Dec. 22, 1936. E. A. SWEELEY ET AL 2,065,251

HEATING APPARATUS

Filed Nov. 15, 1935 3 Sheets-Sheet 1

Fig. 1

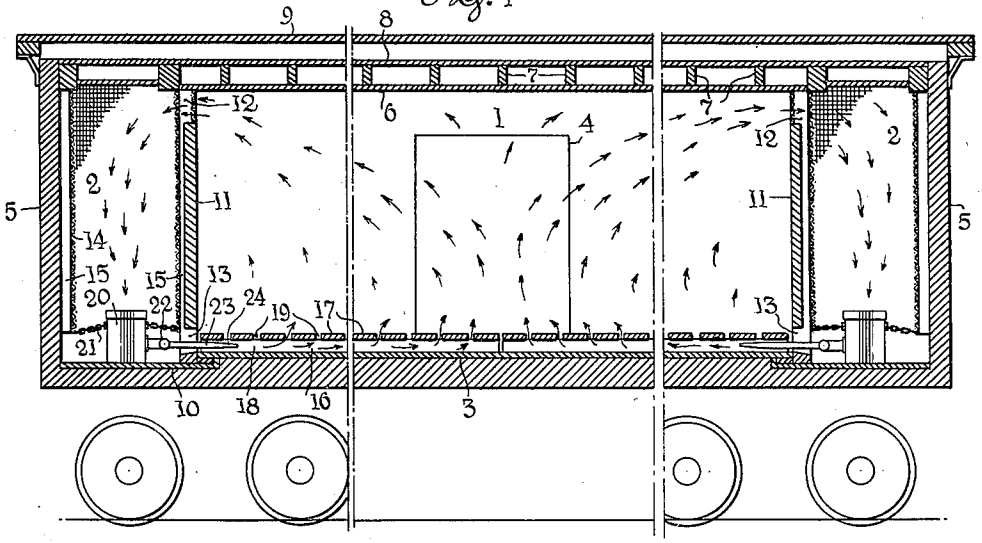


Fig. 2

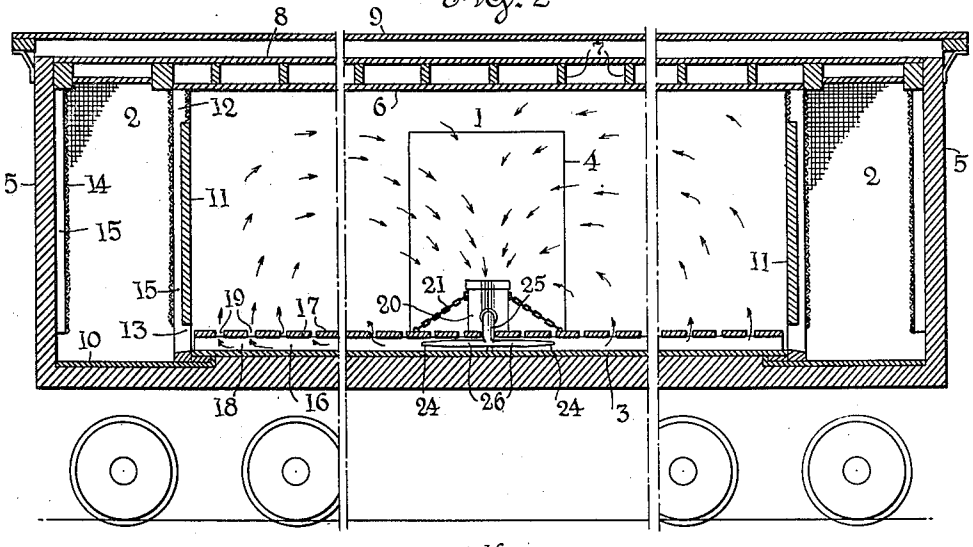


Fig. 3

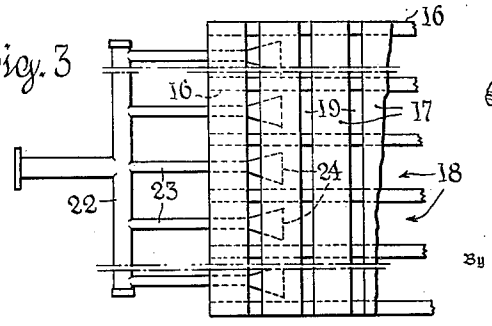


Fig. 4



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HEATING APPARATUS

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Fig. 5

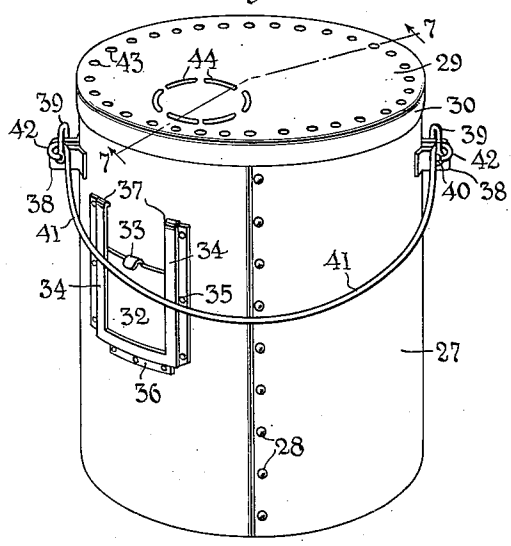


Fig. 6

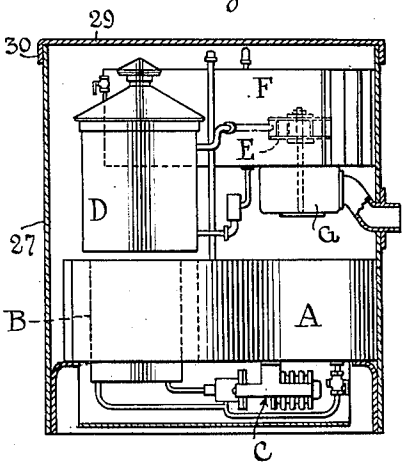


Fig. 7

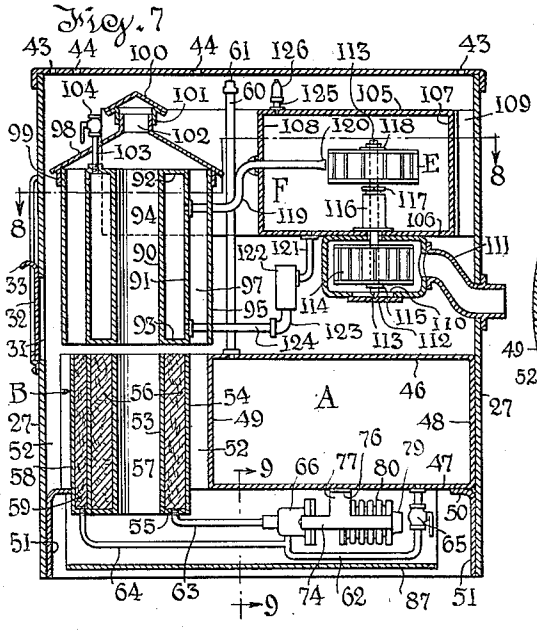


Fig. 8

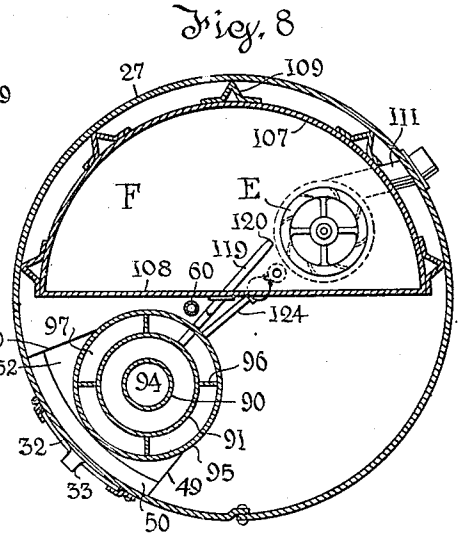
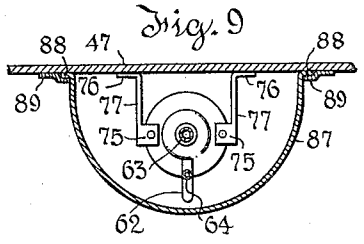


Fig. 9



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Fig. 10

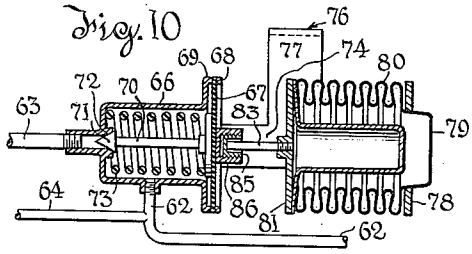


Fig. 11

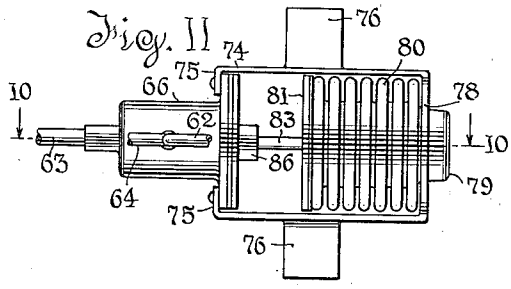


Fig. 12

