

July 18, 1939.

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2,166,906

REFRIGERATING APPARATUS

Filed Jan. 21, 1936

2 Sheets-Sheet 1

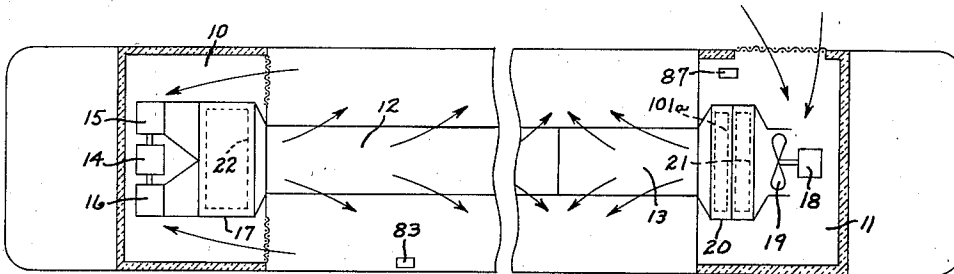


Fig. 1

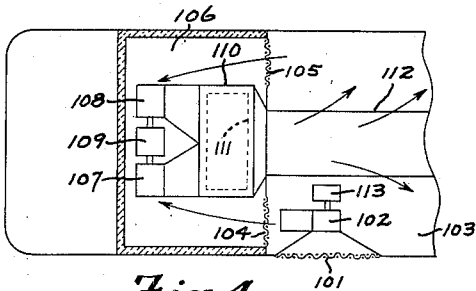


Fig. 4

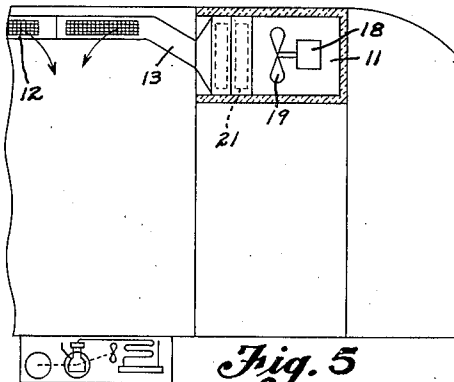


Fig. 5

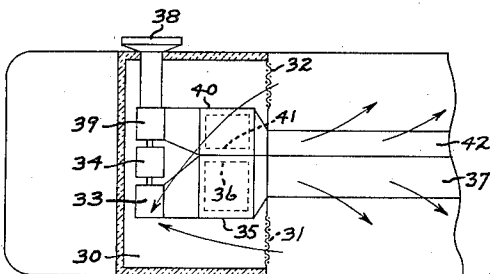


Fig. 2

Fig. 6

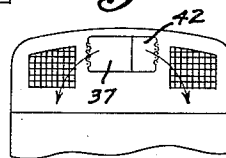


Fig. 7

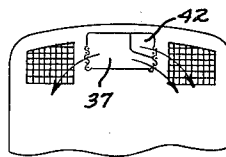


Fig. 8

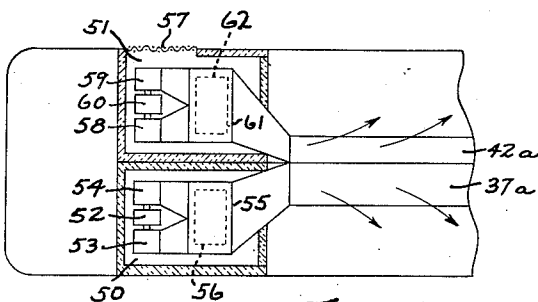
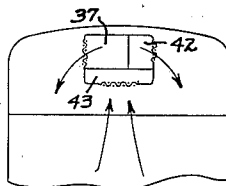


