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METHOD AND MEANS FOR AIR CONDITIONING

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My invention is related to a method and means of conditioning air and in circulating the same about and through an enclosed storage space. In general, the invention is concerned with a method and means of controlling the temperature and humidity in and about an enclosed space such as the storage space of a transport vehicle used for the transportation of fresh or frozen foodstuffs and the like. More particularly it is concerned with a method and means of providing proper refrigeration within a railway vehicle used for the transportation of fresh or frozen cargoes such as perishable foodstuffs of all varieties and in maintaining substantially constant conditions within the controlled space despite changes in either direction of the atmosphere ambient to the carrier.

In recent years there has been a marked increase in the demand for fresh perishable foodstuffs and it has been a major problem to the transportation industry to transport such products from their source of origin to relatively distant points in a manner to prevent spoilage in transport. It is estimated that the loss effected by spoilage amounts to approximately one-fourth of the gross value of the product. Moreover, even though complete spoilage may not occur, the task of maintaining the conditions of certain products within an optimum range of temperature during transport is particularly critical, and this is most evident in certain forms of fresh vegetables and frozen foods.

As one example, choice grades of eating apples which are maintained under cold storage conditions after harvesting, should be kept at a temperature of substantially 31° F. plus within 3° F. plus or minus 5° F. plus at temperatures ranging between -10° F. and 0° F. However, some of these foods such as fish, poultry, orange concentrate, and strawberries, and the like, will either spoil or change in flavor in a matter of hours if their temperature is permitted to rise to as much as +20° F.

Hereofore it has not been possible to maintain a substantially constant temperature within the storage space of refrigeration cars. Prior carriers used on railroads, it has been the general practice to rely on the use of natural ice, or a brine solution refrigerated by ice, as the principal means of cooling the cargo space. In such carriers it is customary to provide bunkers at either ends of the car within which a large amount of ice is placed. Generally by means of fans operated from the vehicle mechanism, the atmosphere within the enclosed space is circulated relative to these bunkers to cool the space. This means of providing refrigeration is expensive both from the point of view of the cost of the ice and brine, as well as the destructive effect of the brine upon the cars and associated equipment. In the conventional manner of transporting refrigerated cargoes, it is customary to re-ice the vehicles at stations along the right-of-way which are spaced about 300 to 400 miles apart. This is not only a costly means of refrigeration from the point of view of re-icing, but where there are delays, it frequently happens that the temperature within the cargo space will have substantially exceeded the safe upper limits for the cargo, thus resulting in spoilage for which, if evident, the carrier must pay damages.

In further consideration of the problems arising out of the transportation of perishable products, there are times and occasions where the problem is one of maintaining the temperature within a certain area where climatic conditions are relatively warm to or through areas where climatic conditions are relatively cool, and under these conditions it is necessary to prevent the produce from freezing. In the prior art it has been customary to refrigerate the cars as they are passing through the warm climate, and as they approach the area of colder climatic conditions, to remove the ice from the bunkers and provide some means of supplying a small amount of heat to the enclosed space so as to maintain the temperature therein above the freezing point. Quite frequently it occurs that climatic conditions will change, or the cars will be delayed in transit, so that the change-over is delayed and the produce will spoil either by freezing or by such inaccurate control of the system as to permit a certain amount of decomposition to set in.

It is proposed to substitute mechanical condition control means to take the place of the natural refrigerating means. I am, of course, aware of the fact that there have been prior attempts made to use mechanical air conditioning means within railway cars. Insofar as I am aware, however, these prior art efforts have not been entirely successful because to a large extent the mechanical apparatus herebefore used has been a permanent part of the car structure. A principal objection to this arrangement has been the fact that the cost of installing mechanical equipment in the cars is excessive and in order to justify the expense, cars so equipped must be kept in substantially continuous use. Another defect of this arrangement has been that such mechanical heretofore used, has not been able to withstand vibration and the severe shocks resulting from impact between the locomotive and the cars, and between the cars themselves when a train is being made up or separated. Practically every time a train is made up, the cars are shunted along various tracks where they slam into each other during the connecting operations. Not infrequently cars will be traveling at rates from two to seven or eight miles per hour at the time they impact a string of stationary cars, and the result of such impacts is to cause disconnection of essential parts, and fatigue of other parts of the car, which always result in leakage of the essential refrigerating fluid. I am further aware of the so-called "package units," one of which is shown and described in Numero and Jones Patent 2,302,857, and another as shown in the Jones Reissue Patent 23,000, both of which are assigned to the present assignee. Both of these units are provided with a portion containing the operating mechanism which is normally positioned on the outside of the vehicle, and a condition-changing portion which is normally maintained on the inside of the vehicle. In the one disclosure the unit is mounted beneath the vehicle body while in the other disclosure the unit is mounted in an upper wall portion of the vehicle body. The present invention contemplates certain improvements over either of these former disclosures.

In the present invention I have provided an improved means of controlling both the temperature and the humidity conditions within a transport vehicle by providing what I consider to be an entirely different concept of air conditioning both as to the vehicle, the mechanical apparatus used for controlling the condition of the air, and the control of the mechanical apparatus.

Insofar as the vehicle itself is concerned, I have provided a structure which includes an internal chamber provided with damper controlled vents and which is insulated from the walls of the vehicle and within which the cargo is carried. At one end of the car and within the cargo which is substantially equal to one of the ice bunkers found in prior art cars, the mechanical air conditioning structure is mounted. The mechanical structure is a complete unit which may be bodily removed from the car, and includes a heat transfer portion which extends into a part of the enclosed chamber but is separated from
the cargo-carrying portion by a partition which forms a passage through which the air is passed in heat exchange relation with the engines or machinery in the cabin and is returned to the engine or machinery just before returning the engine or machinery. The separated portion of the chamber actually extends to the one end of a car so as to form separated compartments on either side thereof. Within each of these separate compartments an independent air conditioning unit is removable mounted through an opening in the car and closed by a slidable partition. A vertical section of the unit is thus carried entirely within the car and has its heat exchange portion extending in opposition to a similar portion of the other unit through restricted openings into the passage between the open sides of the chamber.

In one modification the enclosed chamber is composed of five walls of material having a low thermal drop there- through and is open on its remaining side. In addition to being insulated from the car structure, the chamber is also separated therefrom so as to form an insulated passage or air duct about the five sides of the chamber. This duct or air passage communicates with the heat exchange passage that contains the air conditioning device and a circulating fan. The heat exchange chambers communicate with the interior of the cargo chamber adjacent the open side thereof. One of the walls of the cargo chamber is provided with a series of damper controlled openings disposed in spaced relation across the wall so as to form entry ways between the general air duct and the cargo chamber and when the dampers are in an open position permit a portion of the circulated air to pass through the interior of the cargo chamber and in direct contact with the ladings therein. The dampers are controlled openings are opened at the outset of the transit period for precooling the cargo space and the cargo itself after loading to assure a quick reduction of the temperature of the cargo to a desired cold temperature, after which the dampers are closed so that the circulated air in the general air passage passes about the exterior of the chamber and in contact with the outer surfaces thereof before returning across the open sides thereof to the first opening of the heat exchange passage, thus minimizing contact between the circulated air and the ladings within the chamber.

Under certain conditions it may be necessary to humidify the air to prevent dehydration of the cargo, and to supply this need, moisture absorbent means is carried by the car over which the conditioned air is passed prior to entering the chamber.

In another modification the conditioned air is intro-
duced directly into the top of the chamber, whence it is distributed in an even manner throughout the length of the chamber both at the center and sides there-
of to descend into the enclosed space and thereafter be withdrawn directly at the end of the chamber where, as in the preceding modification, it is passed downwardly over the heat exchange passage before being returned to the chamber.

When the heat exchange portion is operative to change the condition of the air, air circulating means is in con-
tinuous operation to continuously move the air cyclically from the chamber downwardly over the heat exchange portion and thence back to the chamber. During periods when the heat exchange portion is inoperative, as by way of a satisfied condition within the chamber, an auxiliary air circulating means is placed in operation, so that the air is always being circulated within the compartment.

In order that the air conditioning units may be readily inserted or removed from the car, they are each mounted on a frame or other structure which incorporates a slidable portion which is capable of extending outwardly through the opening in the side wall of the car so that the unit may be readily mounted thereon or removed therefrom by a mechanism. To leave the unit in place with unauthorized persons, the respective openings through which they are inserted into the car are closed by a sliding door arrangement, and to provide accommodation for the train crews, each of the doors carries a ladder which telescopi-
cally slides with respect to a stationary ladder portion positioned on the car above the doors. To prevent the door from being opened by unauthorized persons, a lock-
ning mechanism cooperates with the door control means to lock the door in its closed position. To avoid any possibility of a car being dispatched with its doors open, the means for opening and closing the doors constitutes a key for controlling the locking mechanism. This key, which is in the form of a crank, will be supplied only to persons authorized to have access to the air conditioning units.

As the operative portion of each of the air conditioning units includes by the engine or machinery and may be provided for disposing of the exhaust gases as well as the heat generated by the engines, and for this purpose I have provided within each of the aforementioned com-
partments a passage communicating therewith that extends through the upper wall of the car. The hose structure fits directly over the top of the operating portion of the air conditioning device, but is connected to the front of the structure which is telescopically mov-
able when the door is opened and the device is sidewise moved outwardly on its frame for replacement. The hood contains a thermostatically controlled damper for returning a portion of the heated air to the operating portion when climatic conditions are such that a portion of the heat should be returned to maintain the engine and its cooperating parts in a heated condition.

The air conditioning units themselves each constitutes a unitary casing within which the several portions of the device are divided into an operating portion including an engine, compressor, condenser, and a fan for cooling the condenser, and a heat transfer portion which includes an evaporator for having a driving fan for air downwardly in heat exchange relationship with the evaporator. A set of dampers are mounted in the casing portion above the evaporator and are operable to prevent the circulation of air when the device is in inoperative condi-
tion. These dampers, however, will remain open during either heating or cooling of the air. The operation of the dampers is controlled by a fluid system, which is circu-
lated when the engine is operating.

The refrigerant fluid system of the unit, which includes the condenser, and evaporator, are interconnected by a control system, the control system being operable to completely reverse the flow of refrigerant in the fluid system, the functions of the evaporator and the condenser may be reversed. The operation of this valve is normally automatic, and is controlled by the control system.

As mentioned above, the air conditioning units may be used to either heat or cool the storage chamber, and their operation for either purpose are controlled by a control system which is capable of initially starting and stopping one of the engines in response to the condition within the controlled space. In the event that the one engine is not capable of maintaining the desired condition within the controlled space, or should for any reason become inoperative, the control system provides means for initiating the operation of the other unit which normally serves in an auxiliary capacity to keep the temperature means for automatically changing the function of the air conditioning units from cooling units to heating units so as to maintain a substantially constant condition within the controlled space when the weather conditions are changing climatic conditions. When the units are used in conjunction with a car during the winter season, there is always the possibility that climatic temperatures may be so low as to eventually cause the engines and their coop-
era ting elements, including the lubricating fluid, to be cooled down to an inoperative temperature. This condi-
tion could arise when the temperature within the control-
space remains static for a substantial period of time. To remedy these conditions, the control system includes means for starting the engines solely for the pur-
purpose of warming up the electrical system, and if the electrical system is not responsive or for the safe transport of the cargo to be aware of the conditions within the enclosed space. Ch-
Accordingly, control panels are mounted on either side of the car adjacent the openings through which the units are inserted. The panels include indicating means for showing the condition of the enclosed storage space and also means for pre-setting the temperature at which the space will be maintained. The panels also include visual means for showing the operating condition of each of the mechanisms and is capable of indicating whether these units are operating on either the refrigerating or the heating cycle or if they are momentarily inoperative. It is also indicated on the control unit that the units are capable of operating when the need requires the same. Since the cars containing these panels will be moved during the hours of daylight and darkness, they will be fitted with a light of adequate intensity of lights which will enable an inspector to tell the condition of each of the cars as they are moved past a fixed point. The supply of fuel necessary for the operation of the engine, and suitable batteries for starting and ignition as well as supplying current for other circuit needs, are carried by the car independent of the units. Means are provided for simply and easily connecting the fuel supply, the current supply and the conductors to and from control portions to the units by easily detachable means so that either unit could be removed in a relatively few minutes if desired, replaced, repaired.

An object of the invention is to provide an improved method and means of refrigerating or of maintaining in a substantially constant refrigerated condition, perishable or similar articles, which may be stored or transported under the most desirable conditions and without deterioration due to changes in temperature or in moisture content.

Another object is to provide a method of both precoo ling and refrigerating perishable products in transit by loading the products into an enclosure whose surfaces are composed of material having a low thermal drop there through and which surfaces are separated from an insulated wall to form a general air passage in which refrigerated air is circulated, passing some of the circulated air from the enclosure in the short circuit path for one continuous period until the space or products therein are precooled, thereafter permanently terminating the circulation of the air in the short circuit path through the enclosure and in contact with the product while continuing the circulation of air within the general air passage and in contact with the exterior surfaces of the chamber to maintain the products at reduced temperature principally by thermal transfer through the surfaces of the enclosure.