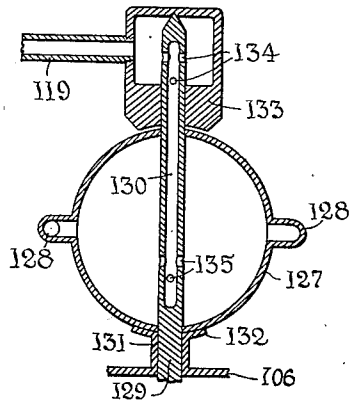


Fig. 13

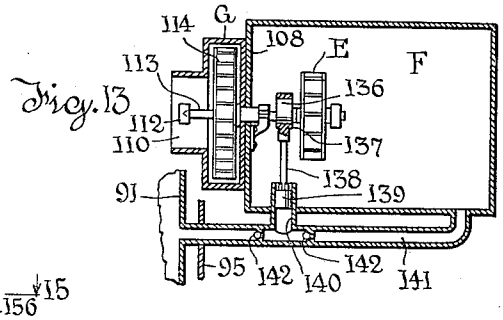


Fig. 14

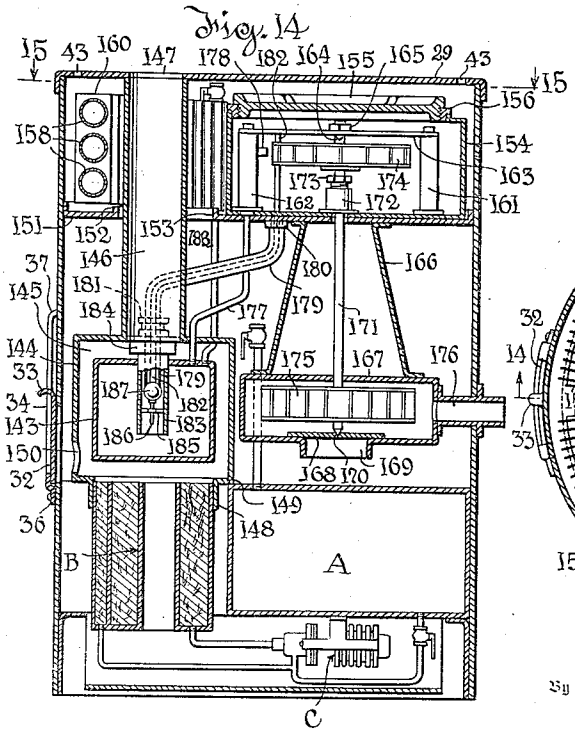
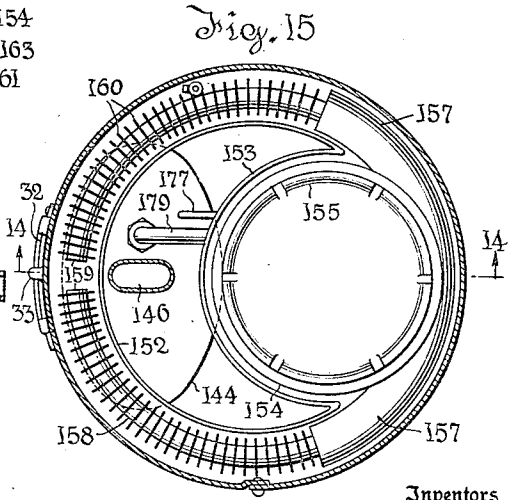


Fig. 15



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Patented Dec. 22, 1936

2,065,251

UNITED STATES PATENT OFFICE

2,065,251

HEATING APPARATUS

Edward A. Sweeley and Ralph Killingstad, Alexandria, Va., assignors to Fruit Growers Express Company, a corporation of Delaware

Application November 15, 1935, Serial No. 50,052

17 Claims. (Cl. 237—28)

This invention relates to heating apparatus, and more particularly to a heating device for use in heating storage chambers to protect stored or transportation loads of fruits and other perishable commodities against injury or damage due to freezing or undesired low temperatures.