Fig. 3

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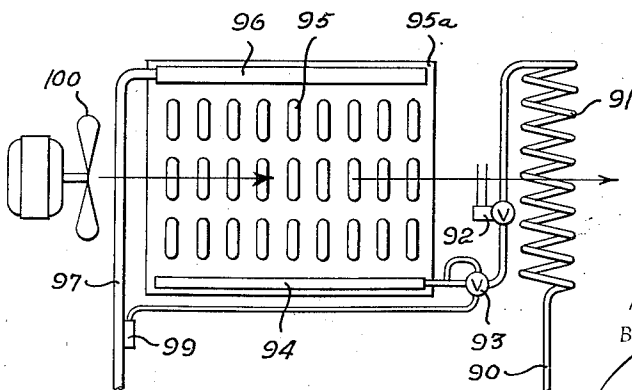
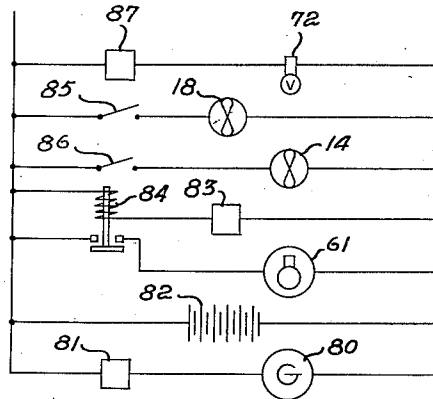
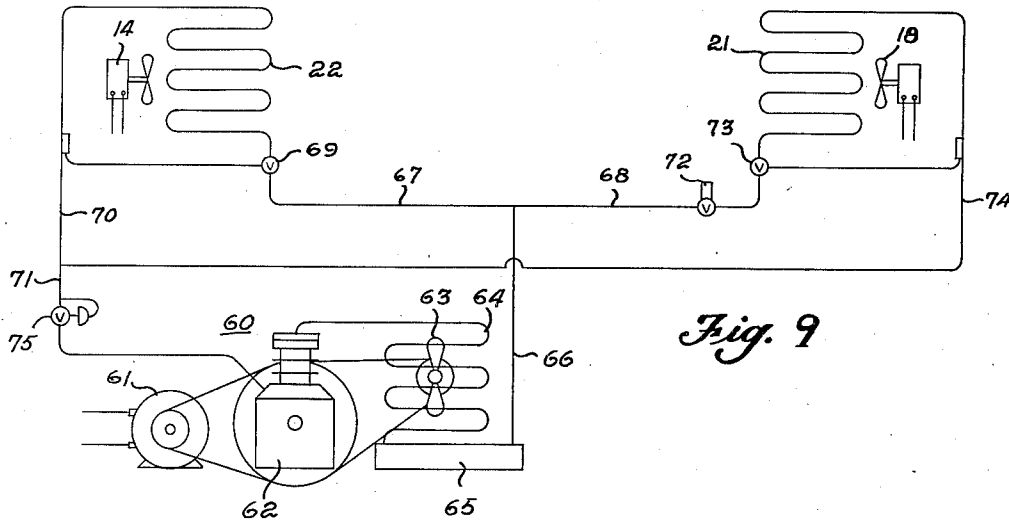
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REFRIGERATING APPARATUS

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2 Sheets-Sheet 2



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REFRIGERATING APPARATUS

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Application January 21, 1936, Serial No. 60,088

15 Claims. (Cl. 98—10)

This invention relates to refrigeration.

It is an object of this invention to provide an improved air conditioning system for railway cars and other enclosures.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred form of the present invention is clearly shown.

In the drawings:

Fig. 1 is a diagrammatic plan for conditioned air circulation in accordance with my invention;

Fig. 2 is a plan view of another type of air circulation;

Fig. 3 is another diagrammatic plan view of another type of air circulation;

Fig. 4 is still another plan view of a different type of air circulation;

Fig. 5 is a diagrammatic vertical cross-section of a portion of Fig. 1;

Figs. 6, 7 and 8 are diagrammatic transverse cross-sections of air ducts applicable to the modifications of Figs. 2 and 3;

Fig. 9 is a diagrammatic view showing a refrigerating cycle applicable to Figs. 1, 2 and 3;

Fig. 10 is a wiring diagram showing the electrical controls for Fig. 9; and

Fig. 11 is a diagrammatic showing of an air cooling refrigerant coil applicable to all of the modifications.

Air for a railway car or the like may be conditioned and discharged into the passenger space of a railway car by providing a recirculated air cooling unit 10 at one end of the car and a fresh air cooling unit 11 at the other end of the car. These units may be located above the level of the normal head room in said passenger space. These units are adapted to cool the air and discharge it through overhead ducts 12 and 13 arranged along the center and top of the car with suitable outlets along the sides or bottom of the duct. In either case, the cooling units may include motor driven blowers and refrigerant evaporators or coils through which the air is blown by the blowers before being discharged into the ducts 12 and 13. In the case of unit 10, the motor 14 may drive two blowers 15 and 16 having air intakes at the sides and discharging into a casing 17 within which a refrigerant evaporator 22 of any approved type may be provided. In the case of unit 11, a motor 18 may drive a blower 19 through the casing 20 which contains an evaporator 21 of any desired type.