Another object is to provide a method of both precoo ling and refrigerating perishable products in transit by loading the products into an enclosure whose surfaces are composed of material having a low thermal drop there through and which is open to the air surrounding the enclosure by an air duct in which refrigerated air is circulated, passing some of the circulated air through the interior of the enclosure in a short circuit path for one continuous period at the outset of the transit period to reduce the temperature of the space within the enclosure, thereafter permanently terminating the circulation of the air in the short circuit path through the enclosure and in contact with the product while continuing the circulation of the air within the general air passage and in contact with the exterior surfaces of the chamber to maintain the products at reduced temperature principally by thermal transfer through the surfaces of the enclosure and by some interchange of air across the open side thereof.

Another object is to provide an improved refrigerator vehicle embodying a cargo chamber composed of material having a low thermal drop there through and which is open on one side and which is enclosed with an air duct in which refrigerated air may be circulated about the chamber, together with damper controlled openings in one or more of the chamber walls communicating with the circulating air in the duct.

Another object is to provide a unitary air conditioning unit adapted for use in a railway refrigerator car. Another in combination with a railway car and an air conditioning unit adapted for use therein, means for supporting the unit in such a manner that the same may be readily placed in or removed from the car.

Another object is to provide in combination with a railway car and an air conditioning unit for use therein, means for supporting the unit in such a manner as to protect the unit from shock and injury resulting from movement and jolting of the car.

Another object is to provide in combination with an air conditioning unit including an internal combustion engine and other parts forming the operating mechanism a protective hood, together with means for recirculating a portion of the heated air from the engine so as to maintain the engine and its associated parts in an operating condition during cold weather.

Another object is to provide an air conditioning unit which is capable of either refrigerating or of heating the space within an enclosure and which is controlled by means which are capable of automatically reversing the heat exchanging function of the unit in response to the condition of the enclosed space.

Another object is to provide in an air conditioning unit which includes an evaporator and a fan for circulating air over the evaporator, a casing surrounding the evaporator having a set of movable dampers between the fan and the evaporator for shutting off the flow of air during a detaching operation.

Another object is to provide in combination with a mechanical air conditioning unit used to maintain a substantially constant condition within an enclosed space, control means for controlling the operation of the unit to respond in response to a change of temperature within the enclosed space, a condition of the unit itself, or a change of temperature of the air surrounding the enclosed space.

Another object is to provide in combination with a pair of air conditioning units which are not normally under manual supervision, control means for controlling the operation of the units under a plurality of variable conditions which may arise during the absence of manual supervision.

Another object is to provide means for storing or transporting perishable foodstuffs in which the foodstuffs may be refrigerated if necessary, or maintained at a substantially constant temperature and moisture content, which includes a railway car having an internal chamber which is insulated on all sides from the walls of the car and which is supported in spaced relation to several of the walls so as to form an air passage and an area of moisture transfer, together with means for circulating air or heating the air to attain or maintain the desired temperature within the internal chamber, and means for automatically controlling the last named means under a variety of varying conditions.

Other and further objects may become apparent from the following specification and claims, and in the appended drawings in which:

Fig. 1 is a perspective view of an improved refrigerator railway car and air conditioning apparatus therefor, with certain parts broken away and others shown in section; Fig. 2 is a perspective view of a portion of a car seen on a side opposite of that shown in Fig. 1; Figs. 3-8 are detailed views of the car structure shown in Figs. 1 and 2; Figs. 9-12 are sectional views of a modified form of refrigerator car; Figs. 13 and 14 are detailed views of a damper control mechanism used in conjunction with the refrigerator car described in Figs. 9-12; Figs. 15 and 16 are perspective views of a mechanical air conditioning unit used in conjunction with either of the refrigerator cars disclosed herein; Fig. 17 is a schematic showing of the refrigerant fluid system incorporated in the air conditioning unit disclosed in Fig. 15; Figs. 18-29 illustrate a structure which supports the air conditioning unit disclosed in Fig. 15 within either of the car structures heretofore disclosed; Figs. 30A and 30B disclose a portion of a hood structure shown in Fig. 18; Figs. 31-35 disclose a door operating mechanism and a locking device used in conjunction with either of the cars heretofore disclosed; Fig. 36 is a schematic diagram of a control system for controlling the operation of a pair of air conditioning units and auxiliary devices used in connection therewith; Fig. 37 is a schematic diagram on enlarged scale show-
Fig. 38 is a schematic diagram of a portion of the control system used in conjunction with the refrigeration system disclosed in Figs. 9-12 and the damper controls shown in Figs. 13 and 14; and, Figs. 39-41 show a thermostatic control device used in conjunction with the control device schematically shown in Figs. 36 and 37.

Referring now to the several figures of the drawing, the invention may be described in detail. Referring first to Figs. 1-7, general reference numeral 50 designates a railway vehicle ordinarily referred to as a refrigerator car and used for the transportation of perishable food-stuffs in an ice-like frozen or chilled condition. The vehicle consists of an undercarriage designated at 51 in Figs. 4 and 7, which is supported on wheels for mobility on railroad tracks, as shown in Figs. 1 and 2. Reference numeral 52 designates a floor surface of the car and reference numeral 53 designates an outer top surface on which is mounted a catwalk 54.

Referring now to Fig. 3, reference numerals 55, 56, 57 and 58 designate the outer lateral walls of the car. Cargo loading doors 59 and 60, Figs. 1 and 5, are mounted on each of the lateral central surfaces of the car for moving the cargo along the interior thereof.

As shown in Fig. 2, supported beneath the undercarriage 51 are a pair of fuel tanks 61 and 62 which are interconnected by a header 63. A conduit 64 extends to a fuel surge chamber 65 and a fire-protection blanket later is secured on the lateral side of the car and connected by a conduit 67 to tank 61 for safety purposes.

Cabin 68, the side of the car, and of which only one is shown in Fig. 2, is a vertically movable door 69 having therein a grill 70. The doors 68 are slidable movable in tracks 70 and 71 on the side of the car. A ladder portion 72 which forms a part of the door is telescopically movable with respect to a stationary ladder portion 73 to permit members of a train crew to climb up to a grill 74 located on the top of the car and at one side of the catwalk 54. A crank 75 is provided. For controlling the movement of doors 68 and also for locking the same in their closed positions, and this crank is adapted to be remotely inserted into socket portions 76 on either side of the end 58 to operate the doors and their respective telescopic ladders.

Also mounted on the outer surface of the car on both sides thereof are a pair of control panels 77 and 78, as seen in Figs. 1 and 2. Referring now to Figs. 3 and 4, is shown an interior cargo-carrying chamber designated by the general reference numeral 80. As shown in Figs. 4 and 6, is insulated from the bottom wall 81 by three layers of thermal insulation 87 which are protected by longitudinal extending beams 82 and covered by a wooden floor 82a. The sides of chamber 80 are thermally insulated from the lateral sides of the car by a first layer of thermal insulation 83 which is protected by Z-bars 84 and inner lateral layer 83 is another layer of thermal insulation 85 which is protected by longitudinally extending beams 86, as shown in Fig. 4. Between the layers 83, 82 is a layer of plywood 83a and on the inner side of layer 85 is a second layer of plywood 85a. The upper surface of the chamber 80 is protected from the top wall 83 by a very thick layer of thermal insulation 87 which is protected by a plurality of longitudinally extending members 88. It should be particularly noted that at all points the thermal insulation is permitted to maintain its original depth or thickness and is not permitted to be deformed, thereby providing a relatively thin thermal wall on all of the interior sides of the car structure.

Referring further to these figures, the side walls 55, 56 which are composed of relatively thin sheet members 89 which are spaced from the inner insulating wall surface 85a by a plurality of vertically extending beams 90 so as to form air channels 91 between the outer surface of wall 89 and the inner surface of the plywood layer 85a. At the end of the chamber 80 adjacent the end wall 56, seen in Fig. 3, panel 92 is separated from the plywood surface 85a by a plurality of beams 93 so as to form a plurality of relatively wide air channels 94.

At its opposite end from that just disclosed, chamber 80 is formed with a bay or compartment 95 which extends through to the end wall 58 and is thermally insulated from the outer walls of the car in the same manner as the remainder of the chamber. Panels 96 are positive used with the refrigeration system disclosed in Fig. 36; Fig. 38 is a schematic diagram of a portion of the control system used in conjunction with the refrigeration system disclosed in Figs. 9-12 and the damper controls shown in Figs. 13 and 14; and, Figs. 39-41 show a thermostatic control device used in conjunction with the control device schematically shown in Figs. 36 and 37.

Referring now to the several figures of the drawing, the invention may be described in detail. Referring first to Figs. 1-7, general reference numeral 50 designates a railway vehicle ordinarily referred to as a refrigerator car and used for the transportation of perishable food-stuffs in an ice-like frozen or chilled condition. The vehicle consists of an undercarriage designated at 51 in Figs. 4 and 7, which is supported on wheels for mobility on railroad tracks, as shown in Figs. 1 and 2. Reference numeral 52 designates a floor surface of the car and reference numeral 53 designates an outer top surface on which is mounted a catwalk 54.

Referring now to Fig. 3, reference numerals 55, 56, 57 and 58 designate the outer lateral walls of the car. Cargo loading doors 59 and 60, Figs. 1 and 5, are mounted on each of the lateral central surfaces of the car for moving the cargo along the interior thereof.

As shown in Fig. 2, supported beneath the undercarriage 51 are a pair of fuel tanks 61 and 62 which are interconnected by a header 63. A conduit 64 extends to a fuel surge chamber 65 and a fire-protection blanket later is secured on the lateral side of the car and connected by a conduit 67 to tank 61 for safety purposes.

As shown in dotted lines at 108, Fig. 4, the surface of insulation 87 and particularly the layers of felt 107 which are individually attached to each of the panels 102 are of progressively decreasing thickness as they extend from the end wall 58, Fig. 4, toward the middle of car 100. The bottom surface of a panel 102 having a flat lower surface and upstanding edges is formed as a part of the floor underneath the moisture absorbing means and supported on the floor surface 82a, as shown in Fig. 4. The pan itself extends from the end wall 56 to the end wall 58 and is shaped to conform to the structure of the bay 95.

As shown in Figs. 3, 4, and 5, the external surface of the bay 95 is formed by a plurality of panels 115 which are secured on the lower surface of insulation 87 and extends over the entire top of the car. However, it should be noted that the top wall panel 115 is spaced upwardly from the upper extremity of the side walls 88, 92 and 106 so as to form an opening designated at 116 which is in communication with the several air channels 91, 94, and 95 formed on the lateral walls of the car.

As shown in Fig. 4, between the end panels 96, and forming a closure for opening 117 is a central panel 118 which completely separates the main chamber 80 from the bay 95. At its upper extremity panel 120 carries a grill 118. As shown in Figs. 3, 4, and 5, within the interior of bay 95 is a floor 131 which is separated above the surface of panels 102. Floor 119 has a first opening 120, Fig. 4, and in rear of opening 120 are a pair of openings 121 beneath each of the units 106a, 106b, one of which is seen in Fig. 8. As shown in Fig. 8, a plurality of baffles 122 and 123 are formed on the undersurface of floor 119. At the extreme right, the metal pan 110, mentioned heretofore, terminates in a curved surface designated at 124. Mounted on floor 119 over the opening 120 is an electric fan 125 of more or less conventional construction.

As will be evident in Figs. 7 and 8, the side walls of the bay 95 extend up to the undersurface of the top wall 115 so that bay 95 may, with the exception of the grill 118 be considered as being a passage separated from the main chamber, thereby providing a relatively thin thermal wall on all of the interior sides of the car structure.

Referring further to these figures, the side walls of the bay 95 which are composed of relatively thin sheet members 89 which are spaced from the inner insulating wall surface 85a by a plurality of vertically extending beams 90 so as to form air channels 91 between the outer surface of wall 89 and the inner surface of the plywood layer 85a. At the end of the chamber 80 adjacent the end wall 56, seen in Fig. 3, panel 92 is separated from the plywood surface 85a by a plurality of beams 93 so as to form a plurality of relatively wide air channels 94.
all of its several sides by a heavy layer of insulation 133 and on its inner surface is sheathed with plywood 134 to protect the insulation. Around its side walls and to space the cargo from the plywood 134, are a plurality of spaced laths 135. A plurality of removable floor beams 144 are longitudinally extending stringers 137 which have cross ventilating openings 138 adjacent their lower extremity and support a plurality of transversely extending laths 139 on their upper ends.

As shown in Fig. 11, the side walls of bay 132 form a pair of separated compartments 149, which are identical to the compartments 101 of the car 58. Towards their lower extremity conclusive wall 171 of the bay are divided with openings 141, each of which is surrounded on its outer edge by a resilient gasket 142. Co-extensive with the lower extremity of the openings 142 is a floor-board 143 which has a pair of openings 144 which are identical to the openings 121 previously described.

As will be evident in Figs. 9 and 11, a pair of metallic ducts 145, 146 extend from each of the openings 144. A bell crank lever 136 which is provided between the damper units 154 which has a pair of openings 144 which are identical to the openings 121 previously described.

Within the lower portion of each of the ducts 145, 146 are electric heaters 151, 151a for melting ice which may accumulate in the bottom of the ducts 145, 146 that forms a part of drain lines 150 that forms a part of drain lines 150 extending from the bottom of the tank for draining water which accumulates in the bottom of the ducts as a result of defrosting of the heat exchange coils.