While the heating system of this invention is especially suited to the heating requirements of railway refrigerator cars, it is obviously adapted for other uses and purposes, and may be employed for heating cars, trucks, ships, and storage houses, generally.

During periods of cold and freezing weather, refrigerator cars are usually provided with heaters to maintain the air in the merchandise or lading chambers at such temperature as will insure the desired protection to the shipment of perishable commodities. The heaters of the prior art, however, are open to the serious objection that they do not maintain all parts of the lading chamber at substantially the same temperature or at the desired temperature. In many instances, this objectionable feature is principally due to the fact the heaters depend on natural circulation and draft for the air which warms the chamber. With such practice, the circulation of air is relatively slow, and the air is much warmer adjacent the ceiling than near the floor, since the warmest, and therefore lightest, air rises to the top of the room and gradually forces the colder (and heavier) air downwardly. As a result, in an effort to warm the lower part of the shipment to the minimum permissible temperature, the part of the lading just below the ceiling has frequently been raised to a temperature in excess of the maximum permissible temperature. Accordingly, the upper part of the shipment often suffered injury and damage from overheating.

It is, therefore, an object of this invention to provide a heating arrangement which will avoid overheating of any part of the shipment, as for example, the upper part.

It is also an object of this invention to provide a heater which will draw air, positively, from the upper part of the chamber being heated, and expel the air in heated condition adjacent the floor level.

The invention also has for its object the provision of a heater which will convert part of the heat energy produced in heating the air into mechanical energy for operating an element to produce a forced circulation of air through the heater.

A further object of the invention is to provide a railway refrigerator car with a heater that will draw air from the upper part of the lading chamber into the heater, and forcibly expel the air in a heated condition from the heater, and into the space below the apertured false floor deck of the lading chamber, so that the heated air will be distributed along the length of the chamber and then rise through the apertured deck and the shipment.

Another object is the provision of novel means for operating the air-circulating fan or blower of a heater.

Another object is to provide a compact and self-contained heater unit for heating and mechanically circulating the air passing through the heater.

It is also an object to provide automatic means for controlling the operation of the heater, so that it will supply heated air as required to maintain desired temperature conditions.

Another object is the provision of an improved steam generator and condenser system for an air heater.

A further object is to generally improve the construction of air heaters.

Other objects and advantages will be apparent from the following detailed description of the preferred embodiments of the invention.

In the accompanying drawings,

Figure 1 is a vertical longitudinal section through a railway refrigerator car, showing the improved heater as applied in the ice bunker space of the car;

Figure 2 is a vertical longitudinal section through a railway refrigierator car, showing the improved heater in the lading space;

Figure 3 is a top plan view on enlarged scale of a detail of Figure 1.

Figure 4 is a perspective view of one of the fan-shaped air outlets shown in Figures 1 to 3;

Figure 5 is a perspective exterior view on enlarged scale of the heater shown in Figures 1 and 2;

Figure 6 is a view in elevation of the heater shown in Figure 5 with part of the casing removed.

Figure 7 is a cross sectional view taken on lines 7—7 of Figure 5.

Figure 8 is a cross sectional view taken on line 8—8 of Figure 7.

Figure 9 is a view partly in cross section taken on line 9—9 of Figure 7.

Figure 10 is a vertical cross sectional view taken on line 10—10 of Figure 11.

Figure 11 is a bottom plan view of the thermostat shown in Figures 6, 7, 9 and 10.

Figure 12 is a vertical cross sectional view of a modified form of drive for the blower shown in Figure 7.

Figure 13 is a vertical cross sectional view of a modified detail for the heater shown in Figures 6 to 8.

Figure 14 is a vertical cross sectional view of a modified form of heater, and is taken on line 14—14 of Figure 15.

Figure 15 is a cross sectional view taken on lines 15—15 of Figure 14.

Referring now to the drawings, Figures 1 and 2 illustrate the invention as applied to a railway refrigerator car of conventional construction.

The car has the usual loading space or merchandise chamber 1, ice chambers or bunkers 2 at each end, floor 3, and doorway shown in outline at 4. The car also has the usual end walls 5, ceiling 6, roof carlines 7, outside roof 8, and outside top running board 9. The floor, side walls and roof of the car may be insulated according to standard practice (not shown).

The floor 10 of the ice chambers 2 is at a lower level than the car floor 3, so that any water collecting on the latter may drain into the ice chambers 2.

The insulated bulkheads or partitions 11 separating the ice chambers 2 and loading space 1 are provided with top and bottom openings 12, 13 to permit air circulation between the two chambers.

In order to provide for circulation of air at the four sides of the ice chamber, screens 14 are spaced from the walls of the ice chamber by means of spacer posts (not shown) to provide vertical air channels 15.

Floor stringers 16 and slats 17 constitute a floor deck, raised somewhat above the car floor, for supporting the lading, which deck may be removably or permanently secured in place. The stringers are spaced apart transversely of the car, and together with the car floor 3 form a plurality of parallel channels 18 extending longitudinally of the car and from bulkhead to bulkhead. The slats 17 are positioned transversely of the stringers 16 and spaced apart to provide slots or apertures 19. It will, therefore, be seen that air may circulate through and along the channels 18 formed by the stringers and floor, and that air may also pass from the channel spaces 18 into the merchandise chamber by way of the slots or apertures 19.

According to this invention, the heater 20 when in use may be positioned in the ice chamber 2 (see Figure 1), which is the generally accepted practice, or in the lading space 1 (see Figure 2). In either case, the heater 20 is suitably anchored to the car by means of chains 21, or other appropriate securing means.

When the heater 20 is placed on the floor of the ice chamber, as in Figure 1, its heated air outlet (described later) may be connected to a manifold 22 provided with branches 23, each preferably having a flared or fan-shaped end 24. The branches 23 may project through the bottom opening 13 of the bulkhead 11, and each flared end 24 is disposed in one of the air channels 18 formed between adjacent stringers 16 (see Figure 3). The heater will circulate air through the car by forcing heated air into the manifold 22, and thence through the branches 23 and flared ends 24 into the air channels 18. The heater is provided with means (described hereinafter) for forcing the air into the manifold, so that when it enters the air channels 18 it will be distributed along the length of same, while the flared ends 24 assist the air in spreading laterally along the channels 18. Thus, heated air will be distributed in all directions beneath the floor deck, and the openings 19 will permit the heated or warmed air to rise throughout the entire floor area of the lading chamber. This heated air, due to its low density, rises toward the ceiling and in so doing circulates through and around the entire cargo. As the air nears the ceiling, it is drawn into the ice chambers by way of bulkhead openings 12 and then downwardly into the heater (for recirculation) by the same means (referred to above and described hereinafter) which expels the air from the heater and into the manifold 22.

