so as to depend from the underside thereof. Each wing includes internal parts for engagement by the hooks 61 of the rods 60 so that the associated assembly may be drawn snugly into position. In a smaller plane wherein only one assembly is to be carried thereby, said assembly may be detachably connected to the bottom of the fuselage of said aircraft.

It will be observed from Fig. 14 that the assemblies 25—25 are spaced an equal distance from the longitudinal axis of the plane. Likewise, they are so disposed on the aircraft so as to be substantially at the center of pressure lines. In this way, the loaded assemblies do not interfere with the stability characteristics of the plane.

*Operation*

Assume that the packages 86 are properly filled with the products to be refrigerated and that the lids 90 thereof have been applied thereto to close the same. Sufficient filled packages are then placed in the container 65 to make up the bottom layer. This is done by inserting the bosses 93 on the bottoms of said packages into the recesses 73 of the strips 72 on the bottom of the product container 65. The successive layers of packages 86 are built up in the container, with the bosses 93 of the packages above engaged in the recesses 97 of the ones below. Thus the packages in each horizontal layer are separated from the neighbors in the same layer and each package in each vertical stack, while supported on the package below, is separated therefrom by an air space, with the air spaces in communication with one another.

After the packages have been arranged as described, the hold down bars 110 are placed in position as before described, after which the cover 70 is applied to close the open top of the product container 65.

The next step is to load the container into the pressure temperature chamber assembly 25. This is accomplished while the shell member 29 is detached from the shell member 28, which is now open at its bottom, it being assumed that the shell parts 28 of both assemblies 25 are in place upon the aircraft as before described. Each loaded container 65 is now raised into its posi-

tion with the associated shell part 28 and when properly fitted therein the bolts 85 are inserted through the openings 64 in the plates 32—38 and into the openings 78 in the angle bar rings 77 of the container 65. This secures each product container in position in its shell part 28 so that said shell part supports the entire weight of the product container.

The shell part 29 is then applied to the associated shell part 28 so that the former forms a closure for the latter, after which the strip sections 30 are applied. The aircraft with the loaded assemblies 25—25 attached thereto is ready to make its flight into the higher atmosphere to some predetermined destination.

The aircraft may now take off for flight to said destination and in said flight rises to a high altitude where low temperature air prevails. The operator in the cabin, from suitable instruments therein, which visually indicate the temperature of air in the assemblies 25—25, may now start the motor 55 in each assembly to drive the associated turbo compressor 57. This builds up a pressure in the compartment 56 of each assembly, sufficient to cause the valve 84 of the associated container 65 to open inwardly thereof and leave its seat 83 so that the air enters said container 65 and circulates through the various spaces between the packages 86 therein. The pressure in each container 65 now builds up to one which causes the valve 81 thereof to leave its seat 80 and move to open position so that the air passes through the duct as provided by the parts 44—44a to enter the front or advancing end 45 of the associated assembly 25.

By reason of the rounded front end 45 of the assembly 25, the moving air in said front end is reversed in direction to follow the contour of the adjacent portions of the shell parts 28—29 to pass successively through openings 49—49 in the plate parts 31—31a to 38—38a inclusive and then into the front end of the annular passage 51 and out the rear end thereof into the space 53 between the pairs of plate parts 39—39a and 40—40a respectively. The air then enters the turbo compressor for recirculation in the path mentioned. This path is indicated by the arrows appearing in Fig. 1.

In the passage or movement of the air through the container 65 and about and between the packages 86 therein, it absorbs heat units from the products in said packages. As the air in its rearward movement contacts the internal surface of the cold metallic skin of the shell parts 28—29, said skin absorbs said heat units and dissipates them to the cold air surrounding each assembly 25 as a whole.

As before explained, the air within the assembly 25 is adapted to be circulated by means of the turbo-compressor 57. As the plane ascends above the earth's surface, the pressure, temperature and density of the atmospheric air decrease. Therefore, if the same number of pounds of air are to be circulated within the assembly 25, (assuming the atmosphere within the assembly to be substantially equalized with the external atmosphere) in order to extract the same number of B. t. u.'s per unit of time, a much greater number of cubic feet must be circulated. The characteristics of the turbo-compressor are such that a constant resistance pressure and weight of air may be delivered by increasing the speed and thus the volume. The motor 55, for driving the turbo-compressor, is of the type that will automatically increase in speed as the air density decreases, thereby maintaining the desired requirements.

The power for the variable speed motor 55, for driving the turbo-compressor, is derived from a source in the fuselage 100 of the carrying aircraft and it is under control of the pilot in the cabin 102.