A pair of dampers 154, 155, Fig. 14, are mounted in the ducts 145, 146, and are each separately supported on rods 156, 157 to control the flow of air through the individual ducts 145, 146. A bell crank lever 158 is supported in the single duct 145 on a rod 159 below an opening 160. An electric fan 152 is supported within the opening 160, Fig. 11.

A pair of dampers 154, 155 and damper 158 to provide for the closing of damper 158 when either of the dampers 154, 155 are opened, and conversely to open damper 158 only when dampers 154, 155 are both closed. As shown in Figs. 13 and 14, a pair of solenoid operators 162, 163 are supported between the ducts, and as shown in Fig. 15, each of the solenoid operators has a rod 165 which supports a roller 166 on its outer end. Above the bellcrank lever 165 is a plate 167 which is solidly mounted on a rod 168 that is surrounded by a coil spring 169, Fig. 14, and is secured to the upper end of the coil spring 169 by a threaded nut 171. The rod 168, as shown in Fig. 15, is angularly bent in opposite angles and at its upper end is eccentrically threaded so that the movement of the coil spring 169 will move the rod 168 to rotate the solenoid operator 163, which supports the roller 166.

The solenoid operators 162, 163 are electrically connected in a circuit which will be described hereinafter and which includes means which will energize either of these operators when the respective air conditioning units 109A, 109B are in operation so as to open the dampers 154, 155 when either of these units are started. When the operator is energized, the rod 164 is moved inwardly in an arcuate lever 165 to rotate it in a clockwise direction bringing the roller 166 in contact with the plate 167 to move the same upwardly, thereby causing rod 168 to move upwardly and close damper 158, which adjacent to the oblique edge of damper 162 or 163 are de-energized, the coil spring 169 will cause a return movement of plate 167 so as to move the damper 158 to an open position. A coil spring 173 which is connected to bellcrank lever 165 is used for rotating the bellcrank lever 165 to its inactive position shown in Fig. 13.

Referring now to Fig. 12 in conjunction with Figs. 9, 10 and 11, a partition 117 separates the chamber 131 and this partition supports a large central grill 175 which forms an outlet from the chamber 131 to the bay 132. A tapered duct 176 extends as a continuation of duct 147 through the opening 171 to connect the insulating wall 131 to distribute the air centrally throughout the chamber. A plurality of manually adjustable louvers 177, Fig. 9, provide for the distribution of the air throughout the chamber where it will circulate from the duct 176 downwardly through the chamber and thence leave the same through grill 175 for return to the bay 132.

Referring now to Figs. 15 and 16, the air conditioning device herebefore referred to by general reference numeral 190, is shown only as to its major elements. The device consists of a general casing 197 which is divided into an operating portion 190 and an air conditioning portion 181 which is of smaller size than portion 190 and forms an integral part of the general casing 197. The two portions are insulated by an ordinary relatively thick wall 182 which is filled with thermal insulation material. Within the operating portion 180 is a prime mover here shown as an internal combustion engine 193 and a multiple grooved drive pulley 185. A compressor, not shown, would normally be supported by a bracket 196 and driven by a shaft 197. On the other hand, the mechanically operable portion 180 is a refrigerant condenser 188 which is cooled by a blower 189.

The air conditioning portion 181 consists of an evaporator 190, which is provided with a set of baffles 191. The upper surface of the portion 181 has a large opening 192 within which are mounted a plurality of dampers 193 connected to a rod 194 whose movement is controlled by means disclosed in Fig. 16. The blower 189 is operated by a belt 195 which extends around the pulley 185 and thence around a pair of idler pulleys 196, 197 before it connects with a pulley 198 on the blower 189. The damper 199 extends from the pulley 185 around idler pulleys 200, 201 and thence around a pulley 202 which is enclosed within a box-like structure 203 above the blower 191. The belt 199 extends through a relatively small passage 204 that penetrates the wall 182 so that the atmosphere within the mechanically operated portion 180 will only be permitted to pass into the box-like structure 203 and not into the general operating portion 180 and the upper side of the evaporator. It will also be noted that by virtue of the idler pulleys 200, 201, which are adjustably supported in brackets 207 and 208 that the blower 191 is operated at an angle with respect to the driven pulley 185.

Referring now to Fig. 16, is shown the means for operating the dampers 193. Indicated at 210 is an oil reservoir which has a conventional dip stick level indicator 211. The tank 210 is connected by an inlet conduit 212 to the crankcase of engine 183. A second conduit 213 forms a part of the exhaust conduit 214 from the oil pump system within the engine to tank 210. A third conduit 214 extends from a portion of the lubricating system to a T 215. While not shown, T 215 has a small internal orifice connection 216 which is disposed in the neighborhood of 7/6 of an inch in diameter. One side of T 215 is connected by a conduit 216 to piston chamber 217 which contains a piston, not shown, having at its upper end a rod 218. The second conduit 219 extends from the piston chamber 217 to a T 220 that is in turn connected to a conduit 221 which forms a return line to the oil tank 210. A breather pipe 222 is connected to this conduit 221 adjacent conduit 222. Between the T 215 and 220 are conduits 223 and 224 and interconnected between the inner ends of these conduits is a solenoid valve 225. It might here be mentioned that the fluid passage 225 is about 9/64 of an inch in diameter and is substantially larger than the orifice opening from conduit 214.

At its upper end the piston rod 218 is connected to a lever 226 which forms a part of a bell crank lever 227. Extending from the bellcrank lever 227 is a rod 228 that is joined to one end of the damper operating lever 194. A coil spring 229 is connected between lever 194 and a part of the bellcrank lever 227. A similar connection to bellcrank lever 227 is a rod 230 which at its lower end is joined to a bellcrank lever 231 that is in turn connected to a rod 232 which has a visual indicator 233 on its outer end that provides a line reading 234 in the operating portion 180 of the general casing 179.

Briefly, the operation of the dampers is as follows: Normally the dampers are closed and will remain in that position under the influence of spring 181. When the engine 183 is in operation, oil from its lubricating system will be under pressure and a portion of this oil will travel through conduit 214 into the T 215 and thence through the conduit 216 to the piston chamber
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217 where it will move the piston rod 218 upwardly to cause rotation of the bellcrank lever 227 which exerts a pushing movement on rods 228, 229, which movement is transmitted through the pivotal links to dampers 193 causing the latter to rotate to an open position. Any oil which may leak past the piston within the piston rod 218 will return through the conduit 219 to the tank 210. When the dampers are in an open position the position indicator 233 will be in an extended position with respect to the casing 189. When it is desired to close the dampers of the evaporator, the solenoid valve 225 is energized by a circuit disclosed in Fig. 36, and moves to an open position to permit the oil which is present in chamber 247 as well as that entering through conduit 241 to pass through the valve and return to tank 210 through conduit 221. Releasing pressure on the linkage allows spring 229 to close the dampers. When the dampers are in an open position, the position indicator 233 will extend outwardly to indicate that position, it being understood that the position of the dampers cannot be otherwise determined when the unit is in place in the car, as will be clearly evident in Fig. 7, and if it is desired to remove the unit, the dampers would be damaged if they were permitted to remain in an open position, in which position they would normally exist and might be accidentally held. The rod 232 could, under those circumstances be pushed inwardly to effect closing of the dampers, although it should be understood that the rod is not a normal functional part of the unit intended to be self-operating. It will be pointed out hereinafter in connection with the fluid circuit described herein what the conduit 241 constitutes a schematic showing of the multiple coil evaporator 190 shown in Fig. 15. It will be noted that portions of conduits 266, 273, 276 extend from the opening of the control device 285 to a thermostat 287. A conduit 270 extends between another side of the T 271 to T 258 and contains a check valve 276. A conduit 277 extends from the center of the conduit 270 to T 255 and has connected thereto a thermostatic bulb 259. A conduit 280 extends between valve 278 and the center of T 255 and contains a check valve 281. A conduit 282 extends from the conveying conduit 283 to T 255 and has connected thereto a T 283. Another conduit 284 extends from T 283 to the inlet side of a control device indicated by the general reference numeral 285, which will be briefly described hereinafter. A conduit 286 extends from the outlet side of the control device 285 to the low pressure side of the compressor 240.

The control device 285 is a pressure operated governor controlling unloaded valve which is fully disclosed and claimed in my copending application Serial No. 31,591, filed June 7, 1948, issued January 8, 1952, as Patent No. 2,581,956.

To control the movement of the piston 251 within the chamber 252, a solenoid operated valve indicated at 290 is mounted in a conduit 291 which extends from the high side of the refrigerant to the high side of the refrigerant in the receiver 261 leaves by the connection 262, through conduit 263, T 265, conduit 266, to the expansion valve 267. Assuming the bulb 269 is calling for refrigerant, the fluid passes through conduit 261, and compresses, in the receiver 261 leaves by the connection 262, through conduit 263, T 265, conduit 266, to the expansion valve 267. Assuming the bulb 269 is calling for refrigerant, the fluid passes through conduit 261, and compresses, in the receiver 261 leaves by the connection 262, through conduit 263, T 265, conduit 266, to the expansion valve 267. Assuming the bulb 269 is calling for refrigerant, the fluid passes through conduit 261, and compresses, in the receiver 261 leaves by the connection 262, through conduit 263, T 265, conduit 266, to the expansion valve 267. Assuming the bulb 269 is calling for refrigerant, the fluid passes through conduit 261, and compresses, in the receiver 261 leaves by the connection 262, through conduit 263, T 265, conduit 266, to the expansion valve 267. Assuming the bulb 269 is calling for refrigerant, the fluid passes through conduit 261, and com
between the openings 243, 246. When this occurs, the refrigerant circuit will be established as follows: The high pressure gas, which is in a heated condition, passes from the compressor 240 through conduit 253 to the opening 244 of valve 242, thence through opening 245 to the bypass valve 242, then through the bypass valve 246 and passing downwardly to the T 271. The check valve 272 will prevent reverse passage of the fluid, which may include liquid as well as gas. However, only the fluid can pass from control device 271 through conduit 275, pass to the valve 276 to the T 278 and thence through conduit 259 and connection 260 into the receiver 261, because the valve 278 is controlled by the bulb 279 which is in contact with conduit 282 and, as will be explained hereinafter, this conduit will conduct heated gases so that in a few moments after reversal of flow, valve 278 will open under the influence of heat to permit the refrigerant to enter conduit 280 passing through the check valve 281 to T 255 and into the conduit 254, which now has become an evaporator or an absorber of heat. In tracing the circuit later from T 255 it should be thoroughly understood that the fluid will pass the path of least resistance and will enter conduit 277 rather than conduit 266, where it would pass the resistance of the high pressure fluid leaving T 271. Returning now to the valve 241, the fluid leaving conduit 254 will enter opening 243 of the body 245 and pass through the passage 247 to the control device 253 through the bypass valve 242 to the control device 253, from whence it passes through conduit 286 to the low pressure side of compressor 240 whence it is reincorporated in the manner just described.

By referring to Fig. 7, it will be clearly evident that the air conditioning unit 100A and 100B are adapted to be removed and housed within their respective compartments. The reason for this is that when not in use or when the necessity for repair occurs, the units may be bodily removed from the car. It will also be evident that the operative portion 180 of each of these units containing an internal combustion engine must have provision for exhausting the spent products of combustion and for cooling these gases by combustion, and for this purpose telescopic hoods are mounted over each of the units. The mechanisms provided for their operation are interrelated and will now be explained in detail.

Refering now to Figs. 18-29, and particularly Fig. 19, general reference numeral 293 indicates a base structure which supports the air conditioning unit 100 and provides for its removal from the car compartment by a sliding drawer-like mechanism shown in Figs. 7 and 20. The supporting structure 293 constitutes a rectangular base frame formed of a pair of heavy channel members 296, 297, Fig. 24, which form the front and rear parts of the frame, and a pair of side channels 298, 299, Fig. 21, which form the side members of the frame. The frame thus formed is mounted on three small rectangular plates 294, one of which is mounted on the underside of the forward end of the cans 294, and the other two are mounted under the rear corners of the frame. The members 296-299 are united to each other at their corners. A pair of side plates 300, 301, Fig. 21, are secured to these corner members, and each of the side plates 300, 301 has a plurality of vertical slots 302, 303 in which are slidable mounted four roller elements 304.

A frame member designated by the general reference numeral 295 in Fig. 20, is supported on the rollers 304 within the interior of the base frame member composed of members 296-299. Frame member 295 is of a cross section in Fig. 24, composed of a bottom plate 305 which on its forward edge supports a channel member 206. Extending downwardly on the inner side of the channel member 206 and across the top of the plate 305 is a heavy layer of sponge rubber 307 which is covered by a thin metal layer 308, that is secured to the plate 305 by a bolt 309 which is adjustable in a slot 310. The rear portion of the frame 295 is composed of an angle iron member 311 which carries a layer of sponge rubber 312 only on its horizontal surface. The layer of sponge rubber is covered by a thin metal layer 313, that is secured to the angle member 311 by a bolt 314 which is adjustably movable in a slot 315. The side portions of the frame 295 are best seen in Figs. 19, 29. Members of the frame 295 are similar in construction to the front member and for purposes of identification are composed of members 316, 317 extending downwardly over the outer edges of which are welded channel members 318, 319.