A heater 20 may be placed in each ice chamber if desired (as shown in Figure 1) and the course taken by the circulated air, when two heaters are used, is shown by the arrows in Figure 1.

If the heater 20 is placed on top of the slats 17 in the lading space, as shown in Figure 2, the heated air is delivered from the heater by way of pipe 25, and a pair of distributor ducts 26 projecting in opposite directions from pipe 25, positioned as within one of the channels 18. In order that the air will spread laterally as within channel 18, as well as move longitudinally thereof, each duct 26 is preferably provided with a flared end 24. From the space under rack slats 17, in which the ducts 26 are positioned, the air rises through the spaces or openings 19 between the slats 17 and circulates through the cargo on its upward path toward the ceiling. As this air approaches and moves along the ceiling, it reaches the zone of down draft created by the heater, and is then drawn downwardly into the heater for recirculation. The course taken by air during circulation, in the practice of this modification, is shown by the arrows in Figure 2. When the heater is positioned in the lading space during use, the top and bottom bulkhead openings 12, 13 may be covered, if desired, by suitable closures (not shown). The bulkhead openings, however, need not be closed.

In practicing the modifications shown in either Figures 1 or 2, one or more distributor ducts 26 or branches 23 may be used. For example, the heater 20 may supply heated air, under forced circulation, into each air channel 18 as shown in Figures 1 and 3, or into only one channel, as shown in Figure 2. Other suitable arrangements of air conducting pipes may be used, and any arrangement is suitable that produces a general distribution of the heated air along the floor of the car. Where only one channel 18 receives air directly as in Figure 2, part of this air will find its way into other channels before it ascends into contact with the cargo, as the air may pass from channel to channel by moving along the slots 19 when solid type stringers 16 are used.

As shown in Figure 5, the heater 20 is constructed with a casing 27, formed by bending sheet metal or other suitable material into cylindrical shape and securing the edges together with rivets 28, or by other suitable means. The top of the casing is provided with a removable cover 29 having a depending flange 30.

A cut-out portion or opening 31 in the casing 27 is adapted to be closed by a sliding door 32 having a handle operating member 33. The door is slidably mounted in vertical bent strips 34, riveted at 35 (or otherwise secured) to the casing.

Horizontal strip 36, also secured to the casing, provides a bottom rest for the door, while inwardly bent ends 37 of strips 33 limit the upward movement of the door when uncovering the opening 31.

A handle 41, for carrying the heater, has its ends 42 bent to form eye sections, through which straps 39 pass. Clips 38, secured to the casing 27, are connected to the U-shaped straps 39 by means of pins 40.

Openings 43 in the cover provide entrance for air to the heater, while slots 44 permit the escape of products of combustion coming from burners (described hereinafter).

Figure 6 shows the general arrangement of the apparatus within the casing 27. A fuel tank A is located in the lower part of the casing, and supplies fuel to the burner B, the flow of fuel being regulated by a thermostat C. In the upper part of the casing, there is positioned a boiler D, to be heated by burner B, and supplying steam for operating a turbine E, mounted within a condenser F. A blower casing G, supported below the condenser F, houses a rotary fan or blower (see Figure 7) that is driven by the turbine E.

The details of the apparatus illustrated in Figure 6 are shown in Figures 7 to 11 and will now be described.

Referring to Figure 7, the fuel tank A is formed of top 46, bottom 47, and side walls 48, 49. The tank side wall 48 conforms to the shape of heater casing 27 to fit tightly therein, while the tank bottom 47 rests upon the horizontal inturned flange 50 of a supporting ring 51 suitably secured to the casing 27, as by riveting or bolting (not shown).

The burner B is mounted within the opening left between the tank side wall 49 and the heater casing 27 and is preferably spaced from them to provide an outer air passage 52 surrounding the burner. In order that the burner may utilize all of the fuel from the tank A, it preferably has its bottom at a somewhat lower level than the tank bottom, as shown in Figures 6 and 7. The burner is preferably of the annular type, being provided with inner and outer shells 53, 54 and a ring-shaped bottom 55 to form an annular chamber for the main burner wick 56 and a central flue space 57.

At the outer periphery of the burner, there is a chamber 58, of circular, triangular or other suitable shape, containing a pilot wick 59.

Tank A may be filled through pipe 60 (see Figures 7 and 8), the latter having a cap 61. Any suitable fluid fuel, such as alcohol may be used. During operation of the heater, tank A supplies this fuel to the chamber holding the burner wick 56 through pipes 62 and 63, and to chamber 58 containing the pilot wick 59 through pipes 62, 64. A manually operable valve 65 (of conventional design) in pipe 62 enables the operator to stop the flow of fuel from the tank A when the heater is not in use.

During operation of the heater, the valve 65 is set in the open position, and the pilot wick 59 is constantly supplied, through pipes 62 and 64, with sufficient fuel to maintain a small pilot light adjacent the top of the burner 51. By raising the door 32, access may be had to the pilot wick 59 for its igniting, or for extinguishing the pilot flame.

As shown in detail in Figures 10 and 11, the thermostat assembly C is provided with a valve housing 66, connected to the ends of pipes 62 and 63, so that fuel may flow into the housing from pipe 62 and leave by way of pipe 63. At one end of the valve housing, a flexible diaphragm 67 is held in place by a ring 68 and lip 69 projecting from the housing. The diaphragm 67 carries, at one side, a valve stem 70, having a valve member 71 which, in the closed position, abuts a valve seat 72, as shown in Figure 10, to stop the flow of fuel into the pipe 63. A spring 73, encircling the valve stem 70, and positioned between the collar of valve stem 70 and the opposite end of the valve housing 66, tends to move the diaphragm to unseat the valve member 71 to permit flow of fuel to burner wick 56 by way of pipe 63.

The thermostat assembly C is suitably supported in position below the fuel tank A. In the drawings, the support is shown as formed from a single piece of metal to provide a ring 78, horizontal members 74, branches 77, flanges 76 and bent portions 75 (see Figs. 9 to 11). This support is secured to the tank bottom 47 (see Figure 9) by means of its flanges 76 and to the valve housing 66 by means of the bent portions 75. The stationary ring 78 is suitably apertured to receive the head 79 of a bellows 80. The opposite end of the bellows 80 is movable and carries a plate 81. A stem 83 extends between the movable end of bellows 80 and the diaphragm 67. At one end, the stem 83 is secured to the plate 81 so as to move therewith, while at its other end, the stem 83 is fitted into a cup-shaped member 85 having threaded engagement within a sleeve 86, mounted on the diaphragm 67.

