Aug. 13, 1940. C. F. HENNEY 2,211,567

AIR CONDITIONING

Filed June 27, 1933 5 Sheets-Sheet 1

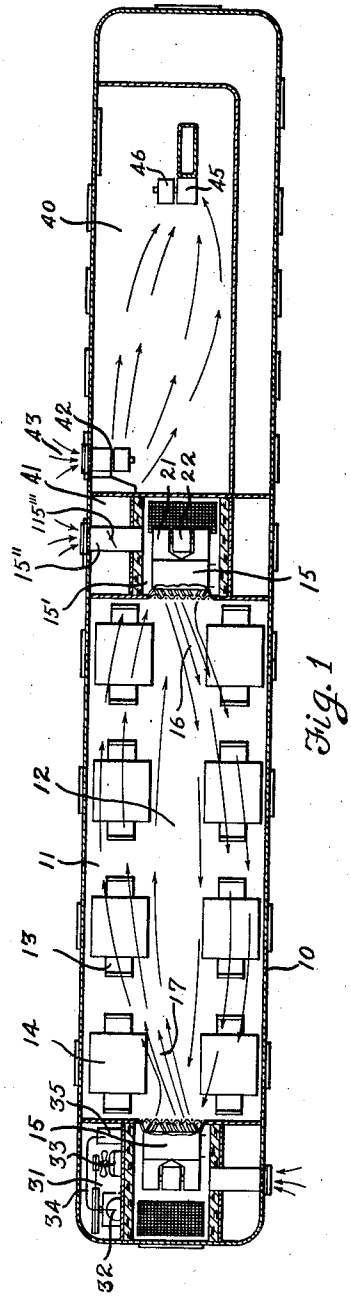


Fig. 1

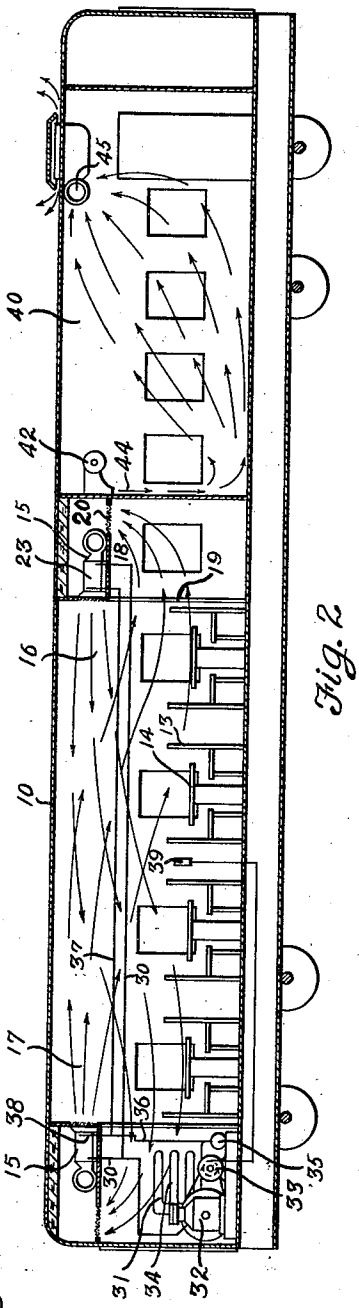


Fig. 2

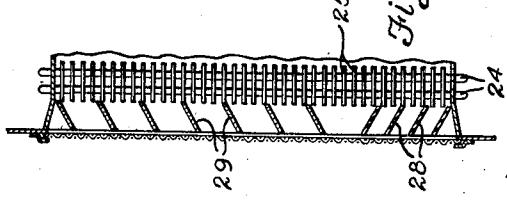


Fig. 3.

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AIR CONDITIONING

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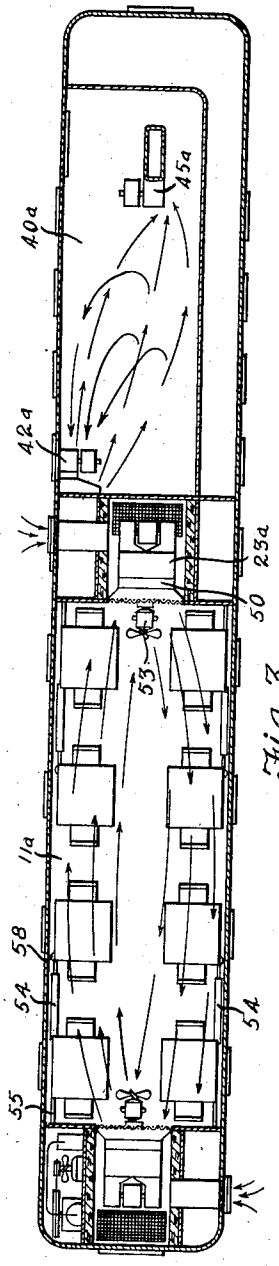