Extending downwardly over the inner surface of the channel members 318, 319 and thence over the top of the members 316 and 317 are thick layers of sponge rubber 320, 321 which are in turn covered by thin metal layers 322, 323 and which are secured by bolts 324. Within the channel members 318, 319 are a plurality of roller elements 326 having bearing portions 327 that are secured within tracks 328, 329 that extend in a channel-like manner over the rollers 304. The bearing portions 327 of rollers 304 are adapted to be removed from the frames 330 that extend horizontally on either side of the base frame, and, as shown in Fig. 20, are journaled in bearings 337. Rigidly secured on each shaft 336, Figs. 20, 21 and 22, are a pair of cans 338 each having a small roller 339 pivotally mounted adjacent the outer end of the can. These cans and their cooperative rollers are adapted to contact the lower surfaces of the angularly shaped members 331, 332 to raise or lower the frame member 295 including the unit 100 therein relative to the base member. The cans and their cooperating parts are shown in each of two positions in Figs. 21 and 22.

In addition to raising and lowering of the base structure 295 which supports the air conditioning device 100, the same mechanism just described has a secondary action with respect to lifting and lowering the frame 295 indicated by the general reference numeral 340 in Fig. 18. Hood 340 is provided with a sponge rubber layer 345a extending along the top of the side of the device indicated by the general reference numeral 295 is a pair of braces 341 which are secured at their lower ends to the angularly shaped members 331, 332. At their upper ends brages 341 are joined to a plate 342 which forms a bearing for a rod 343 on each side of the frame.

Refering now to Figs. 25 and 26, at its lower end each rod 345 carries a collar 344 that extends from an arcuate shaped member 345, which is pivotally mounted on a cam 346 that is in turn supported on rod 336. At its upper end, Fig. 18, each rod 343 is threaded securing by a pair of nuts 347 to a flanged extension 348 on either side of the hood 340. Because of the extended size and relative positions of the members 345 on the forward end of the cans 345, the rods 343 will be in advance of the cans 330 and will raise the hood 340 clear of the top of the unit 100 before the frame member 295 is completely raised.
shaft 349 and located over the reel 350 is another shaft 355 which carries a pair of abutments 356 at its opposite ends. Rigidly mounted on shaft 355 is a collar 357 which, as shown in Figs. 28 and 29, carries an inverted C-shaped member 358 whose opposite finger-like ends are engaged in the grooves of reel 359. The purpose of shaft 355 and collar 357 is to prevent excessive rotation of the shaft 355 with rotation of the reel, and to bring into one of the abutments 356 into engagement with one of the studs 354 on the outer side of either one of the collars 357. As the stop member 75 is moved upward, the same is moved downwardly as shown in Figs. 7 and 32, where it is secured to an angularly shaped bracket 365 which opposes the side surfaces of the reel 360 secured by brackets 366 on the inner side of reel 68.

In addition to the other functions of the structure just described, is a door locking mechanism shown in Figs. 28, 29, and 32, for securing door 68 in a closed position. In this mechanism, a cam 371 is pivotally mounted in the door 68. A bracket 370 is securely attached to the inner side of the door 68 and carries a cam 371 which, as shown in Fig. 29, is pivotally joined to a bracket 372 which carries a rod 373 which is adapted to move through an opening in a side panel of the car and penetrate an opening in a flange portion 362 of the side of the door, which rides in track 71 and thereby moves the door 68 in a vertical direction. Another portion of bracket 370 and a collar portion on the upper extremity of shaft 368. At its lower end, shaft 368, as best seen in Fig. 35, carries an abutment 375 which has a notched portion 376 that is engaged with a collar 75a on the forward end of the crank 75 which is partially shown in Fig. 35. At its outer end the abutment 375 has a flattened portion 377 that is engaged with a collar 378 that is supported by a block 379 on the plate 369.

As best seen in Figs. 28, 29, and 32, the side shafts 368 at their lower end carry a passenger car, which are adapted to engage hardened steel blocks 381 on the outer extremities of the front face member 306 of the movable frame member 295. These cars are connected to a coil spring 382 to provide for an over center snap action of the door 383, which is pivotally supported by a rod 384 in bearings 385. Fig. 28A, 30A and 30B, carries a bellcrank 386 which is connected to a coil spring 387 to provide for an over center snap action of the door 383 as seen in Fig. 7, on the underside of the door 383 which is engaged by an abutment 389 in front of the motor, in the manner shown in Fig. 30, with the exception that the ventilating dampers 293 would be in a closed position, and it is desired to remove the unit 100 from the car, it is necessary for the operator to remove the crank 75, since the cam 371 to withdraw the rod 373 from the openings 366 of the door structure 68 to thereby unlock the door. Therefore, rotation of the crank 75, 290 degrees as fast as shaft 336. Coincident with the rotation of shaft 349, shafts 336 slowly rotate and simultaneously raise the other outer positioning cam member 368 from its position in the forward of the hardened blocks 381. Simultaneous rotation of the shafts 336 will cause rotation of cam 368 so as to raise the members 345, thereby raising the rods 345 to elevate the hood structure 340. The cams 336 will raise the rods 243 before the frame 295 engages the members 331, 332 and therefore the hood 300 is elevated before the frame 295 begins to move. As these members are raised the several rollers 304 are raised in their slots 302, 303 from the position shown in Fig. 22 that shown to Figs. 21 to thereby raise the frame member 295 which actually supports the machine on the base frame. It should be understood that the lower portion of door 68, the raising of hood 349 and the raising of the angular members 331, 332 are accomplished concomitantly. As the reel 350 has turned completed 360 degrees, the same will be returned to its full line position, as shown in Fig. 27, to its dotted line position to thereby bring the abutment 356 on the left hand end of the shaft into engagement with the studs 354 on the left hand collar 353 to thereby prevent excessive rotation with the crank 75. The machine is now ready to be removed and by manually grasping a forward handle the machine is moved inwardly, after which the same is moved outwardly, the several rollers 304 and 326 simultaneously permitting movement of the tracks 298, 329 as well as the supporting frame 295 within which the machine 373a extends beyond the safe distance of outer movement, a stop member 390 carried by each of the tracks engages a stop member 391 mounted on each of the side plates 390, 391. A second set of stops 392, 290, carried by the frame 295, engage portions 393 on the tracks when the frame 295 has been moved to the extent shown in Fig. 20. The amount of effort necessary to accomplish this outer movement is no force and may be performed by one man. As the unit 100 moves out of the hood 349, the abutment 389 on the upper surface of unit 100 engages members 390 and 389 on the rear end of the door 383 to thereby cause the door to pivotally move outwardly and the overwhelming snap action of lever 385 causes the door to snap to a fully open position to be retained in that position when the frame 295 may then be raised from the supporting frame 295 by means of a winch or other raising mechanism which engages in apertures 178 on the side of the machine, as seen in Fig. 7.

The return of the machine to its supporting frame and its insertion within the compartment is substantially the reverse operations of those described heretofore, however, some features of the construction are important insofar as the insertion and return are concerned. Specifically, the thin metal plates 298, 313, 312 and 325, and the sponge rubber layers beneath them are held in place by adjustable bolts, as seen in Fig. 19. These bolts are adjusted so as to give a very tight fit to the machine and cause a certain amount of compression of the sponge rubber layers beneath them in place. When the hood 349 is lowered on the unit 100, the rubber layer 340a is compressed against the abutment 389 and as the machine 295 is pulled in place. Moreover, the base channel members being given a three point support on the plates 294 provides for properly balancing the frame member 293 within the compartment as the machine 295 is pulled in place and also to provide for slight movement caused by impacts sustained by the car. Guarding against injury caused by impacts is a highly important operation, for minor errors in the level of the floor of the car and also to provide for slight movement caused by impacts sustained by the car.
Referring again to Fig. 7, the hood 340 is joined to a telescopic conduit 393 composed of a lower portion 394 and an upper portion 395 which extends through the compartment to the top of the car and is covered by a plate 396 beneath the grill 74 so as to preclude rain or snow from entering the hood structure. Referring now to Fig. 30, hood 340 is joined to an independent conduit 397 for conducting the exhaust gases away from the muffler 382, independent of any heated air which may arise from the mechanical heating or air conditioning of the car. Also mounted within hood portion 394 is a damper 398 which is pivotally mounted at 399 for providing a closing movement to the conduit 394. The purpose of damper 398 is to return heated air arising from the engine and other heat producing portions and directing the same downwardly over the top of the hood into the compartment 181 so that the same may be drawn in about the operating portions by the blower 199. To provide for the operation of damper 398, a control device shown in Fig. 31 is utilized, which is composed of a thermostatic device 401 surrounded by a plurality of fins 402. Within the interior of the device 401 is a solid heat responsive medium, not shown, which when expanded under the influence of heat causes a piston 403 to be moved outwardly against a cam surface 404 mounted on a lever 405. A second lever 406 is mounted within the interior of lever 405 and carries an actuating screw 407. The device is also described in detail in U.S. Pat. No. 2,488,960 which is assigned to the inventor showing a similar form of the described invention. At its outer end lever 405 carves a rod 406a which is joined to a hinge portion 409 on the damper 398, while lever 406 and lever 405 provides for biasing lever 405 against lever 406 in such a manner that roller 404 is biased against the piston 403 for the purposes of biasing damper 398 in a normal position. As shown in Fig. 31, spring 411 is mounted on an extension of rod 408 to compensate for the normal force of the piston 403 after the damper has been moved to a fully closed position illustrative in Fig. 3A.

It will be appreciated that damper 398 is normally in an open position so as to return heated air to the operating mechanism to thereby maintain the engine and compressor and other operating parts heated sufficiently to provide efficient operation. However, when these parts have been properly heated the thermostatic device 401 provides for a normal position at which the damper 398 escapes from the control of the heated air through the top of the car. It can be appreciated that the exhaust products of combustion should not be returned for this purpose and, therefore, the damper 398 is provided for by-passing these products around damper 398 at all times.

Referring now to Fig. 36, is schematically shown in combination with the above discussed ventilating units, the system necessary for controlling the various functions of these units. The several elements making up the two units are shown on the right and left hand sides of the figure and are identical. The control portion of the system is shown in the center of the figure and a portion of this part of the schematic showing is enlarged in Fig. 37.

General reference numerals 184, 184a designate the starter generators composed of armatures 415, 415a having starting windings 416, 416a on one side and generator windings 417, 417a on the other side which are connected through movable switches 418, 418a with resistors 419, 419a. The starter generators are initially energized by batteries 420, 420a by means of starting relay 421 which is capable of energizing armature controller switches 422, 422a when de-energized engages contacts 423, 424 and 423a, 424a, and when energized engages contacts 425, 426 and 425a, 426a. The generator 415, 415a also is shown in connection with the intergenerators 184, 184a which are pressure safety switches 427, 427a that have operable connected thermo switches 429, 429a, and safety thermostats 429, 429a having temperature responsive portions 430, 430a and switches 431, 431a.

Also schematically shown are the pressure unloading devices 235, 235a whose electrically operable portions are controlled by armatures 432, 433a which are actuated by induction coils 433, 433a. Associated with each of the control devices 285, 285a are switches 434, 434a which are governor controlled, and which will remain in the open position shown until the prime movers or engines 183 attain an operating speed equal to at least 50 per cent of their rated speed, at which time the switches will engage contacts 435, 435a.

To periodically defrost the evaporators of the air conditioning units, timing devices 436, 436a are provided. These timing devices are operably connected to the prime movers so as to be driven when the prime movers are in operation, and are here shown as being operated by mechanical connections 437, 437a which extend from the engine or the governor which operates switches 434, 434a. The timers also include cams 438, 438a, which are adapted to actuate switches 439, 439a. Manual operation is provided as 440, 440a for closing switches 439, 439a when desired. The switches 439, 439a are engaged to contact devices 441, 442 and 441a, 442a. Shown above the switches just mentioned are armature connected switches 443, 443a which when de-energized normally engage contacts 444, 444a, and 444b, 444b and when energized by induction coils 446, 446a engage contacts 447, 447a, 447a, and 448, 448b to form holding circuits. Adjacent each of the holding relays just mentioned is a defrosting relay having damper control switches 449, 449a which are adapted to engage contacts 450, 451, and 450a, 451a, and reversing the switches 452, 452a that are adapted to engage contacts 453, 454 and 453a, 454a. The switches 449, 449a and 452, 452a are both controlled by induction coils 455, 455a.

Operably associated with the foregoing switches are induction coils 456, 456a, of the defrosting control devices 290, 290a, and induction coils 457, 457a which control the operation of valve portions 458, 458a of the damper operating valve 459, 459a. When energized with the holding relays are thermostats 459, 459a, having thermostatic bulbs 460, 460a, and normally open switches 461, 461a.

Normally open switches 462, 462a which are adapted to engage contacts 463, 463a, are provided as an alternative control of the electrical portions of valves 225, 225a. These switches are micro switches and are fired by the casing 179 of the units 109. These switches are moved to an open circuit position when the movable frames 295 are lowered within the frame portions as the final acts of mounting the units within their compartments in a car.

Adjacent the upper portions of Fig. 36, are cold starting thermostats indicated at 464, 464a. These devices are provided for starting the units solely for the purpose of warming the engines when outside temperatures become so low as to endanger the engines, their lubricating systems, and associated parts. The thermostats include temperature responsive portions 465, 465a, and normally open switches 466, 466a.