The bellows 80 contains an expansible fluid, (preferably a gas) which, when heated, expands to force the stem 83 carried by plate 81 against diaphragm 67. The latter then moves against the action of spring 73 to seat the valve member 71, as shown in Figure 10. When the bellows collapses, due to contraction of its fluid on cooling, the bellows 80 moves to release stem 83. Then spring 73 will move the diaphragm 67 and the valve stem 70, to unseat the valve member 71.

The screw threaded engagement between the member 85 and sleeve 86 provides an adjustment for changing the travel of the stem 83 in opening and closing the fuel supply valve, so that the thermostat may be thereby regulated to operate at predetermined temperatures.

It will now be seen that when the temperature of the air in the lower part of the heater falls below a predetermined minimum temperature, the thermostat will automatically operate to permit the flow of fuel to burner wick 56, and that it will be ignited by the pilot light. When the temperature in the lower part of the heater rises above a maximum desired temperature, the thermostat will either cut off or appropriately reduce the flow of fuel to the burner wick 56, in order to maintain a desired temperature.

The thermostat may be placed in the lower end of the heater, which is closer to the car floor, so it will respond to temperatures prevailing adjacent the car floor. The thermostat will therefore respond to the temperature of a cold part of the car, and will insure that all parts of the lading space are kept above a minimum low temperature.

In order to protect the thermostat assembly, there is provided, as shown in Figure 9, a removable, flexible, cover 87 having flanged edges 88, which are received in grooves formed by bent strips 89 and tank bottom 47, to which strips 89 are secured. When it is desired to adjust or repair the thermostat, the cover 87 may be removed

by forcing the sides together so that its edges 88 will move out of engagement with strips 89.

As shown in Figures 7 and 8, the boiler D is constructed with an annular boiler chamber, formed of inner and outer shells 90, 91, and ring-shaped end walls 92, 93, providing a central flue space 94. An outer casing 95 is spaced from shell 91 by means of spreaders 96 (see Figure 8), so as to provide an outer flue space 97, surrounding the boiler chamber.

If desired, another form of boiler may be used to eliminate the central flue. At the top of the boiler, a hood 98 is mounted on top of the casing 95, the latter being encircled by the depending flange 99 of the hood. A cap 100 is supported by straps 101 over the opening 102 in the hood 98. The products of combustion coming from burner B and collecting under the hood 98 will pass through opening 102, between straps 101 and under cap 100, which will deflect these gases so that part will pass downwardly in the heater while another part may rise and leave the heater by way of slots 44.

A pipe 103, extending through hood 98, and valve 104 provide convenient means for filling the boiler with water (see Figure 7).

The condenser F is composed of top 105, bottom 106, curved side wall 107 and straight side wall 108. Spreaders 109, secured to side wall 107, space the condenser wall away from the casing 27, and to position the condenser so that substantially its entire exterior surface will be exposed to cooling effect of the downdraft of air entering the heater through openings 43 in the cover 29. The spreaders 109 also serve as cooling fins for dissipating the heat of the condenser.

Blower casing G, rigidly secured to the bottom 106 of the condenser, is provided in its lower wall with a circular air intake opening 110. An air outlet or discharge pipe 111, connected to the blower casing provides a blower exhaust opening leading to the outside of the heater unit. A narrow strap 112, secured across the center of the intake opening 110, has a conical recess to provide a bearing for the pointed lower end of a shaft 113. The blower fan 114 is secured to this shaft 113 by means of a set screw, or other fastening means, and receives support from a nut or bearing 115 also secured to the shaft 113.

The upper end of shaft 113 extends through the top of the blower casing and into the condenser F. A sleeve 116, encircling the shaft 113 has its base welded to condenser bottom 106 to provide a steam and watertight joint. A packing nut 117, of any conventional design provides a steam and watertight joint between the top of sleeve 116 and shaft 113. The shaft 113 is supported from the condenser bottom and below the turbine E, to avoid binding of the shaft as might be the case if a support were placed on the upper end of the shaft and secured to the top condenser wall.

The turbine or rotor wheel E is secured to the shaft 113 by means of a key or set screw, and a nut or cap 118, in order that the turbine will drive the shaft 113 and also derive support from the shaft in order to clear the packing nut 117.

A pipe 119, extending through casing 95 and condenser wall 108, conducts steam from the boiler into the condenser chamber, and the flattened end 120 of the pipe 119 directs a jet of steam against the blades of the turbine to drive the latter. The steam, after acting on the rotor of the turbine, circulates in the condenser, contacts the condenser walls which are being cooled by the downdraft of air in the heater, whereupon the steam condenses into water and collects in the bottom of the condenser.

When the pressure in boiler D has been sufficiently reduced, due to the thermostat C cutting off or diminishing the flow of fuel to the burner 56, the water in condenser F returns by gravity to the boiler D through pipe 121, strainer 122, a conventional type one-way check valve 123, and pipe 124.

A relief pipe 125 having a safety valve 126 is connected to the condenser F for regulating its steam pressure. Abnormal pressure in the boiler and condenser will be relieved by the safety valve 126.

The heater shown in detail in Figures 5 to 11 having been placed and secured in a railroad car, as shown in Figure 1 or 2, has its outlet pipe 111 suitably connected to manifold 22, as in Figure 1, or to pipe 25 as in Figure 2. Door 32 is raised and fuel having been fed to pilot wick 59, the latter is ignited. The operation of the heater will then be automatic, and will effectively maintain the temperature of the space or chamber of its use within a desired range over a relatively long period of time. When the temperature of the air adjacent the lower end of the heater and beneath fuel tank A falls below a predetermined temperature, thermostat C automatically establishes communication between pipes 62 and 63, so that fuel will flow from tank A to wick 56 to be ignited by the pilot light above wick 59. The source of combustion air for the burner flame depends on whether the lower end of the heater is closed or open. If the lower end is closed, as when the heater is placed on an imperforate floor, air is drawn from the upper part of the heater and under the casing 95 to the burner. If the lower end of the heater is open, as when the heater is placed on a grating or deck rack, a limited amount of air will pass up flue spaces 57 and 52 to support the burner combustion.

The burner flame and products of combustion will pass upwardly through boiler flue spaces 94 and 97 to heat water in the annular boiler chamber for generating steam. The products of combustion are deflected outwardly by cap 100, part going down into the heater while part may rise through slots 44. The steam generated in boiler D operates the turbine E, which in turn through the intermediary of shaft 113 drives the blower fan 114. Operation of the fan or blower 114 produces a downdraft of air, in the upper part of the heater, so that air enters through the apertures 43 and is heated by direct contact with the boiler casing 95 and condenser F before being drawn into the blower casing G by way of intake opening 110. The air drawn into the blower casing is discharged through pipe 111. When the temperature of the air in and adjacent the lower part of the heater rises to a predetermined point, the thermostat C cuts off the flow of fuel to the burner wick 56, and the pressure in boiler D is rapidly lowered. This drop in boiler pressure permits condensed steam in the condenser F to return to the boiler for reuse. As the boiler and condenser are part of a closed system, it is only necessary to replenish the supply of water at infrequent intervals.