It is obvious that the final distribution of the frozen food products by aircraft may be impractical, due to short hauls from the concentration point, door to door delivery, etc. However, the product containers 65 are so constructed that they may be moved as necessary by land or by water vehicles. Also, to maintain an adequate supply of such containers at the originating points of fresh products, they may, if desired, be shipped by highway or railway vehicles from the unloading point to the points of origin. This practice probably would be followed where no return load is available, as speed would not then be a factor and no processing of the product would take place.

Assume, therefore, that after the loaded product containers have been unloaded from the assemblies 25 of the carrying aircraft, it might be necessary to move such loaded containers to a point remote from an airplane landing field depot and reachable by a land vehicle such as a railroad car. As the containers 65—65 are of such size that they cannot be conveniently loaded in a conventional refrigerator car and as railroads at the present time do not have an adequate number of mechanically refrigerated cars capable of maintaining a temperature approximating zero F., a number of such loaded containers 65 (preferably four) may be placed upon a flat car 125 as appears in Figs. 16 and 17. Preferably such containers are disposed in side-by-side pairs at the ends of the car so that the pairs of containers are spaced apart at the middle of the car, thus carrying four containers on a single flat car.

In order to provide the necessary refrigeration to maintain the already frozen product in proper condition, a small refrigerating unit is provided and so positioned as to refrigerate all four containers. Each two containers in longitudinal alignment on the car are connected by insulated ducts 127, the ends of which fit over and embrace the tubular extensions 75 and 76 respectively of the containers.

A flanged, heat insulated end or cover plate 128, having semicircular ends and fitting the end extensions 75—75, 76—76 at the respective ends of the car, are applied to container extensions so as to form a connecting duct therebetween, as apparent from Fig. 17. Thus the cover plates 128 and the ducts 127 complete a recirculatory path through the four containers.

A mechanical refrigerating unit, operated by an internal combustion engine, not shown, is provided. It is associated with the duct 127 so as to operate a blower 126 for moving air over the cooling coils of the refrigerating unit and for circulating it through the complete circulatory path provided for the four containers, as before described. Thus, the desired temperature is maintained and the products in the packages reach the ultimate consumer in good condition and without a rehandling from one form of transportation to another.

It is pointed out that since the products being handled are already in a frozen state when the containers 65—65 are loaded upon the car 125, the refrigerating units 126 need only supply the heat

losses through the insulated sides, ends, top and bottom of the container. Thus a portable refrigerating unit of the order used for refrigerating highway trucks will serve the purpose. By this system ordinary freight cars may be used and the necessity of building expensive refrigerator cars avoided.

The refrigerating means and power source are illustrated schematically in Fig. 20. Therein 150 is an internal combustion engine, 151 a compressor, 152 the condensing coil and 153 the cooling coil in the path of the discharge from the blower 126. The engine 150 through pulleys 154 and 155 and connecting belt 156 drives the compressor 151. The rotor of the blower 126 is driven from the engine 150 through shaft 157, pulley 158 thereon, pulley 159 on engine shaft and connecting belt 160.

In returning empty containers 65 to a point of reloading, they may be shipped by flat car 125. In Figs. 18 and 19 I have shown one arrangement wherein nine of such empty containers are loaded on a flat car for shipment. They are arranged in two layers, with six containers in the first layer and three in the second one.

It is believed that the foregoing description will enable those skilled in the art, to which this invention relates, to appreciate the many advantages thereof. However, as by way of illustration and not by way of limitation, some of the outstanding advantages may be summarized as follows:

1. The invention makes possible the profitable carrying of cargo by commercial airways because the product can be processed en route.

2. Apparatus for the practice of the invention can be used in connection with existing type of aircraft.

3. Provides a great flexibility in the operation of airplanes. Those used for passengers can be converted to cargo ships or vice versa, or to mixed carriers quickly and easily.

4. Greatly reduces dehydration losses.

5. Provides methods and means whereby airplanes can be very quickly loaded or unloaded of their full cargo.

6. Reduces to a minimum the necessary handling of the product between producer and consumer.

7. Provides for flexibility of interchange between airways, highways and railways.

8. Provides for high load ratio between product and carrying means.

9. Provides efficient means for the prevention of shifting of the cargo.

10. Provides packaging means especially adapted for use in refrigerating the product.

While, in describing the invention, I have referred in detail to the form, arrangement and construction of the parts involved, the same is to be considered only in the illustrative sense so that I do not wish to be limited thereto except as may be specifically set forth in the appended claims.