Also shown in the upper portions of the figure are incandescent lamps 467, 467a, 468a, 468a. These lamps indicate conditions of the units and in actual practice all six are mounted as a part of each of the panels 78 on each side of the car, as seen in Figs. 1 and 2. At the lower portion of the figure and forming parts of each of the units are high tension ignition coils 470, 470a.

General reference numeral 475 indicates a voltage control device for selectively controlling the flow of power from one of the batteries 420, 420a to the motor of fan 125. An armature connected selector switch 476 when de-energized engages contacts 477, 477a and when energized by an induction coil 479, engages contacts 480, 481. Another armature connected selector switch 482 when de-energized engages contacts 483, 484a and when energized by an induction coil 485, engages contacts 486, 481.

Indicated by a broken line in Fig. 36 is a control panel 490 which supports control means for operating the several portions of each of the units. The control panel 490 is also shown in plan form in Fig. 31. General reference numeral 491 designates a manual change-over switch which is connected to a plurality of switches 492, 493, 494, 495, 496, 497, 498 and 499. The switches 492-499 are adapted to be moved either to a neutral position, as shown, or into engagement with contacts on the right or left side of neutral position and which will be referred to hereinafter by the same reference numeral as the switches except that those contacts on the right will be referred to as contacts 492a-499a, while those on the left will be referred to as contacts 492b-499b. When the actuator 491 is in a central
or neutral position, power is cut off from both of the units, whereas when it is in the left position in engagement with the contacts 492a–499a, the unit on the left becomes the primary unit that will carry the major portion of the load while the unit on the right becomes the secondary or standby unit; whereas when the actuator is moved to the right into engagement with contacts 492–499, the unit on the right becomes the primary unit and the upper side of the major portion of the load and the unit on the left becomes the standby unit.

A conductor 500 extends from switch 495 through a junction with switch 499, to lamp 469a and constitutes a “primary” conductor for the unit on the left. A conductor 500a extends from switch 495 to lamp 468a and constitutes a “control” conductor for the unit on the right hand unit. A similar conductor 501a extends from switch 497 to lamp 468a and constitutes a “heating” conductor for the left hand unit. A conductor 505 extends from switch 495 to lamp 467 and constitutes a “heating” conductor for the right hand unit. A conductor 505a extends from switch 497 to lamp 466a to constitutes a “heating” conductor for the right hand unit. Referring now to the upper side of the switching device, a conductor 503 extends from contacts 492, 492a, and through switch 431 and, as will be explained hereinafter, supplies power to the control panel 490. A similar conductor 503a extends from contacts 499a, 499b to one of the contacts of switch 431. These can be conductor 504a, 504b on the left, and conductors 500a–503a on the right, constitute all of the electrical connections between the panel 490 and the remainder of the units.

On the lower sides of the switches the several contacts are joined in pairs by six conductors as follows: a conductor 504 extends from contact 493 to contact 498b and contains a junction 504a; a conductor 505 extends from contact 493a to contact 499a and contains a junction 505a; a conductor 506a extends from contact 494a to contact 499a and contains a junction 506a; a conductor 507a extends from contact 495a to contact 496a and contains a junction 507a; a conductor 508a joins contact 496a, and contains a junction 508a; a conductor 509a joins contact 497a, and contains a junction 509a; and a conductor 510a joins contacts 498a and 499a.

Above the change-over switch and its circuit connections is a thermostatically operated switching device which incites a switching bar designated at 516. This bar is placed in a position at 517 to a bracket at 519 and in turn pivotally mounted at 519 to a bracket 520. An angular extension 521 of the bracket 520 is connected to the end of a spring 522, whose other end is connected to a vertical arm of the bell crank lever 5218 that extends in the direction of the switching bar 516. The bar 516 is connected to four switches designated at 523, 524, 525, and 526, and has over travel slots therein designated at 527, 528, 529, 530. The slot 520 will permit a greater range of movement of bar 516 with respect to switch 524 than slot 517 will permit with respect to switch 523. The slots 529, 550 will permit a greater range of movement of bar 516 with respect to switches 525, 526 than slot 528 will permit with respect to switch 524. Switches 523, 524 are interconnected by a bar 531. On either side of switches 523–526, the plurality of contacts designated at 532, 533, 534, 535, 536, 537, 538 and 539. A conductor 540 extends from switch 532 to contact 536. A conductor 541 extends from contact 533 through a junction 534 to contact 537. A conductor 543 extends from contact 534 to contact 538. A conductor 544 extends from junction 535 to contact 539.

Starting on the left of this portion of the figure, a conductor 546 extends from junction 505 to switch 525. A conductor 547 extends from junction 509 to switch 523 and extends from junction 515 to junction 542. A conductor 549 extends from junction 515 to junction 545. A conductor 550 extends from junction 511 to switch 524. A conductor 551 extends from junction 517 to switch 525.

The conductors necessary to join the various elements with each other and with the “power,” “control” and “heating” conductors will now be described. From batteries 420, 420a extend conductors 426, 426a, and from contacts 425, 425a, conductors 556, 556a extend through junctions 557, 557a to the starting winding 416a, 416b of the starter generator 584, 184a. From junctions 558, 558a, on conductors 555, 555a, conductors 559, 559a extend to manually closable switches 560, 560a which are adapted to engage contacts 561, 561a, and from these contacts conductors 562, 562a extend to pressure switch contact 432, 432a. From contacts 428, 428a conductors 563, 563a extend to the starting winding 416a, 416b. The circuits established through these conductors will extend through switches 492 and 499 to the lights 469, 469a to supply power to the circuit when switches 492 and 499 are closed.

Extending from the junction 557, 557a, conductors 576, 576a extend to the governor switches 434, 434a, and from contacts 435, 435a conductors 565, 565a extend to the induction coils 455, 455a, conductors 568, 568a extend to one of the end of the respective induction coils 569, 569a extend to ground. From junctions 570, 570a on conductors 501, 501a, from one side of these junctions, conductors 573, 573a extend to one pole of the high tension ignition coils 470, 470a. Conductors 574, 574a extend from the other pole of the ignition 470, 470a to the two engines designated at IGN. Conductors 575, 575a also extend from the junctions 572, 572a to the induction coils 422, 422a of the current relays, while conductors 576, 576a extend from the other end of these coils to ground.

The defrosting control devices are connected by conductors which will now be described. From junctions 577, 577a on the power conductors 500, 500a, conductors 578, 578a extend to contacts 442, 442a and from contacts 441, 441a conductors 579, 579a extend through junctions 581, 581a to one of the contacts of the switches 461, 461a, and conductors 580, 580a extend from the other of these contacts to contacts 448, 448a. The induction coils 446, 446a are connected between the conductors 589, 589a and ground by short connections, not designated. From junctions 591, 581a on conductors 579, 579a, conductors 582, 582a extend to contacts 444, 444a and from these same conductors, not designated, extend to contacts 447, 447a. Extending from contacts 445, 445a conductors 583, 583a extend to induction coils 455, 455a, whose other ends extend to ground. From junctions 584, 584a on conductors 578, 578a conductors 585, 585a extend to contacts 450, 450a. From these same conductors, by short connections, not designated, extend from the conductors 585, 585a to the current coils 451, 451a. Conductors 586, 586a extend from contacts 454, 454a, to junctions 589, 589a on the heating circuit conductors 502, 502a. Junctions 590, 590a join one end of the induction coils 456, 456a of the reversing valve 298, 298a to the heating circuit conductors 502, 502a and the other end of these coils are connected to ground. From junctions 591, 591a on the power conductors 500, 500a, conductors 592, 592a extend to switches 464, 464a. Conductors 593, 593a extend from switches 456, 456a to one end of the induction coils 457, 457a of the valve 225, 225a, and the other end of these coils are connected to ground. Conductors 594, 594a extend between contacts 451, 451a to junctions on conductors 593, 593a.

The connections for the “cold starting” thermostats will now be described. Conductors 596, 596a extend from junctions 4, 48, 47 on the power conductors 500, 500a to one side of the open switches 466, 466a, and conductors 597, 597a extend from the other side of the switches to junctions 598, 598a on the control conductors 501, 501a.

The circuit for the operation of the voltage control device includes a conductor 599 which extends from a junction 600 with the power conductor 500 to contact 595. A conductor 599a extends from a junction 600a on conductor 599a to contact 575. A conductor 600 extends from contact 477 to the induction coil 485 whose other end is connected to ground. A conductor 610a extends from contact 484 to the induction coil 479 whose other end is connected to ground. A conductor 610 joins at one end to conductor 604 and extends to one...
The operation of the control system will now be described. With the parts in the positions shown, both units would be inactive because the several switches 492A to 499A are in a neutral position, thus current cannot pass through the control panel. If the actuator 491 is moved to the left to bring switches 492B to 499B into engagement with contacts 492C to 499C, the unit on the left will be the first to operate and the unit on the right will become the standby unit, whereas, if the actuator 491 is moved to the right, into engagement with contacts 492D to 499D, the unit on the right will become the primary unit and the unit on the left will become the standby unit. When moved in either direction, and provided the manual switches 560, 560A, the pressureregulate switches 428, 428A and the safety thermostat switches 431, 431A are closed, the switches will act.

Assuming the temperature in the control space is substantially above the desired temperature, the driven member 610 will have rotated the bellcrank lever 518 in a counterclockwise direction bringing bar 516 to the left to bring the switches 523 to 526 into engagement with their respective contacts 532, 534, 536 and 538. This will initiate the operation of both of the units as may be traced as follows:

Considering first the unit to the left, power will flow from battery 428 through conductor 555 to junction 558 through conductor 559, switch 560, contact 554, conductor 562, switch 488, conductor 563, switch 431, conductor 503, contact 492B, switch 492, conductor 509, switch 493, contact 493A, conductor 504 to the junction 560, conductor 546, switch 525, contact 536, conductor 540, contact 532, switch 523, conductor 547 to junction 569, conductor 508, contact 494A, switch 494, conductor 501 through the junction 570 to lamp 466 and also through conductor 571 to the junction 572. From the junction 572 current will flow through conductor 575 to the induction coil 421 and thence to ground through conductor 576. Current will also flow through conductor 577, the ignition coil 470 and thence through conductor 574 to the ignition points. When the induction coil 421 is energized, switch 422 will engage and 422A will be broken.

Current will then flow from battery 420 through conductor 555 to contact 426, switch 422, contact 425, conductor 556, to the starting coil 416 of the starter generator 184 to motorize the engine on the left unit. When motorized, current will flow from the generator coil 417 back through conductor 556 and conductor 555 to the battery. The circuit for the unit on the right is identical with that described for the unit on the left, except as to its path through the control panel 490. Commencing with conductor 503A, current will pass through contact 499A, switch 499, conductor 508B to switch 498B, thence through contact 498A and conductor 506 to the junction 507, whence it flows through conductor 551 and switch 526, contact 538, conductor 543, contact 539, switch 485 to junction 511 and thence through conductor 510 to contact 497A, switch 497 and conductor 501A to the junction 570A. Thereafter lamp 468 becomes illuminated and the starter generator 184 moves in a manner as that described for the starter generator 184.

When the temperature in the controlled space is approximately 1°F above the desired temperature, the driven member 610 will move counterclockwisely to move bar 516 to the right for a sufficient distance to cause switch 423 to disengage from contact 523. When this occurs, the circuit to the unit on the left will be broken and the unit on the left will cease to operate. However, the unit on the right, the standby unit, will continue to operate until the bar 516 moves further to the right to break engagement switch 524 and contact 534. However, the switches 525 and 526 will still be in engagement with contacts 536, 538 and on a slight rise in temperature, switch 523 will be the first to make contact with contact 532 and current will pass through both batteries to cool the space, and while the unit on the left is the first to stop, thereafter it will carry the load of maintaining the controlled space within the desired temperature and the unit on the right will remain to move downwardly under the influence of spring 522 in response to a decrease in temperature within the controlled space.

When both of the air conditioning units are shut down, the fan motor 125 is energized to continue the circulation of air with respect to the enclosed space. The voltage control device 475 is provided to selectively determine whether battery 420 or battery 420A will supply the power to operate the fan motor and will always select the strongest battery for this purpose. Assuming that battery 420 is the stronger of the two batteries, the circuit for operating the fan motor 125 may be traced as follows: From battery 420 through contact 555, junction 556, conductor 559, switch 485, contact 561, switch 562, contact 563, switch 431, conductor 503, contact 492A, switch 492, and power conductor 500. From the junction 680, current will flow through conductor 599, switch 493, switch 493A, conductor 599, junction 603 to contact 498, thence through the closed switch 482 and contact 484, conductor 601A to the induction coil 479 and thence to ground. When coil 479 is energized, switch 476 is again in engagement with contacts 480, 481. When this occurs, a new circuit is established from conductor 599 through junction 603 and conductor 602 to contact 480, switch 481, conductor 599, conductor 600, conductor 601, pole of the fan motor 125 and thence through conductor 608, contact 424A, switch 422A, contact 423A, conductor 606, contact 423, switch 422, conductor 424, conductor 607 to ground. The fan motor 125 will continue to operate on this circuit until one of the relay switches 422A or 422A is again moved downwardly. However, in the event that the temperature in the controlled space remains static for some period of time, battery 420 might be excessively drained. To prevent this condition, the induction coils 479 and 485, each have a limited number of turns so that when the voltage falls below a predetermined value, the coil will become de-energized and the voltage control device 475 will again operate to form a new circuit to the other battery, that the voltage 420 falls below the predetermined value, coil 479 becomes de-energized and switch 476, by spring means, will be returned to the circuit for the unit on the right.