Fig. 3

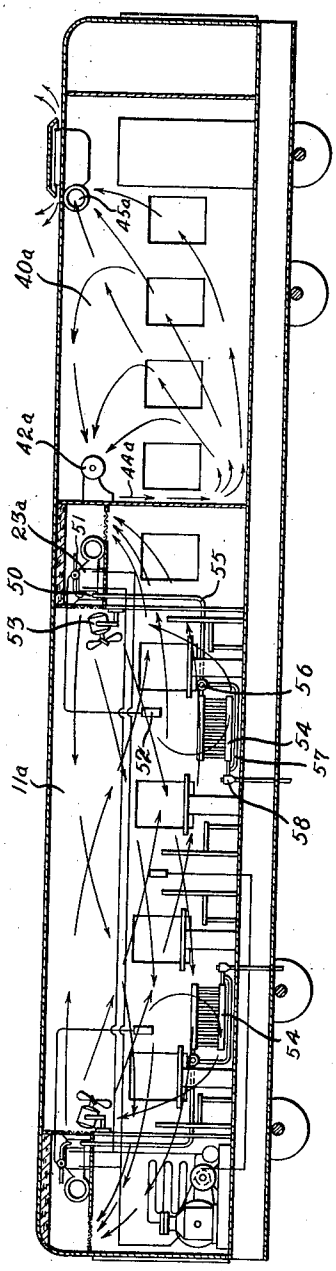


Fig. 4

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AIR CONDITIONING

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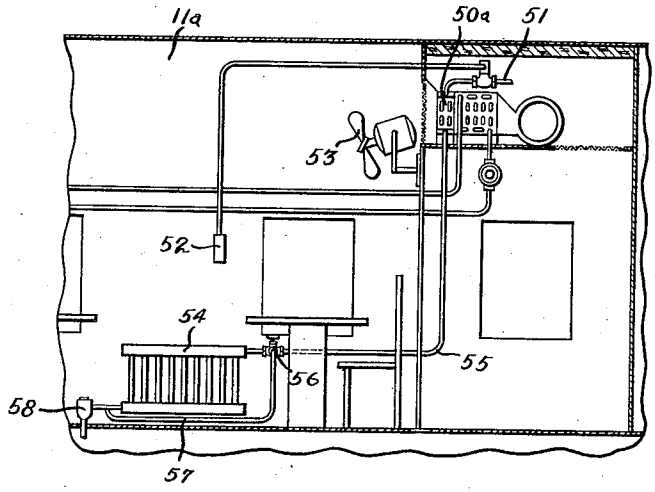


Fig. 5.

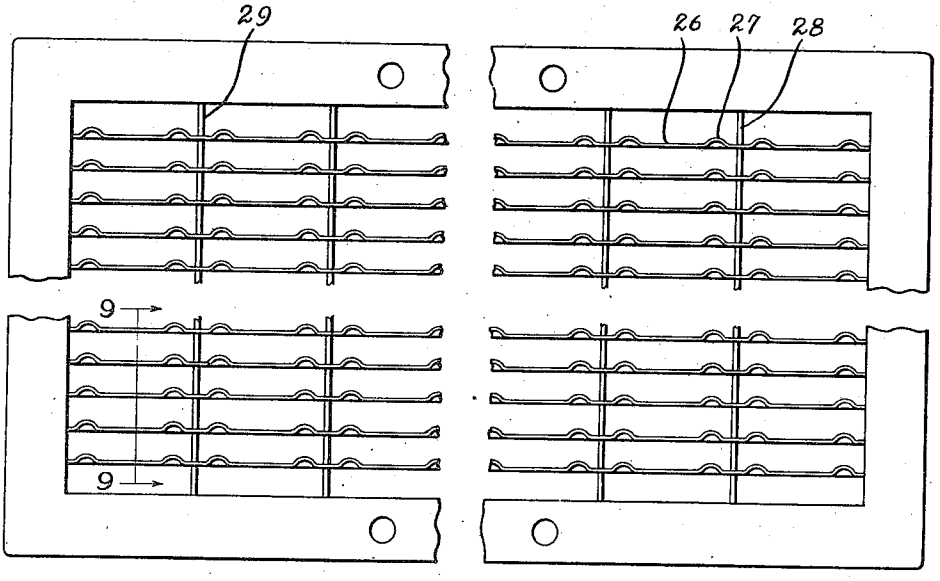


Fig. 6.