I claim as my invention:

1. In a refrigerating apparatus, the combination of a vehicle, a plurality of containers positioned on the vehicle in spaced relation, said containers being formed to permit the passage of refrigerated air therethrough, conduit means connecting said containers, means for refrigerating the air and means for circulating the refrigerated air through said containers.

2. In combination with a vehicle, a plurality of heat insulated containers having openings therein for the circulation of refrigerating air therethrough, carried by said vehicle, conduit means extending between said containers and serving to connect the openings thereof, and means for refrigerating air and for circulating the refrigerated air through said conduit means and into said containers.

3. In a refrigerating apparatus, a vehicle, a plurality of containers arranged in spaced relation on the vehicle, and each formed for the passage of refrigerated air therethrough, conduit means connecting said containers, means for refrigerating said air, and means for circulating said refrigerated air through said containers and said conduit means.

4. In a refrigerating apparatus, a vehicle, a plurality of containers arranged in spaced relation on the vehicle, and each formed for the passage of refrigerated air therethrough, conduit means connecting said containers, means in a part of said conduit means for refrigerating said air, and means for circulating said air through said containers and said conduit means respectively.

5. In a refrigerating apparatus, a vehicle, a plurality of containers arranged in spaced relation on the vehicle and each formed for the passage of refrigerated air therethrough, conduit means connecting said containers, and means in a part of said conduit means for refrigerating and circulating said air through said containers and said conduit means.

6. In a refrigerating apparatus, a vehicle, a plurality of containers arranged in spaced relation on the vehicle, and each having an inlet and an outlet for the passage of refrigerated air therethrough, conduit means connecting the inlet of one container to the outlet of another container and coacting with said containers in forming a closed circulatory system for said refrigerated air, means for refrigerating said air, and means for circulating the refrigerated air through said system.

7. In a refrigerating apparatus, a vehicle, a plurality of containers arranged in spaced relation on the vehicle and each having an inlet and an outlet for the passage of refrigerated air therethrough, conduit means connecting the inlet of one container to the outlet of another container and coacting therewith in forming a closed circulatory system for said refrigerated air, and means in a part of said conduit means for refrigerating air and for circulating it through said system.

8. In a refrigerating apparatus, a vehicle, a container mounted thereon and having an inlet and an outlet for the passage of refrigerated air therethrough, unitary means for refrigerating and circulating said air and which means is adapted to be detachably connected to said inlet opening, and self-closing valve means positioned at said inlet and said outlet respectively, both of said self-closing valve means being movable to open position under the action of said medium when in circulation.

9. In a refrigerating apparatus, a vehicle, a plurality of containers mounted thereon, and each having an inlet and an outlet for the passage of refrigerated air therethrough, tubular projections associated with the inlet and the outlet of each container, conduit means detachably connected to the tubular projection associated with the inlet of one container to the tubular projection associated with the outlet of another container, means for refrigerating said air, and

means for circulating said air through said container and said conduits.

10. In combination, a vehicle, a plurality of heat insulated containers carried thereby and each having an inlet and an outlet for the passage therethrough of refrigerated air, conduit means detachably connecting the inlet of one container with the outlet of another container, and means in a part of said conduit means for refrigerating and circulating said air through said containers and said conduit means.

11. In combinaton, a vehicle, a plurality of heat insulated containers carried thereby and each having an inlet and an outlet for the passage therethrough of refrigerated air, conduit means adapted to detachably connect the inlet of one container with the outlet of another container, means in a part of said conduit means for refrigerating and circulating said air through said containers and said conduit means, and valve means positioned at the inlet and the outlet of each container, said valves being formed to open when said circulation is established through said containers and conduit means and being formed to close when said circulation is discontinued.

12. In combination, a vehicle, a plurality of side by side sets of heat insulated containers carried by and extending longitudinally of the vehicle, each container having an inlet and an outlet at opposite ends for the passage therethrough of refrigerated air, conduit means connecting the inlet of one container and the outlet of the adjacent container in one set, other conduit means connecting the outlet of the container at each end of each set with the inlet of the container at each end of the other set to provide a closed circulating system therethrough, and means in a part of one of said conduit means for refrigerating and for circulating said air through the system as provided by the containers of both sets and the connecting conduit means.



13. In transport refrigerating apparatus, the combination of a vehicle, a product container removably mounted on the vehicle and having exterior insulated walls, said container having an end opening for the admission of a refrigerating air inwardly of the exterior insulated walls, a refrigerating unit carried by the vehicle and detachably connected to said container and positioned to supply a refrigerated air through said opening, and means for closing said opening when said refrigerating unit is removed from the container.

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