In the modification shown in Fig. 2, the car may be provided with an overhead air condition-

ing compartment 30 having recirculated air inlets 31 and 32. The air from these inlets enters a blower 33 driven by a motor 34, and is discharged into the casing 35 containing a refrigerant coil 36. The air cooled by this coil is discharged through the duct 37 into the upper part of the car, the duct 37 being placed in the overhead space. Fresh air passes through a filter 38 into a blower 39 and is discharged into a casing 40 containing a refrigerant evaporator 41. The air cooled by this evaporator is discharged through the duct 42 into the upper portion of the car.

The ducts 37 and 42 may be made as shown in Fig. 6, in which case the duct 37 discharges along one side of the car and the duct 42 discharges along the other side. The ducts 37 and 42 may be made as indicated in Fig. 7, in which case the duct 37 discharges the major portion of air along the left hand side, and a minor portion along the right hand side, while the duct 42 discharges along the right hand side. In this case the combined flow along the right hand side is balanced volumetrically to equal that of the left hand side. If a duct as shown in Fig. 8 is desired, the cooled air discharge may be substantially as described with respect to Fig. 6, and return air may be returned to the cooling compartment through the duct 43 which extends along the length of the passenger compartment in lieu of openings 31 and 32.

In the modification shown in Fig. 3, two air conditioning compartments 50 and 51 are provided. The compartment 50 is adapted to cool recirculated air and the compartment 51 is adapted to cool fresh air. The motor 52 drives blowers 53 and 54. Recirculated air enters the compartment 50 and from thence through the blowers 54 into a casing 55 containing an evaporator 56, and the cooled air is discharged into the duct 37a. Fresh air enters through a filter 57 into the compartment 51. From thence it enters the blowers 58 and 59 driven by the motor 60. The air is forced through a casing 61 having an evaporator 62, and the cooled air is discharged into the duct 42a. The ducts 37a and 42a may be of similar construction as duct 37 and 42 and may have transverse cross-sections as indicated in Figs. 6, 7 and 8.

The evaporators used in Figs. 1, 2 and 3 may be connected to suitable refrigerant circulating means. In Figs. 9 and 10, a refrigerating system is shown which may be used to circulate refrigerant through the evaporators shown in Figs. 1, 2 and 3; but the reference characters have been 55

applied in Figs. 9 and 10 to correspond to Fig. 1, it being understood that similar controls and refrigerating apparatus may be connected to the evaporators, blowers, etc., of Figs. 2 and 3. In applying the invention to Fig. 1, a refrigerant liquefying unit 60 may be placed anywhere in the car, preferably underneath the floor thereof or in any other compartment provided. The liquefying unit may include a motor 61 driving a compressor 62 and condenser fan 63. The compressor 62 discharges into a condenser 64 having a receiver 65. Liquid refrigerant flows through the line 66 to the branches 67 and 68 leading respectively to the recirculated refrigerant evaporator 22 and the fresh air evaporator 21. The liquid refrigerant flowing through the branch 67 passes the automatic expansion valve 69 and returns through the suction line 70 to the common suction line 71. Liquid refrigerant flowing through the liquid line 68 flows through the solenoid valve 72 and automatic expansion valve 73 into the coil 21 and the evaporated refrigerant returns through the suction line 74 to the compressor 60. If desired, the common suction line 71 may be provided with an automatic pressure regulating valve 75 which automatically throttles the line 71 whenever the suction pressure tends to be reduced below a predetermined limit. This predetermined limit is preferably selected so that moisture removed from the air cannot freeze on the coils 21 or 22, and the temperature of the coils is thus reduced only sufficiently to condense the moisture in the air to liquid and not to freeze it.

The electrical controls for the system are shown in Fig. 10. Thus the car may be provided with a generator 80 driven from the axle of the car, this generator being provided with the usual cut-out 81 which disconnects the generator from the storage battery 82 whenever the car speed falls below a predetermined limit. The generator 80 is provided with the usual voltage regulation to charge the battery 82 properly at all permissible car speeds. A thermostat, humidostat or the like 83 is placed in the passenger car space, or in a recirculated air duct, and controls a relay 84. When the temperature in the passenger compartment rises to a predetermined limit, the thermostat 83 closes thus energizing the relay 84 and starting the compressor motor 61. The compressor motor continues to operate until the temperature in the passenger compartment is reduced to a predetermined temperature at which the thermostat 83 opens thus deenergizing the relay and stopping the motor 61. The blower motors 14 and 18 are placed under the control of manual switches 85 and 86 and can be made to run continuously as long as desired. A thermostat, humidostat or the like 87 is placed where it is responsive to the temperature of the outside atmosphere or uncooled fresh air. Thus it may be placed under the car or any place outside of the car where direct sun rays will not strike it. It may also be placed in the fresh air intake inside of the fresh air cooling compartment which is representative of outside temperature or humidity conditions. This thermostat is preferably so calibrated that when the outside temperature falls below a predetermined limit, it opens and energizes the solenoid valve 72. This closes the valve 72 and prevents liquid refrigerant from flowing to the evaporator 21. When the outside temperature rises above a predetermined limit, the thermostat 87 opens the valve 72 and supplies refrigerant to evaporator 21.