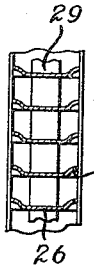


Fig. 7.

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AIR CONDITIONING

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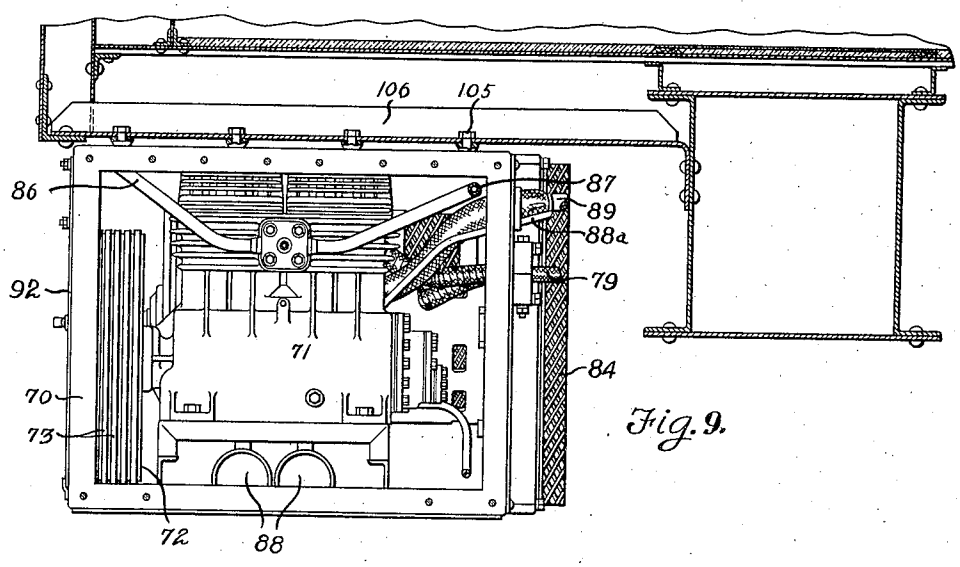


Fig. 9.

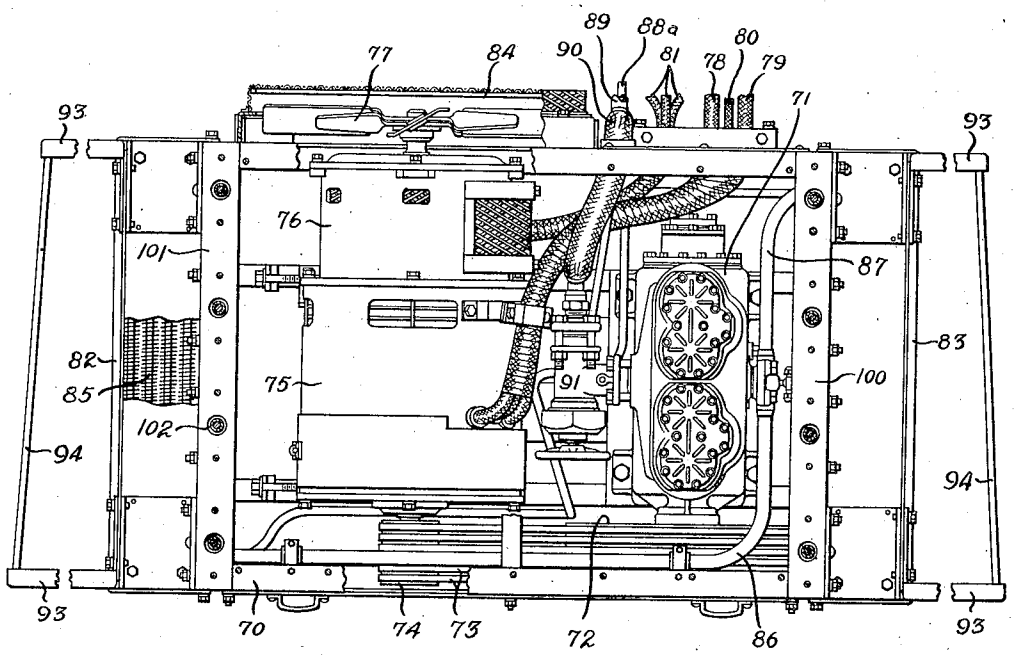


Fig. 10.