Figure 12 shows a modified form of turbine drive which may be substituted for that shown in Figures 6 to 8, without changing the other parts or the general operation of the heater. In this construction, a ball type of turbine 127 having nozzles 128 is secured to a shaft 129 having an

axial steam passage 130. A sleeve 131, welded to the condenser bottom 106, and having an upper flange 132, provides a bearing surface and steam packing for the lower end of the turbine ball 127. A hollow fitting 133, having threaded connection to the end of pipe 119 provides a support for the upper end of shaft 129. Steam from boiler D (see Figures 6 to 8) is conducted to the interior of fitting 133 by pipe 119. From the fitting, the steam passes through ports 134, hollow space 130 in shaft 129 and ports 135 into the interior of the turbine ball 127. The steam then issues from the nozzles 128, and the reaction from its discharge rotates the turbine and shaft 129 carrying a blower fan at its lower end in the same manner as shaft 113 in Figure 7.

Figure 13 illustrates a modified arrangement for the turbine E, blower 114, and driving shaft 113. These parts operate as in Figures 6 to 8, but have been rearranged so that the shaft 113 is supported in a horizontal position, and extends through condenser wall 108, on which the blower casing G is mounted. The turbine E is driven as in Figures 6 to 8 and blower fan 114 draws air in through intake 110 and expels it through the side of the casing as in Figures 6 to 8. Instead of a gravity-flow return for the condensed steam shown in Figures 6 to 8, a force-feed return is illustrated in Figure 13. An eccentric 136, secured to shaft 113, drives a strap 137 connected to the rod 138 of piston 139, so that the piston will be reciprocated upon rotation of the turbine shaft 113. Piston 139 reciprocates within a cylinder 140, having connection with a pipe 141, leading from condenser F to the boiler. Conventional one-way valves, indicated diagrammatically at 142, allow water to be drawn into cylinder 140 from condenser F on the intake stroke of piston 139 and to be forced into the boiler chamber from cylinder 140 on the delivery stroke of the piston. This construction provides for return of condensed steam while the boiler is under pressure.

Figures 14 and 15 show a modified heater unit, which may be used in a merchandise chamber or refrigerator car in the same manner as the heater shown in Figures 5 to 11. In this construction, the fuel tank A, burner B, thermostat C and fuel supply connections are the same as in Figures 6 to 8, except that the shape of the burner is oval in cross section. Other shapes for the boiler, however, may be used if desired, the oval shape being used in this unit in order to use available space while avoiding interference with other elements of the unit.

The boiler chamber 143 and boiler housing 144 are both of oval shape (the outline of the housing being shown in Figure 15), and these elements are spaced apart to provide a flue space 145 in communication with an oval-shaped flue 146 leading to an outlet opening 147 in the cover 29. To maintain the burner, boiler and boiler housing in their relative positions, the boiler housing has downwardly bent flanges 148 which fit over the burner B, and shoulders 149 which are supported by the edge of the top of tank A. A door 32, and opening 150, in housing 144 permit access for igniting the pilot, when it is desired to condition the unit for its intended automatic operation.

A partition 151 is fitted within the heater casing, and turned up flanges 152 and 153 thereof define a crescent-shaped aperture (see Figure 15) through the partition. A condenser chamber 154, mounted upon the partition 151, is provided with a removable handhole cover 155, having screw-thread engagement with a ring 156 secured in the top condenser wall. On either side, the condenser 154 is provided with hollow extensions 157 (see Figure 15), from which project arcuate condenser pipes or tubes 158 closed at their outer ends 159. Condenser chamber 154 and condenser pipes 158 present a relatively large area of heat radiating surface for contact with the air to be warmed, and the total area of heat radiating surface is further increased by mounting fins or plates 160 on pipes or tubes 158. Two standards 161, 162 within the condenser chamber support the ends of a strip or bar 163, which latter carries a pointed bearing 164, adjustably held in place by a nut 165. A housing 166 secured to and depending from the under side of partition 151, supports a blower casing 167. The air inlet 169 to the blower casing is at its under side, and a spider or bar 168 extends across this opening, the bar having a conical recess 170, to afford a bearing for the lower end of a shaft 171 which extends through partition 151 and has its upper end engaging bearing 164 near the top of the condenser casing. Where the shaft 171 passes through the partition 151 and condenser bottom, a sleeve 172 and packing nut 173 surround the shaft to provide a water and steam-tight joint between the shaft and the bottom of the condenser chamber 154.

The turbine wheel 174, and blower fan 175 are each secured to and supported by the shaft 171, so that the fan will be driven upon rotation of the turbine wheel 174. During its operation, the fan draws air through intake 169 and forces it out of the heater casing through the delivery pipe 176.

Steam for operating the turbine 174 is conducted from boiler chamber 143 by pipe 177 and standard 162, which is hollow for this purpose, to a nozzle 178 projecting from the upper end of the standard. The nozzle 178, which may have a flattened end, directs the steam in a manner to impinge upon the rotor and to thereby drive the turbine 174. After passing the turbine, the steam circulates in the condenser tubes 158, where is condenses, due to the large heat radiating surface presented by the tubes 158 and fins 160. The condenser tubes 158 are inclined toward the condenser chamber 154, and the condensed steam flows by gravity into the latter. With the construction of this modification, it is found the steam is condensed rapidly, and that the boiler may therefore operate at a relatively low pressure, which is an important consideration for this type of heater.

During operation, blower fan 175 creates a circulation of air through the heater. Air to be heated is drawn into the heater through apertures 43, arranged in cover 29, as shown by Figure 5 and moves toward the crescent-shaped opening in the partition 151 defined by the flanges 152 and 153. The arrangement of the apertures 43 and the crescent-shaped opening is such that the air in passing from the former to the latter will come in contact with and be heated by the outer surfaces of the condenser chamber 154, extensions 157, tubes 158, fins 160 and flue 146. From the crescent-shaped opening the air passes downwardly and a large part is further heated by contact with boiler housing 144, before the air is drawn into the blower casing 167 by way of intake opening 169. The air, now in heated condition, is expelled from the blower casing by way of pipe 176, which corresponds in purpose and function to pipe 111 shown in Figures 6 to 8.