From the above it will be seen that whenever the temperature in the passenger compartment rises to a predetermined limit where refrigeration is required, the thermostat 83 starts to operate the refrigerant liquefying unit and causes refrigeration to be provided at least to evaporator 22. If the outside temperature is relatively high, so that the thermostat 87 is closed, then refrigeration will also be provided at the evaporator 21, also. When the outside temperature falls, refrigeration at 21 is stopped by the thermostat 87. The blower 19 continues to operate, however, and introduces uncooled fresh air into the passenger compartment, this uncooled fresh air tending to prevent the temperature in the passenger compartment from becoming uncomfortable on mild days.

The system shown in Fig. 9 may also be applied to Fig. 2, it being understood that the evaporator 36 is to be substituted for the evaporator 22 and the evaporator 41 is substituted for the evaporator 21. Likewise, with respect to Fig. 3, the evaporator 46 is substituted for the evaporator 22 and the evaporator 62 is substituted for the evaporator 21. The corresponding motors and necessary valves, controls, etc., in Figs. 2 and 3 are to be supplied in a manner corresponding to the disclosure in Figs. 9 and 10.

Both the fresh air and recirculated air cooling evaporators may be of the type diagrammatically shown in Fig. 11. This type of evaporator is adapted to use the unexpanded liquid refrigerant to reheat slightly the cooled air, thus tempering it and at the same time providing for maximum air drying. The liquid refrigerant enters at 90 and passes through an air heating coil 91. Thereafter the refrigerant passes through a solenoid valve 92, if such a valve is necessary, and thereafter passes through the automatic expansion valve 93. The expanded refrigerant thence enters the lower header 94 and is distributed to the serpentine coils 95 having longitudinal parallel fins 95a having their discharge portions connected to the header 96, the evaporated refrigerant passing out through the evaporated refrigerant line 97. The automatic expansion valve 93 is of the type that automatically opens when the suction pressure is reduced below a selected pressure. Also a thermostatic bulb 99 is placed near the suction line which automatically throttles the valve whenever the refrigerating effect tends to overflow into the suction line. The blower 100 forces air over the evaporator as indicated by the arrows. The air is cooled by refrigerant flowing through the coils 95 where the air has its moisture content reduced. Thereafter the air is reheated to some extent by the unexpanded liquid refrigerant in the coil 91, the liquid refrigerant at this point being substantially at condenser temperature. In the case of an air cooled condenser, this may be a few degrees higher than the outside temperature.

In the modification shown in Fig. 4 the fresh air is never cooled before being introduced into the passenger compartment. Thus a fresh air intake is provided at 101 and is discharged by the blower 102 into the passenger compartment 103. If desired, the discharge of the blower 102 may be directed towards a recirculated air inlet 104. The recirculated air inlets 104 and 105 are connected to an air conditioning compartment 106 placed in the upper part of the car. The blowers 107 and 108 are driven by the motor 109 and discharge into casing 110 provided with an evaporator 111. The cooled air is discharged by

an overhead conduit 112 into the compartment 103. The blower 102 is driven by a motor 113. The evaporator 111 is connected to a suitable refrigerant liquefying unit such as previously described and energized from the usual storage battery along with the motors 109 and 113.

In all the modifications a steam heating coil may be placed in both the recirculated air and fresh air units. One such coil is indicated at 101a.

While the form of embodiment of the present invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. The method of refrigerating a space which comprises continuously circulating air to and from said space through a first cooling zone adjacent one end of said space, controlling the cooling in said zone in accordance with air conditions in said space, continuously circulating fresh air through a second cooling zone adjacent the other end of said space into said space, and controlling the cooling in said second zone in accordance with outside air conditions.

2. A vehicle having a passenger space, a recirculated air cooling unit above the level of the normal head room in said space and having its inlet and its outlet connected to said space, a fresh air cooling unit located above the level of the normal head room in said space and having its inlet connected to the outside of said vehicle and its outlet connected to said passenger space, and means for controlling said fresh air unit in response to temperature changes in the outside air.