Assuming that battery 420 is now the more powerful battery, current will flow from the conductor 503A through the junction 508A and conductor 599A through junction 603A to contact 478 and thence across switch 476 to contact 477 and thence through conductor 601 to the induction coil 485 to ground. When this occurs, switch 482 will move downwardly into engagement with contacts 486, 487 to establish a circuit from conductor 599A through junction 603A and conductor 602A to contact 487 and thence through switch 482 to contact 485 and conductor 501 to contact 497A and thence through the circuit previously described to ground. In the event that both batteries are drained of power to an extent that neither one is capable of energizing the induction coils, then the fan motor 125 will become inoperative. The effective number of turns in each of the coils 479, 485 is such as to require a voltage in excess of that needed to energize the starter generators and, therefore, will prevent the fan motor from draining power from the batteries to such an extent that they will no longer be capable of energizing the starter generators.

A portion of the circuit for energizing the starter generator is disclosed in Nagro and Paran, 2,337,164 dated December 21, 1943.

Assuming now that the cargo being carried within the enclosed space 80 of car 50 consists of material...
having a high moisture content such as lettuce, the continuous circulation of cold air will have carried some of the moisture to the evaporator, where it will have formed a layer of frost on the evaporator coils of sufficient thickness to warrant defrosting the coils. The timer is used for the evaporator when the temperature of the frost on the coils is deemed high enough to warrant defrosting. The timer is normally set for 10 hours, and the defrosting will be repeated bi-weekly. The timer will be turned off when the temperature drops below 50°F.

It should be understood that in the present invention, the defrosting operation is dependent upon the mere passage of time from the last defrosting operation, but rather upon the elapsed operating time. Accordingly, therefore, the timers 436, 436a are driven only when the units are in actual operation, and as bare disclosed, they are driven by members 437, 437a which constitute mechanical connections from the governor, which are capable of closing switches 434, 434a, thereby closing any other means of driving the timers when the units are in operation may be used.

Assuming, therefore, that the unit on the left of FIG. 3 is in operation for some time and that the period of time for which the coil 438 had been pre-set has elapsed, it shall be understood that while switch 439 may be manually closed by the actuator 440, normally it is not electrically closed, but in either event the compressor must be in operation in order to effect defrosting.

When switch 439 engages contacts 441, 442, a circuit will be established which may be traced as follows: From battery 428 through conductor 555, conductor 559, switch 560, contact 561, conductor 562, switch 428, conductor 563, switch 431, conductor 563, contact 492a, switch 429, conductor 564, through junction 600 to junction 579, thence through conductor 578 to contact 442, thence through switch 439 and contact 441 to conductor 579, thence from junction 581, through conductor 582 to contact 444, through switch 445, contact 445, conductor 583, to the induction coil 455, thence to ground. When coil 455 is energized, switch 449 is moved into engagement with contacts 450, 451, and also switch 452 is brought into engagement with contacts 453, 454. The closing of these switches establishes a first circuit to valve 225 and a second circuit to valve 290. The first of these circuits may be traced as follows: From battery 428, through conductor 555, switch 560, contact 561, switch 562, conductor 563, switch 431, conductor 563, switch 431, conductor 564, through junction 600 to junction 577, thence through conductor 578 to contact 442, thence through switch 439 and contact 441 to conductor 579, thence from junction 581, through conductor 582 to contact 444, through switch 445, contact 445, conductor 583, to the induction coil 455, thence to ground. When coil 455 is energized, armature 458 moves downwardly to permit hydraulic fluid from the reservoir 218 to flow through valve 225 to effect the closing of dampers 193 so as to prevent air from being circulated over the evaporator during a defrosting operation. The closing of switch 452 establishes a second circuit which may be traced as follows: From the contact 559, which is now carrying current, as previously described, through the undesignated branch to contact 453, switch 455, contact 454, conductor 556 to junction 590, thence through conductor 546 to the junction 590, thence through the induction coil 456 of the valve 290 to ground. When coil 456 is energized, the reversing valve 241 shifts the position of valves 29, 29a on the flow of hydraulic fluid through valve 225 to permit the dampers 193 to open again and also to permit the reversing valve 241 to assume its normal refrigeration position. When the evaporator 190 is again cooled, the thermostat 459 will break the circuit through conductor 579 below the timer, and the electric circuit is completed until the timer completes its cycle and opens switch 539 with respect to contacts 441, 442, at which time the holding circuit is broken.

The circuit concerned with the energization of coil 456 and the breaking of that circuit by thermostat 459 is fully disclosed and claimed in my above-mentioned application Ser. No. 758,053, issued May 23, 1950, as Patent No. 2,509,099.

Switch 462, 463 is also intended to provide an alternate means of energizing the induction coil 457 of valve 225. This switch 463a, as was previously explained, is carried on the casing 179 and is moved to an open position when the frame 295 is lowered into department 101. The reason for this is that in removing one of the air conditioning units 100 from the compartment, it is essential that the dampers 193 be closed to prevent damage. Normally, when a unit is not in operation, the dampers 193 would be closed, but this switch serves as safety means to assure the closing of the dampers when a unit 100 is removed in an operable condition from the railway car.

From time to time, railway cars containing the units described hereafter may be passing through areas where climatic temperatures are very cold. During these periods, the temperature within the controlled space will remain comparatively stable, the radiating heat, and therefore, there will be little or no need of refrigeration. During such periods of idleness the engines and their lubricating systems may be chilled to a point where the engine and the cooling system could not be started. To prevent this from occurring, the thermostats 464, 464a are provided for starting the units, even though the dampers 225 and 232 are spaced from the direction 352, 354.

The temperature responsive voltages 465, 465a are placed in heat transfer relationship with an essential part of the unit so as to bring about a starting operation when that portion becomes excessively cold. It will be noted that a drop in temperature adjacent bulbs 464, 465b, will move the switches 466, 466a to closed positions. Considering only the unit on the left, this establishes a circuit which may be traced as follows: From battery 428, through conductor 596, current will flow through conductor 596 to valve 466, and when the latter is closed, through conductor 597 to junction 598 of the control conductor 501. This brings about a starting operation. The switch 523 is spaced from contact 532 by a circuit which may be traced as follows: From battery 428, through conductor 522, switch 523, contact 524, conductor 526, switch 428, conductor 530, conductor 531, contact 492a, switch 492, conductor 509, junction 595, conductor 596, switch 466, conductor 597, to the junction 598 of the control conductor 501 and thence through that conductor to junction 570, and thence through conductor 571 to the junction 572, and thence through conductor 575 to energize coil 421 and also through conductor 573 to the spark coil 470 in a manner previously explained. The thermostat 464 is a slow acting thermostat and will not move the switch 466 to an open position until the bulb 465 has attained a fairly high temperature. Thus, it is in effect preventing either of the engines from becoming excessively cool.

When, as a result of extremely cold outside temperatures, or when the engines are started at frequent periods, even though there may not be a need for refrigeration, the enclosed space may become excessively cooled, and in fact, refrigerated below a safe lower limit. When this occurs, the driven member 350 operates the governor dog 352 for a sufficient distance to permit spring 522 to move the switching bar 516 to the right to an extent that switches 525 and 526 are closed, and the current to the solenoid 537, 539, it being understood that switches 522, 524 will already be in engagement with contacts 533 and 535.

When this occurs, both of the units will start up and in effect, will provide a means to break the circuit to the engine so that they will supply a heating medium to the enclosed space so as to bring the temperature of the latter within the predetermined limits. The circuit for the unit on the left will be traced when this condition arises: From-
tory 420, through conductor 555, switch 559, switch 560, contact 561, conductor 562, switch 428, conductor 563, switch 431, conductor 563, contact 492a, switch 491, conductor 492, switch 564, conductor 492, contact 565, the current flows from conductor 560 to contact 494a, switch 494, conductor 501, to the junction 570 and thence in one direction to lamp 468 and in the other direction to the junction 572 to energize the starting relay and the contact 570 to the manner previously described. Current will also flow from conductor 541 through the junction 542 to conductor 548, through junction 513 to conductor 512, and thence through contact 514, switch 512, conductor 513, switch 515, conductor 516, and thence through switch 524 to energize the induction coil 456 of the control device 290 and also illuminates lamp 467. Thus the unit on the left is started, but the refrigerant flow is reversed so that evaporator 198 of this unit becomes a heating heat exchanger. At the same time, the unit on the right is also started and the circuit is substantially the same as that previously described, except that power flows through different switches of the changeover switch and the thermostat. Commencing with input conductor 530, current flows through contact 499a and switch 499 to conductor 500a in one direction to illuminate lamp 469. At the same time, the current flows through switch 499b, contact 499b, conductor 500b to junction 507 and thence through conductor 551 to switch 552. From switch 552 the current flows through contact 497a, switch 497a, conductor 497a to contact 560 and thence through switch 524 to conduct 550. The starting of the engine occurs when the current flows from conductor 550 through contact 497a and switch 497a to switch 552. At the same time, reversal of valve 290a occurs when current flows from conductor 544 through the junction 545 to the conductor 549 which connects with conductor 514 at junction 516. Current flows through switch 548 and switch 492 to conductor 502 to energize the coil 456 in the same manner as coil 456.

When the enclosed space approaches its maximum temperature, switch 523 will break from contact 533 before switch 524 will break from contact 535 so that again the unit on the right will run for a slightly longer period of time than the unit on the left. However, the switches 525 and 536 will remain in engagement with contacts 537 and 539 and the unit on the left will cycle until the space temperature has risen sufficiently to permit switches 525 and 526 to engage with a snap action into engagement with contacts 536, 538.

In conjunction with the function of the lights 467, 468, 469, and their equivalent numbers 476a, 486a, and 496a, two lights will be mounted on each control panel 77 and 78 so that the condition of the units can be determined from either side of the car. Briefly, these conditions are that when lamps 469, 469a are illuminated, the unit is in a normal operating condition. When lamps 463, 469a are also illuminated, the respective units are operating on refrigeration cycle, and when in addition to the other lamps, lamps 467, 467a are illuminated, the units are either defrosting or are furnishing heat to the enclosed space.

Referring now to Fig. 38, is schematically shown a portion of the electrical control system used in conjunction with one of the units 100, but which is specifically adapted for controlling the movement of dampers 154, 155 and energizing an electric heater 151, disclosed in the patent applied for in Figs. 9-14. The major parts of the system, such as battery 420, starter generator 184, timer 436, thermostat 459, control valve 290, control device 610, and the control panel 164 and the heater 151 are shown. Timer 436 is adapted to move switch 611 into engagement with contacts 612, 613. An armature controlled switch 614 which is adapted to be energized by a holding circuit through contacts 616, 617 and when energized, is moved into engagement with contacts 618, 619. For energizing the control device 162, the heater 151 and the induction coil 456, a control device 616 and the timer 164 are shown. Timer 164 is adapted to close a pair of contacts 162, 161 and when moved, engages a pair of contacts 621, 622. A second switch 623 is adapted to engage a single pair of contacts 624, 625. The armature connected switches 618, 623 are adapted to move to their second positions when energized by a coil 626.