A pipe 179 opening into the condenser chamber 154 has its lower end within the boiler 143 for returning condensed steam. Conventional packing 180 and packing nut 181 are provided for sealing the joints where the pipe 179 passes through the partition 151 and the boiler housing 144, respectively. A steam pipe 182 extending through the interior of pipe 179 has its upper end near the top of condenser chamber 154 and its lower end terminating within the lower end of pipe 179. A sleeve 183, having an enlarged head 184 secured at its upper end to the housing 144, surrounds the lower end of pipe 179 and carries a guide 185 for the stem 186 of ball valve 187.

Steam in boiler 143 has access to the interior of the open-ended sleeve 183 and acts on the lower side of valve 187 to seat it against the ends of both pipes 179 and 182, shaped and positioned to fit the valve. As water collects in condenser 154, it passes downwardly through pipe 179, and around pipe 182, until stopped by a valve 187. At the same time, the air or steam pressure in condenser 154 is communicated to the valve 187 through pipe 182. Water is therefore returned to the boiler during its operation, whenever the pressure exerted on top of the ball valve 187 by the head of water in pipe 179 and steam or air in pipe 179 and steam or air in pipe 182 exceeds the pressure exerted on the bottom of the valve by the steam in boiler 143.

Since the condenser and boiler are in a closed system, and the condensed steam is returned to the boiler, the necessity of replenishing the water of the system is minimized. However, when necesary, feed water may be introduced into the filling pipe 188 leading to the boiler chamber.

While water and steam are mentioned for use in the closed fluid system herein disclosed, it is to be understood that equivalent fluids can be used, without departing from the spirit of the invention or the scope of the appended claims.

A further feature of the heater shown in Figures 14 and 15 is that the partition 151 with its flanges 152 and 153 will trap and collect any moisture which may condense on and drip from the condenser pipes 158 and fins 160.

It will be understood that while the invention is particularly applicable to railroad refrigerator cars, it offers obvious advantages when practiced in connection with other types of railway and road vehicles including so-called ventilator cars, box cars, express cars, and motor trucks, as well as ships and in storage houses.

Only preferred embodiments of this invention have been shown and described, but other forms and modifications embodying the invention may be readily devised within the spirit and scope of the invention, as defined by the following claims.

What we claim is:

1. In combination with a merchandise chamber having means for distributing heated air therein adjacent to and along its floor to provide horizontal and upwardly flowing streams of warm air effective to maintain a protective temperature for the merchandise in said chamber, a portable, self-contained heater unit comprising mechanically operated means to draw air to be heated from said chamber into the unit from above and to expel the said air therefrom into said distributing means, means to heat the air during its passage through the unit, whereby air is drawn from the upper part of said chamber and distributed in heated condition adjacent the floor of said chamber, and means responsive to ambient temperatures of the chamber for controlling the operation of the heater unit.

2. In combination with a merchandise chamber having a load supporting deck spaced above its floor with ventilation openings therethrough to provide for circulation of air, means for distributing heated air within said chamber and beneath said load supporting deck to provide horizontal and upwardly flowing streams of warm air effective to maintain a protective temperature for the merchandise in said chamber, and a portable, self-contained heater unit comprising mechanically operated means to draw air to be heated from said chamber into the unit from above and to expel the said air therefrom into said distributing means, means to heat the air during its passage through the unit, whereby air is drawn from the upper part of said chamber and distributed in heated condition adjacent the floor of said chamber, and means responsive to ambient temperatures adjacent the floor of the chamber for controlling the operation of the heater unit.

3. In combination with a merchandise chamber having a load supporting deck spaced above its floor with ventilation openings therethrough to provide for circulation of air, means for distributing heated air within said chamber and beneath said load supporting deck to provide horizontal and upwardly flowing streams of warm air effective to maintain a protective temperature for the merchandise in said chamber, and a portable, self-contained heater unit comprising mechanically operated means to draw air from the said chamber into the unit from above and to expel the said air therefrom into said distributing means beneath the load supporting deck, means to heat the air during its passage through the unit, whereby air is drawn from the upper part of said chamber and distributed in heated condition adjacent the floor of said chamber, means for converting part of the heat energy produced in the unit into mechanical energy for operating said mechanically operated means, and thermostatic means responsive to ambient temperatures adjacent the floor of the chamber for controlling the operation of the heater unit.

4. In combination with a vehicle for transportation of perishable commodities, the vehicle having a merchandise chamber in which a load supporting deck is spaced above the floor of the chamber and the said deck is provided with ventilation openings therethrough for circulation of air, a portable self-contained heater unit for maintaining a protective temperature for the commodities in said chamber, the said unit comprising a mechanically operated element for drawing air to be heated into the unit from above and discharging said air in horizontally directed streams beneath the said deck, means for heating the said air in its passage through the unit, means for converting a part of the heat energy developed in the unit into mechanical energy for operating the said element, and means responsive to ambient temperature in the chamber adjacent its floor for controlling the operation of the heater unit.

5. In combination with the lading chamber of a railway vehicle, the said chamber being constructed for the stowing of perishable merchandise and having a load supporting deck spaced above the floor with ventilation passages therethrough and beneath the same, a portable self-contained heater unit for maintaining a desired temperature in said chamber, the said unit comprising mechanically operated means to draw air

to be heated from said chamber into the unit from above and to expel the said air beneath said deck for upward movement through said ventilating passages to maintain a protective temperature for the merchandise in said chamber, means to heat the air during its passage through the unit, whereby air is drawn from the upper part of said chamber and distributed in heated condition adjacent the floor of said chamber, and means responsive to ambient temperatures of the chamber for controlling the operation of the heater unit.

6. In combination with a merchandise chamber having means for distributing heated air therein adjacent to and along its floor to provide horizontal and upwardly flowing streams of warm air effective to maintain a protective temperature for the merchandise in said chamber, a portable, self-contained heater unit comprising a casing having an air inlet through which air to be heated is drawn from said chamber into the unit from above and an air outlet through which heated air is discharged into said distributing means, mechanically operated means to provide circulation of air from said air inlet to said air outlet, means to heat the air during its passage through the unit, whereby air is drawn from the upper part of said chamber and distributed in heated condition adjacent the floor of said chamber, and means within the casing responsive to temperature for controlling the operation of the heater unit.

7. In combination with a merchandise chamber having means for distributing heated air therein adjacent to and along its floor to provide horizontal and upwardly flowing streams of warm air effective to maintain a protective temperature for the merchandise in said chamber, a portable, self-contained heater unit comprising a fluid fuel burner, a fuel reservoir connected to said burner for supplying fuel thereto, means responsive to ambient temperatures for controlling the flow of fuel to said burner, a closed fluid system including a boiler heated by said burner and a condenser to receive steam from said boiler, an operating element within said system positioned to be driven by the steam generated in said boiler, and a blower operated by said element for drawing air from said chamber into the unit from above for heat exchange contact with the elements of said system and for discharge of heated air into said distributing means whereby air is drawn from the upper part of said chamber and distributed in heated condition adjacent the floor of said chamber.