3. A vehicle having a passenger space, a recirculated air cooling unit above the level of the normal head room in said space and having its inlet and its outlet connected to said space, a fresh air cooling unit located above the level of the normal head room in said space and having its inlet connected to the outside of said vehicle and its outlet connected to said passenger space, means for controlling the cooling action in said recirculated air cooling unit in accordance with air conditions in said space, and temperature responsive means for controlling the cooling action in said fresh air cooling unit.

4. A vehicle having a passenger space, a recirculated air cooling unit above the level of the normal head room in said space and having its inlet and its outlet connected to said space, a fresh air cooling unit located above the level of the normal head room in said space and having its inlet connected to the outside of said vehicle and its outlet connected to said passenger space, means for controlling the cooling action in said fresh air cooling unit in accordance with fresh air conditions.

5. A vehicle having a passenger space, a recirculated air cooling unit above the level of the normal head room in said space and having its inlet and its outlet connected to said space, a fresh air cooling unit located above the level of the normal head room in said space and having its inlet connected to the outside of said vehicle and its outlet connected to said passenger space, means for controlling the cooling action in said recirculated air cooling unit in accordance with air conditions in said space, and means for controlling the cooling action in said fresh air cooling unit in accordance with fresh air conditions.

6. The method of refrigerating a vehicle compartment which comprises circulating air to and from said compartment through a first cooling zone discharging adjacent one end of said compartment, and independently circulating fresh air through a second cooling zone discharging adjacent the other end of said compartment into said compartment.

7. A vehicle having a passenger space, a recirculated air cooling unit above the level of the normal head room in said space and having its inlet and its outlet connected to said space, a fresh air cooling unit located above the level of the normal head room in said space and having its inlet connected to the outside of said vehicle and its outlet connected to said passenger space, means for controlling the cooling action in said recirculated air cooling unit in accordance with air conditions in said space, and a single conduit for distributing the air provided with one passageway for the fresh air and a different passageway for the recirculated air.

8. A vehicle having a passenger space, a recirculated air cooling unit above the level of the normal head room in said space and having its inlet and its outlet connected to said space, a fresh air cooling unit located above the level of the normal head room in said space and having its inlet connected to the outside of said vehicle and its outlet connected to said passenger space, temperature responsive means for controlling the cooling action in said recirculated air cooling unit, and a single conduit for distributing the air provided with one passageway for the fresh air and a different passageway for the recirculated air.

9. The method of distributing conditioned air in a passenger compartment of a vehicle which comprises discharging a first stream of conditioned recirculated air and a second stream of conditioned fresh air into said compartment from opposite sides respectively of a centrally disposed longitudinally extending duct located in the upper part of the vehicle.

10. The method of refrigerating a passenger space in a vehicle which comprises continuously circulating air to and from said space through a first cooling zone, controlling the cooling in said zone in accordance with air conditions in said space, independently circulating fresh air through a second cooling zone into said space, and controlling the cooling in said second zone in response to changes in temperature of the outside air.

11. A vehicle having a passenger space, a recirculated air cooling unit above the level of the normal head room in said space and having its inlet and its outlet connected to said space, a fresh air cooling unit located above the level of the normal head room in said space having its inlet connected to the outside of the vehicle and its outlet connected to said passenger space, and a single conduit for distributing the air provided with one passageway for the fresh air and a different passageway for the recirculated air.

12. A vehicle having a passenger space, a recirculated air cooling unit above the level of the normal head room in said space and having its inlet and its outlet connected to said space, a fresh air cooling unit located above the level of the normal head room in said space and having its inlet connected to the outside of said vehicle and its outlet connected to said passenger space, and means for reheating the air leaving one of said cooling units.

13. A vehicle having a passenger space, a recirculated air cooling unit above the level of the normal head room in said space and having its inlet and its outlet connected to said space, a
5 fresh air cooling unit located above the level of the normal head room in said space and having its inlet connected to the outside of said vehicle and its outlet connected to said passenger space, and means for reheating the air leaving one of
10 said cooling units, said means comprising an air heating coil through which unexpanded liquid refrigerant is caused to circulate.

14. The method of conditioning air for an enclosure which comprises circulating a stream of
15 conditioned recirculated air into said enclosure,

circulating a separate stream of fresh air into said enclosure, conditioning said fresh air at least part of the time, and controlling the conditioning of said fresh air in accordance with one function of the psychrometric condition of the unconditioned fresh air.

15. The method of distributing streams of conditioned recirculated air and conditioned fresh air which comprises discharging said conditioned recirculated air and said conditioned fresh air
10 into the compartment to be cooled from separate discharge outlets and conveying the fresh air in the unmixed condition into widely separated portions of the compartment.

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