The conductors used in this system are essentially the same as that disclosed in the systems of Fig. 36, but since there is a different showing, new reference numerals are applied. Extending from battery 420 a conductor 631 extends to a broken line portion indicated at 632. The structure of reference numeral 632 includes a plurality of the control features of the prior circuits including means for energizing the starter generator 184. From the other side of the structure 632, a conductor 633 extends through a junction 634 to contacts 635. A conductor 637 extends from contact 612 to one side of switch 641, and contains two short branches, not designated, which extend to contacts 616 and 618. A conductor 638 extends from one side of switch 641 to the induction coil 615 and contains a short branch, not designated, to contact 619. A conductor 639 extends from contact 617 to the induction coil 626. A conductor 640 extends from junction 634 on conductor 633 to contact 624. A conductor 639 extends from one side of the generator 184 to contact 619 and contains a short branch extending to contact 631. A conductor 642 extends from contact 612 to the induction coil 630, whose other end is connected to ground. A short branch 641 extends from conductor 649 to contact 623. A conductor 642 extends from contact 623 to a booster coil 643 and the other end of the connector 641 is connected to ground. A conductor 645 extends from contact 622 to the heater 151, whose other end is connected to ground. A conductor 645 extends from the other end of the induction coil 456, whose other end extends to ground. The operation of the system of Fig. 38 will now be explained. When the starter generator 184 is energized and the engine is started, and means not shown, current will travel through conductor 639 to contact 619', through switch 613' to contact 620 and thence through conductor 640 to the induction coil 630 and thence to ground. Current will travel from conductor 649 through the branches 641 to contacts 628 and thence through switch 627 to contact 629 from whence it passes through conductor 642 to the booster coil 643 and thence to ground. When this occurs the two induction coils 630, 643 will move the armature downwardly to cause the linkage 164 to rotate the damper 154 from a closed position, as shown, to an open position to permit air to circulate through the ducts shown in Figs. 13 and 14. As soon as coils 630, 643 are energized, the switch 627 moves to an open circuit position with respect to contact 623, 629 to thereby de-energize the booster coil 643, but this does not de-energize the coil 630 and, therefore, the damper is held in an open position and the function of the booster coil 643 is merely to hold open the damper. Assuming now that the time has arrived for a defrosting operation, the timer 436 will move the switch 611 into engagement with contacts 613, 613 to establish a circuit from battery 420 through coil 615 which will be traced. From battery 420 through conductor 631 and the controlled portion 632, to conductor 633 and thence to contact 613, through said switch 611, to contact 612 and thence through conductor 635 and the short branch to contact 616. Current will flow from contacts 616 through switch 614, contact 617 to the coil 626 and thence to ground. When coil 626 is energized, the switches 618, 623 will be moved downwardly with switch 619' breaking the circuit from contact 619' to contact 620 and thence to the control device 162 and establishing a new circuit 21 between 612 and 611. Current through conductor 644 to the electric heater 151. Switch 623 will be brought into engagement with contacts 624, 625 to establish a circuit from conductor 633 through the junction 634 and conductor 626 to contacts 616, 617, 623, contact 625 and conductor 645 to the induction coil 456 of the reversing valve 290. When the heat of the hot gases passing through the evaporator affects the thermostat bulb 460 sufficient to close the thermostat switch 210, the circuit is established which extends from the conductor 633 to contact 613, switch 611, contact 612, conductor 635 to one side of switch 641 and thence from the other side of this switch, now in reverse, thence to contact 619, through the conductor 636 to the induction coil 615 and thence to ground. When coil 615 is energized, switch 614 breaks the circuit from contacts 616, 617 to the coil 626 and establishes a holding circuit through contacts 616, 619. The holding circuit, as explained briefly, is retained until the timer
2,686,086

436 has completed its cycle and moves the switch 611 away from contacts 612, 63. Referring now to Figs. 39-41, and particularly Fig. 39, general reference numeral 650 indicates a thermostat for operating the switching bar 516, shown in Fig. 37. A rod 610 is a driven member, but its outer end in engagement with the horizontal portion of the bellcrank lever 518. The inner end of rod 610 is secured to the inner sealed end of a bellows 651. Bellows 651 is attached to a casing 632 whose lower flanged portion 653 seals the open end of the bellows 651 to a plate 654 which forms the upper surface of bracket 520. Extending from the upper end of casing 632 and through the outer sides of a rod 610 is a conduit 656 whose other end is secured to one of a sealed and connected thermostat bulb 657. Bulb 657 is of substantial length and capacity and is surrounded by a plurality of fins 658. Within the bulb 657, conduit 656, and casing 632, and on the outer surface of bellows 651, is a liquid which constitutes the thermostatic medium and is a liquid having a relatively constant viscosity, such as kerosene or the like. The relationship of the size of bulb 657 and bellows 651 is critical in that there is a very large ratio between the size of bulb 657 and the diameter of bellows 651, so that a relatively slight increase or decrease of the volume of the thermostatic liquid will effect a substantial movement of the bellows, and through the bellows to the rod 610.

Extending from the center of 7 655 is a conduit 659 which is connected to a casing 660 in bellows 661 having a threaded rod 662 secured to its inner end. The outer end of casing 660 and bellows 661 are secured to a plate 663. Within bellows 661, in surrounding relationship to rod 662 and extending the length of the inner end of the bellows and plate 663 is a heavy coil spring 664. Surrounding plate 663 is a larger plate 665 which is spaced from plate 663 to form a slot in the plate 663 and 665 at 666. Mounted on the outer end of threaded rod 662 and shown in Fig. 40, is a control knob 667 which has secured thereto a spring pointer 668. The pointer 668 is adjustable in the grooved portion 669 of any plurality of adjustable stops 670, one of which is shown in cross section in Fig. 41 and consists of a lower portion 671 and an upper portion 672, which portions are secured with bolts 673.

Being a liquid filled thermostat, any change in volume of the liquid within the closed system will materially affect bellows 651 to cause movement which will move the switch 611 away from contacts 612, 63. In the event that the liquid within the system should expand to a considerable extent after having driven the bellows 651 and the driven member 610 to the full extent of its travel, it is desired to provide means for preventing such expanded liquid from entering the control switch. This is accomplished by a plurality of detents 675-677, which are all joined to a vertically extending control rod 684 which is secured to an upper control bracket 685 on one of the beams 93. Extending from the upper end of bracket 685 at its upper end is a lever 686 which is engageable in a plurality of stops 687 of the bracket structure 685.

The damper 661 is driven by a cam 688 which engages contacts 689-690. Referring to Figs. 49 and 50 as an actuator 691 is located on the rear panel 92 and is connected by a lead wire 692 to a point 693 on the switch 516.

The general operation of the invention will now be explained. When the thermostat 650 is not actuated by the control system, the actuator 691 is operated by the control system 894 so as to prevent air entering the chamber 90 through the opening 116 at the top of the panel 92.

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and include products that are packed in hermetically sealed containers.

Who provides the cooling devices to maintain there may be long periods when the blowers 191 are inactive, and the atmosphere within the cargo space under these conditions tends to stratify causing substantial variations in temperature throughout the height of the cargo chamber. The smaller fans 125 are used during the periods of inactivity of blowers 191 and serve to very gently circulate the air within the cargo space to maintain uniformity of temperature throughout and prevent stratifications. The fan 125 is operated by a battery supplied power under supervision of the voltage control device 475, and this device serves to prevent the fan motor from drawing power from the batteries to the extent that the batteries might be incapable of starting the engines.

In hauling a product from an extremely warm climate, or a product which may be high in moisture content, the precooling operation may cause considerable amounts of moisture to be collected on the evaporator coils, which is removed by defrosting, and the defrosting control device is under the supervision of a timer 436 and may be adjusted for varying intermittent periods of defrosting. The moisture removed may be either drained away as undesired water, or returned to the felt pads, and the latter may be removed from the vehicle by means of a blower 191 and a defrosting blower 193, and the latter are interconnected. During defrosting dampers 193 are closed to prevent the circulation of heated air. On occasions when the vehicle is traveling through a snow belt or another area where the temperature is below the freezing point, the heat exchangers to prevent the products from being frozen, and under these conditions the dampers 193 must remain open to heat the space. It should be clearly understood that during the heating cycle the equivalent is capable of furnishing a substantial amount of heat to the enclosed space, and sufficient to counteract heat losses to the environment atmosphere.

The advantages of my invention are numerous. Primarily, I believe that I have provided the first means of continuously transporting severely frozen foods entirely automatically. Each of said enclosures, each of said devices being adapted to be independently removable through one side of the car and include products that are packed in hermetically sealed containers. With either car there may be long periods when the blowers 191 are inactive, and the atmosphere within the cargo space under these conditions tends to stratify causing substantial variations in temperature throughout the height of the cargo chamber. The smaller fans 125 are used during the periods of inactivity of blowers 191 and serve to very gently circulate the air within the cargo space to maintain uniformity of temperature throughout and prevent stratifications. The fan 125 is operated by a battery supplied power under supervision of the voltage control device 475, and this device serves to prevent the fan motor from drawing power from the batteries to the extent that the batteries might be incapable of starting the engines.

In hauling a product from an extremely warm climate, or a product which may be high in moisture content, the precooling operation may cause considerable amounts of moisture to be collected on the evaporator coils, which is removed by defrosting, and the defrosting control device is under the supervision of a timer 436 and may be adjusted for varying intermittent periods of defrosting. The moisture removed may be either drained away as undesired water, or returned to the felt pads, and the latter may be removed from the vehicle by means of a blower 191 and a defrosting blower 193, and the latter are interconnected. During defrosting dampers 193 are closed to prevent the circulation of heated air. On occasions when the vehicle is traveling through a snow belt or another area where the temperature is below the freezing point, the heat exchangers to prevent the products from being frozen, and under these conditions the dampers 193 must remain open to heat the space. It should be clearly understood that during the heating cycle the equivalent is capable of furnishing a substantial amount of heat to the enclosed space, and sufficient to counteract heat losses to the environment atmosphere.

The advantages of my invention are numerous. Primarily, I believe that I have provided the first means of continuously transporting severely frozen foods entirely automatically. Each of said enclosures, each of said devices being adapted to be independently removable through one side of the car and include products that are packed in hermetically sealed containers. With either car there may be long periods when the blowers 191 are inactive, and the atmosphere within the cargo space under these conditions tends to stratify causing substantial variations in temperature throughout the height of the cargo chamber. The smaller fans 125 are used during the periods of inactivity of blowers 191 and serve to very gently circulate the air within the cargo space to maintain uniformity of temperature throughout and prevent stratifications. The fan 125 is operated by a battery supplied power under supervision of the voltage control device 475, and this device serves to prevent the fan motor from drawing power from the batteries to the extent that the batteries might be incapable of starting the engines.
a cargo chamber, two independent air conditioning units carried by said vehicle for controlling the temperature of the space within said vehicle, said units being adapted for independently operating, a motor driving said vehicle and adapted to operate when both of said units are inoperative, said units each having an electrically energizable circuit means including a battery for energizing said units, and a voltage control operably connected with said circuit for selectively connecting said fan motor with one of said batteries which contains the highest electrical potential.

8. In combination with a transport vehicle body, a cargo chamber within said body, a machinery compartment within said body and isolated from the cargo chamber, an air conditioning device within the machinery compartment including a casing, an engine within said casing, an independent duct supported above the casing for conducting heated gases from the engine, supporting means beneath the casing including a stationary portion and a mobile portion, means for elevating the mobile portion relative to the stationary portion, and a connection between said mobile portion and the duct for raising the latter when the mobile portion is elevated.

9. In combination with a transport vehicle body embodying top, bottom, side and end walls, a product chamber on the said body and supported in spaced relation to the several walls of said body, a machinery compartment within the vehicle body formed with insulated walls which isolate the space surrounding the product chamber, one wall of said machinery compartment having an opening communicating with the space surrounding the product chamber, one wall of the vehicle body having an opening communicating with the machinery compartment, a mechanical air conditioning device, comprising an operating portion and a heat exchange portion carried within the machinery compartment with the heat exchange portion extending through the first named opening in the machinery compartment wall and in heat exchange relationship with the space surrounding the chamber, and a mobile support mounted within the machinery compartment and supporting said air conditioning device for movement through the opening in the vehicle body whereby the air conditioning device is adapted for bodily removal and insertion as a unit relative to the machinery compartment.

10. In combination with a transport vehicle body embodying top, bottom, side and end walls, a product chamber on the said body and supported in spaced relation to the several walls of said body, a machinery compartment within the vehicle body formed with insulated walls which isolate the same from the space surrounding the product chamber, the wall of said machinery compartment including an opening communicating with the space surrounding the product chamber, one wall of the vehicle body having an opening communicating with the machinery compartment, a mechanical air conditioning device, comprising an operating portion and a heat exchange portion carried within the machinery compartment with the heat exchange portion extending through the first named opening in the machinery compartment wall and in heat exchange relationship with the space surrounding the chamber, supporting means secured within the machinery compartment including a stationary member and a mobile member supported on the stationary member, said mobile member being adapted to support said air conditioning device for movement relative to the openings in said compartment, driving means connected to the mobile member for moving said member in one plane relative to the stationary member, a closure carried by the vehicle body for closing the operating portion in the vehicle body wall, and a connection between said last named means and said closure for moving said closure when the mobile supporting member is moved in said one plane.

11. A transport vehicle embodying a body formed of top, bottom, side and end walls, at least one layer of thermal insulation within the body forming an enclosed space which is thermally isolated from the body walls, an air conditioning device carried by the body and positioned within the enclosed space, a product chamber supported within the thermally enclosed space and spaced from all portions of the thermal insulation to form a passage surrounding the chamber, an air conditioning device carried by the body and said passage, a fan supported in said passage for circulating the air in said passage in heat exchange relationship with said air conditioning means, driving means carried by the body exterior to the enclosed space and operatively connected to the air conditioning device and the fan for simultaneously operating the device and the fan, said last named means being intermittently operable, said product chamber having an outlet opening and an inlet opening communicating with said passage, and a second fan carried by the body and operatively associated with one of said openings for circulating air relative to the product chamber when the first named fan is inoperative, said second fan being operatively independent of said last named means.

12. A transport vehicle embodying a body formed of top, bottom, side and end walls, at least one layer of thermal insulation within the body forming an enclosed space which is thermally isolated from the body walls, a product chamber supported within the thermally enclosed space and spaced from all portions of the thermal insulation to form a passage surrounding the chamber, an air conditioning device carried by the vehicle body and said passage, a fan supported in said passage for circulating the air in said passage in heat exchange relationship with said air conditioning means, driving means carried by the body exterior to the enclosed space and operatively connected to the air conditioning device and the fan for simultaneously operating the device and the fan, said last named means being intermittently operable, said product chamber having an outlet opening and an inlet opening communicating with said passage, and a second fan carried by the body and operatively associated with one of said openings for circulating air relative to the product chamber when the first named fan is inoperative, said second fan being operatively independent of said last named means.