8. A portable self-contained heating unit for use in merchandise chambers to maintain perishable commodities stored therein at a protective temperature, comprising mechanically operated means to draw air to be heated into the unit from above and to expel the said air from the unit, means for discharging the heated air in a horizontal direction adjacent the floor of the chamber to be heated to produce a desired distribution of heated air, means to heat the air during its passage through the unit, and means responsive to ambient temperatures of air adjacent the base of the unit for controlling the operation of the heating unit.

9. A portable self-contained heating unit for use in merchandise chambers to maintain perishable commodities stored therein at a protective temperature, comprising mechanically operated means to draw air to be heated into the unit from above and to expel the said air from the unit, means for discharging the heated air in a horizontal direction adjacent the floor of the chamber to be heated to produce a desired distribution of heated air, means to heat the air during its passage through the unit, means for converting a part of the heat energy developed in the unit into mechanical energy for driving said first-mentioned means, and means responsive to ambient temperatures of air adjacent the base of the unit for controlling the operation of the heating unit.

10. A portable self-contained heating unit for use in merchandise chambers to maintain perishable commodities stored therein at a protective temperature, comprising a fluid fuel burner, a fluid fuel reservoir connected with said burner for supplying fuel thereto, said burner and reservoir being arranged side by side and in the lower part of the heating unit, a fluid heating system arranged in the upper part of said unit, said system including a boiler heated by said burner and a condenser receiving steam from said boiler, mechanically operated means for producing a forced draft of air into and through the heating unit for heat exchange contact with the elements of said system, means operated by the steam generated in said boiler for driving said draft producing means, and temperature responsive means for controlling the operation of the heating unit.

11. A portable self-contained heating unit for use in merchandise chambers to maintain perishable commodities stored therein at a protective temperature, comprising a fluid fuel burner; a fluid fuel reservoir connected with said burner for supplying fuel thereto; a closed fluid system including a boiler to be heated by said burner, a condenser, and connections for conducting steam from said boiler to the condenser and returning the condensed steam to said boiler; mechanically operated means for producing a forced draft of air into and through the heater unit for heating by heat exchange contact with the elements of said system; means operated by the steam generated in said boiler for driving said draft producing means; and temperature responsive means adjacent the base thereof for controlling the operation of the heating unit.

12. A portable self-contained heating unit for use in merchandise chambers to maintain perishable commodities stored therein at a protective temperature, comprising a fluid fuel burner; a fluid fuel reservoir connected with said burner for supplying fuel thereto; a closed fluid system including a boiler to be heated by said burner, a condenser, and connections for supplying said condenser with steam from said boiler and returning condensed steam to said boiler; mechanically operated means to return said condensed steam to said boiler; mechanically operated means for producing a forced draft of air into and through the heater unit for heating by heat exchange contact with the elements of said system; means operated by the steam generated in said boiler for driving both said draft producing means and said condensed steam returning means; and temperature responsive means adjacent the base thereof for controlling the operation of the heating unit,

13. A portable self-contained heating unit for use in merchandise chambers to maintain perishable commodities stored therein at a protective temperature, comprising a casing, a fluid fuel burner, a fluid fuel reservoir connected with said burner for supplying fuel thereto, said burner and reservoir being positioned side by side and in the lower part of said casing, a boiler positioned above said burner to be heated thereby, a condenser con-

nected to said boiler to receive steam therefrom, said boiler and condenser being arranged in the upper part of said casing, a turbine mounted within said condenser and adapted to be driven by steam from said boiler, and a blower mounted within the casing and positioned therein to be driven by said turbine for establishing air flow through said casing and for bringing air to be heated into heat exchange contact with the heated elements of said unit, said casing being constructed to permit said blower to draw air into the casing and to expel the air in heated condition from the casing.

14. In a portable self-contained heating unit for use in merchandise chambers to maintain perishable commodities stored therein at a protective temperature, the combination comprising a fluid fuel burner; a fluid fuel reservoir connected with said burner for supplying fuel thereto; and a closed fluid system including a boiler heated by said burner, a condenser connected with said boiler to receive steam therefrom and to return condensed steam thereto, means driven by steam passing from said boiler to said condenser, a pressure responsive valve controlling a gravity flow return of condensed steam to said boiler, and means providing for exposure of one side of said valve to the steam pressure in said boiler and for direct exposure of part of its opposite side to the steam pressure in said condenser and of another part of said opposite side to the pressure exerted by the weight of the returning condensed steam, whereby the condenser steam pressure will supplement the gravity action of the returning condensed steam in unseating said valve to permit return of condensed steam while the boiler is under pressure.

15. A portable self-contained heating unit for use in merchandise chambers to maintain perishable commodities stored therein at a protective temperature, comprising a fluid fuel burner; a fluid fuel reservoir connected with said burner for supplying fuel thereto; a closed fluid system including a boiler heated by said burner, a chamber for collecting condensed steam, condenser tubes positioned to receive steam from said chamber and to return thereto condensed steam, and connections for supplying said chamber with steam from said boiler and returning condensed steam to the boiler; mechanically operated means for producing a forced draft of air into and through the heater unit for heat exchange contact with the elements of said system including the said condenser tubes; and means operated by the steam generated in said boiler for driving said draft producing means.

16. A portable self-contained heating unit for use in merchandise chambers to maintain perishable commodities stored therein at a protective temperature, comprising a fluid fuel burner; a fluid fuel reservoir connected with said burner for supplying fuel thereto; a closed fluid system including a boiler heated by said burner, a chamber for collecting condensed steam, condenser tubes provided with heat radiating fins and inclined downwardly toward said chamber from which they receive steam and into which they discharge condensed steam, and connections for supplying said chamber with steam from said boiler and returning condensed steam to the boiler; mechanically operated means for producing a forced draft of air into and through the heater unit for heat exchange contact with the elements of said system including said fins and condenser tubes; and means operated by the steam generated in said boiler for driving said draft producing means.

17. In a method for providing a protective temperature for commodities stored in a merchandise chamber having a load supporting deck provided with ventilating openings and spaced above the chamber floor, the steps comprising creating a downdraft to withdraw air from said chamber and adjacent the ceiling thereof, heating the withdrawn air in its downward course, and discharging the heated air in horizontally directed streams beneath the load supporting deck to secure a distribution of heated air beneath the deck and rising streams of heated air throughout a substantial portion of the chamber.

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