13. A transport vehicle embodying a body formed of top, bottom, side and end walls, at least one layer of thermal insulation within the body forming an enclosed space which is thermally isolated from the body walls, a product chamber supported within the thermally enclosed space and spaced from all portions of the thermal insulation to form a passage surrounding the chamber, an air conditioning device carried by the body and said passage, a fan supported in said passage for circulating the air in said passage in heat exchange relationship with said air conditioning means, driving means carried by the body exterior to the enclosed space and operatively connected to the air conditioning device and the fan for simultaneously operating the device and the fan, said last named means being intermittently operable, said product chamber having an outlet opening and an inlet opening communicating with said passage, and a second fan carried by the body and operatively associated with one of said openings for circulating air relative to the product chamber when the first named fan is inoperative, said second fan being operatively independent of said last named means.

14. A transport vehicle embodying an enclosed thermally isolated space, a machinery compartment within said space, a mechanical air conditioning device including an air conditioning portion normally located in the isolated space and an operating portion normally located in the machinery compartment, a mechanical device comprising an internal combustion engine, a duct carried within the machinery compartment and extending through an outer wall of the compartment for conducting heated air from the engine out of the machinery compartment, said duct having an opening intermediate its opposite ends communicating with the machinery compartment, a movable damper in said duct adjacent said opening which when in a first position effects passage of heated air in the direction of the operating portion, and thermostatic means carried by said duct and operably connected to said damper for controlling the movement thereof, wherefore heat of the engine is exhausted to outside or returned to the machinery compartment to maintain the engine in a heated condition.

15. A transport vehicle embodying a thermally isolated space within the interior of the vehicle, a compartment formed within said vehicle on one end thereof and which is exterior to the isolated space, said compartment having a first opening extending through the vehicle and a second opening extending into the isolated space, a unitary air conditioning device comprising a mechanical device being adapted to be inserted through said first opening with the mechanical portion wholly contained within the compartment and the heat exchange portion extending into the isolated space, means for supporting said device within the compartment comprising a stationary member, a movable member supported on the stationary member and adapted
for movement relative to the stationary member through the first named opening in the vehicle body, said movable portion being adapted to receive the machinery portion of the device, resilient means carried by the movable portion and forming a casing surrounding said portion of the device, a pair of brace rods connected at one end to the stationary member and extending vertically on either side of the casing and extending through the opening incorporating said portion of the device, resilient means between said last named means and the device, and resilient means carried by the vehicle situated on the second opening of the vehicle including a stationary member, a frame carried by the stationary member and adapted to receive the base portion of the machinery casing, resilient means carried by the frame forming a cushion which supports the base portion of the casing, a pair of tie rods secured at one end to the stationary member and extending vertically therefrom on either side of the casing, means secured to the other end of the tie rods normal holding the casing in engagement with the resilient means and the frame to thereby hold the machinery portion in a secure but shock resisting relationship with the vehicle.

20. In combination with a transport vehicle, a mechanical air conditioning device including a casing portion, a casing surrounding and supporting the machinery portion, of means for supporting the machinery portion on the vehicle including a stationary member, a frame carried by the stationary member and adapted to receive the base portion of the machinery casing, resilient means carried by the frame forming a cushion which supports the base portion of the casing, a pair of tie rods secured at one end to the stationary member and extending vertically therefrom on either side of the casing, means secured to the other end of the tie rods normally holding the casing in engagement with the resilient means and the frame to thereby hold the machinery portion in a secure but shock resisting relationship with the vehicle.

21. In combination with a transport vehicle embodying a cargo chamber, a mechanical air conditioning unit carried by the body including a heat exchange portion within the cargo chamber including an internal combustion engine carried by the body exterior to the cargo chamber, a starting motor operatively connected to the engine carried by the body and responsive to the temperature within the cargo chamber, a second thermostat means carried by the machinery portion and responsive to engine temperature, a first circuit operatively connecting said first thermostat means and the starting motor for energizing the motor when the temperature within the cargo chamber varies from a predetermined temperature, and a second circuit including means responsive to engine temperature and a portion of the first circuit for energizing said motor when the temperature of the engine descends below a predetermined temperature.

22. In combination with a transport vehicle embodying a cargo chamber, two independent air conditioning devices carried by the vehicle, each including an air conditioning portion within the cargo chamber and a machinery portion exterior to the chamber, and comprising a compressor, an engine connected to the compressor, a starting motor operatively connected to the engine, and an ignition system operatively connecting the engine, a pair of parallel circuits operatively connecting the starting motor and ignition system of each of the engines, a thermostat means responsive to engine temperature within the cargo chamber and being operable to initially energize both of said circuits and thereafter sequentially de-energize said circuits whereby the space temperature is normally maintained by only one of said devices, and a two position change over switch adapted for connection to either of said circuits and when closed with respect to one of said circuits selects the respective device as the operating device.

23. A transport vehicle embodying a body formed of top, bottom, side and end walls, at least one layer of thermal insulation within the body forming an enclosed space which is thermally isolated from the body walls, an air conditioning device carried by the body and positioned in the isolated space, a partition within the isolated space and with the thermal walls forming a compartment within the isolated space, said partition having an opening therefor in forming an air inlet from the space to the compartment, a duct within the isolated space forming communication between the compartments and the remaining unpartitioned isolated space for discharging air from the compartment to the space, a first fan within the compartment for driving air from the compartment into the duct, driving means exterior to the compartment for operating said fan, said driving means operatively connected to the air conditioning device and said first fan for intermittently operating the fan and the air conditioning device, and a second fan in said compartment and operatively connected to said driving means for circulating air throughout said duct when said first named fan is inoperative, said second fan being operatively independent of the driving means.

24. A transport vehicle embodying a body formed of top, bottom, side and end walls, at least one layer of
thermal insulation within the body forming an enclosed space which is thermally isolated from the body walls, a partition within the one layer of thermal insulation and a portion of the thermal insulation forming a compartment within the isolated space, an air conditioning unit carried within said compartment, said partition having an opening therein for air inlet between the partition and said part of the thermal insulation forming the compartment, a duct extending from one side of the air conditioning unit into the isolated space for returning air to the isolated space, a first fan operatively associated with the conditioning means for driving air through said duct into the isolated space, said duct having an opening therein between its opposite ends, a second fan supported on the vehicle on the opposite side of said last named opening and being effective to circulate air between the compartment and the isolated space when said first named fan is inoperative, a first damper within the interior of the duct adjacent the air conditioning device, a second damper carried by the duct on one side of said second fan, a solenoid operator connected to one of said dampers, a linkage connected between said last named damper and the other damper and being operative to close one of the dampers when the other damper is open, and circuit means operatively connected to said solenoid operator and responsive to a condition of the air conditioning unit for operating said solenoid operator.

25. A transport vehicle, comprising a body formed of top, bottom, side and end walls, an insulating wall composed of at least one layer of thermal insulation within the interior of the body and forming an enclosed space which is thermally isolated from each of the body walls, a cargo chamber supported within the thermally enclosed space composed of five walls formed of material having a low thermal drop therebetween, said cargo chamber being disposed on one side of said cargo chamber, and a damper operatively associated with each of said opened openings and movable between open and closed positions with respect thereto to provide controlled communication between the cargo chamber and the interior of said cargo chamber, whereby when air is circulated in said enclosed space and the dampers are in an open position, said dampers direct a portion of the circulating air in spaced paths turbulent through the interior of the chamber, and when closed said dampers permit the circulating air within the integral duct to form an envelope surrounding the cargo chamber.

26. A transport vehicle, comprising a body formed of top, bottom, side and end walls, an insulating wall composed of at least one layer of thermal insulation within the interior of the body and forming an enclosed space which is thermally isolated from each of the body walls, a cargo chamber supported within the thermally enclosed space composed of five walls formed of material having a low thermal drop therebetween, said cargo chamber being open on one side, an integral air duct formed within the enclosed space adjacent one wall of the cargo chamber and disposed to form a low pressure zone across said wall and the open side of said chamber and a high pressure zone about the four remaining walls of said chamber, one of said four remaining chamber walls having a series of spaced openings therein forming communication between the high pressure zone of said air duct and the interior of the enclosed space, and a damper operatively associated with each of said opened openings and movable between open and closed positions with respect thereto to provide controlled communication between the high pressure zone of said air duct and the interior of said cargo chamber, whereby when the dampers are in an open position, said dampers permit air from the high pressure zone of said air duct to enter the interior of said cargo chamber and when closed said dampers permit the circulating air within the integral duct to form an envelope surrounding the cargo chamber.

27. A transport vehicle, comprising a body formed of top, bottom, side and end walls, an insulating wall composed of at least one layer of thermal insulation within the interior of the body and forming an enclosed space which is thermally isolated from each of the body walls, a cargo chamber supported within the thermally enclosed space composed of five walls formed of material having a low thermal drop therebetween, said cargo chamber being open on one side, an integral air duct formed within the enclosed space adjacent one wall of the cargo chamber and disposed to form a low pressure zone across said wall and the open side of said chamber and a high pressure zone about the four remaining walls of said chamber, one of said four remaining chamber walls having a series of spaced openings therein forming communication between the high pressure zone of said air duct and the interior of the enclosed space, and a damper operatively associated with each of said opened openings and movable between open and closed positions with respect thereto to provide controlled communication between the high pressure zone of said air duct and the interior of said cargo chamber, whereby when the dampers are in an open position, said dampers permit air from the high pressure zone of said air duct to enter the interior of said cargo chamber and when closed said dampers permit the circulating air within the integral duct to form an envelope surrounding the cargo chamber.

28. A transport vehicle, comprising a body formed of top, bottom, side and end walls, an insulating wall composed of at least one layer of thermal insulation within the interior of the body and forming an enclosed space which is thermally isolated from each of the body walls, a cargo chamber supported within the thermally enclosed space composed of five walls formed of material having a low thermal drop therebetween, said cargo chamber being open on one side, an integral air duct formed within the enclosed space adjacent one wall of the cargo chamber and disposed to form a low pressure zone across said wall and the open side of said chamber and a high pressure zone about the four remaining walls of said chamber, one of said four remaining chamber walls having a series of spaced openings therein forming communication between the high pressure zone of said air duct and the interior of the enclosed space, and a damper operatively associated with each of said opened openings and movable between open and closed positions with respect thereto to provide controlled communication between the high pressure zone of said air duct and the interior of said cargo chamber, whereby when the dampers are in an open position, said dampers permit air from the high pressure zone of said air duct to enter the interior of said cargo chamber and when closed said dampers permit the circulating air within the integral duct to form an envelope surrounding the cargo chamber.
temperature by thermal transfer through the surfaces of the enclosure.

30. A method of precooling and refrigerating perishable products in transit, comprising loading the products within an enclosure composed of material having a low thermal drop therethrough, and which is open on one side, forming a confined body of air which is isolated from ambient atmosphere and which envelopes the enclosed load, circulating the confined body of air in heat exchange relationship with a refrigerant exterior to the enclosure to effect cooling of the confined body of air, continuously passing a portion of the refrigerated air through the enclosure for the remainder of the transit period while continuing the circulation of the cooled air exterior to the enclosure and across the open side thereof when the temperature of the circulated air is above a predetermined minimum temperature to maintain an envelope of cooled air within the confined space in contact with the outer surfaces of the enclosure and partially in contact with the atmosphere within the enclosure to maintain the products at reduced temperature by thermal transfer through the surfaces of the enclosure and by interchange of air across the open side thereof.

31. A method of preserving fresh perishable food products in transit, comprising loading the products in an enclosure whose surfaces are composed of material having a low thermal drop therethrough and which envelops the enclosed load, circulating the confined body of air that envelopes the enclosure and is substantially isolated from heat exchange with ambient atmosphere, forcibly circulating the confined body of air in heat exchange relationship with a refrigerant exterior to the enclosure to reduce the temperature thereof and cool the enclosure, passing a portion of the circulated air in short circuit paths through the interior of the enclosure to the heat exchanger and thence in contact with the refrigerant heat exchanger for one continuous period during initial stages of transit to refrigerate the products and transfer moisture from the interior of the enclosure to the heat exchanger and prevent its subsequent deposition within the interior of the enclosure, and thereafter permanently terminating the short circuiting of the circulated air through the interior of the enclosure for the remainder of the transit period to minimize contact between the products and the circulated air, while continuously circulating the confined body of air that envelopes the enclosure in heat exchange relationship with the heat exchanger when the temperature of the circulated air is above a predetermined minimum temperature, to reduce the temperature of the circulated air to at least the temperature of the frozen foods and concurrently reduce the moisture content of the air, passing a portion of the refrigerated circulated air in short circuit paths through the interior of the enclosure in contact with the products and thence in contact with the refrigerant heat exchanger for one continuous period during initial stages of transit to transfer moisture from the interior of the enclosure to the heat exchanger and prevent its subsequent deposition within the interior of the enclosure, and thereafter permanently terminating the short circuiting of the circulated air through the interior of the enclosure for the remainder of the transit period to minimize contact between the products and the circulated air, while continuously circulating the confined body of air that envelopes the enclosure in heat exchange relationship with the refrigerant heat exchanger when the temperature of the circulated air is above a predetermined minimum temperature to reduce the temperature of the circulated air to at least the temperature of the frozen foods and concurrently reduce the moisture content of the air, passing a portion of the refrigerated

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