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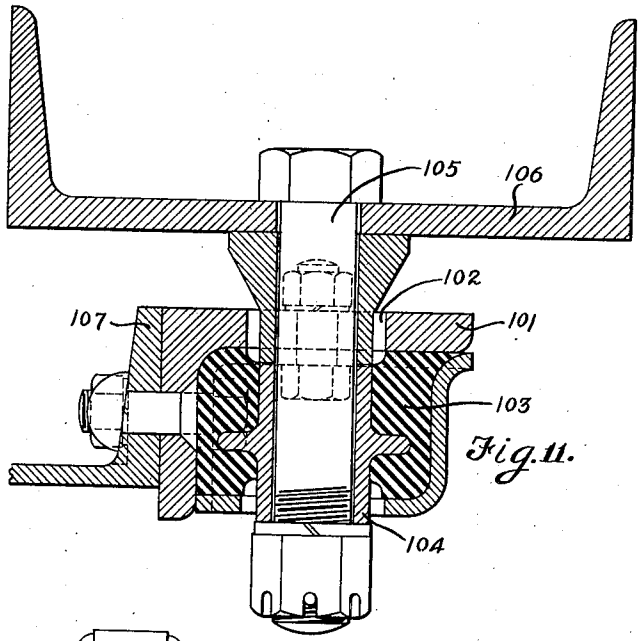


Fig. 11.

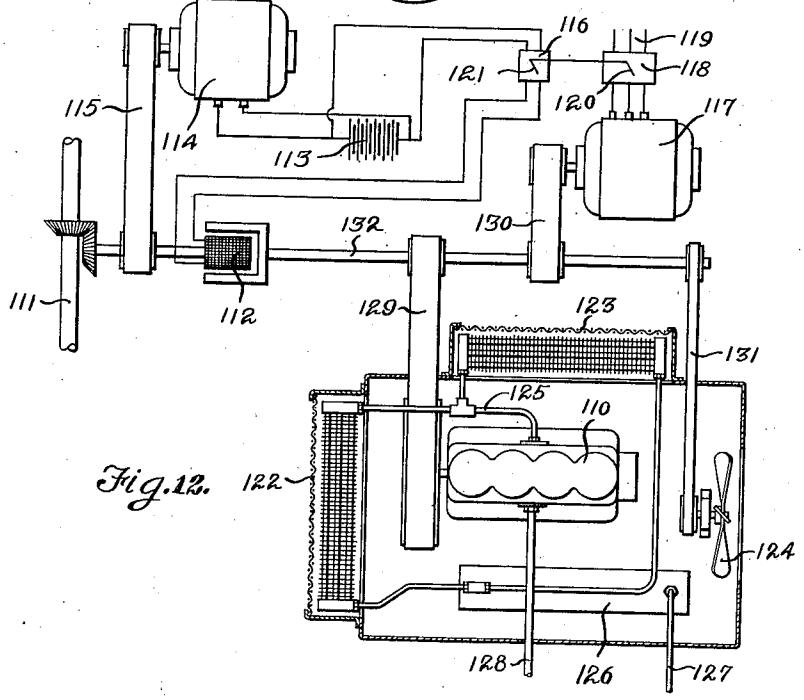


Fig. 12.

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UNITED STATES PATENT OFFICE

2,211,567

AIR CONDITIONING

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Application June 27, 1933, Serial No. 677,876

7 Claims. (Cl. 257—7)

This invention relates to air conditioning.

It is among the objects of this invention to provide an improved method and apparatus for conditioning air in compartments occupied by persons, and particularly passenger compartments in railroad cars or the like.

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 horizontal cross-sectional view, partly diagrammatic, of a railroad car embodying features of my invention;

Fig. 2 is a vertical cross-sectional view of the car shown in Fig. 1;

Fig. 3 is a view, somewhat similar to Fig. 1, but in which the invention embodies means for both heating and cooling the air in the car;

Fig. 4 is a vertical cross-sectional view of the car shown in Fig. 3;

Fig. 5 is an enlarged diagrammatic view of a portion of the apparatus shown in Fig. 4;

Fig. 6 is a front view of the grille which may be used in air conditioning units used in the embodiment of the invention depicted in Figs. 1 to 4 inclusive;

Fig. 7 is a vertical cross-sectional view of a portion of Fig. 6;

Fig. 8 is a horizontal cross-sectional view of the front portion of an air conditioning unit of the type shown in Figs. 1 to 4 inclusive;

Fig. 9 is a front elevation of a portion of the cage which holds the refrigerant liquefying unit under the car;

Fig. 10 is a top plan view of the cage shown in Fig. 9;

Fig. 11 is a detailed cross-sectional view of the suspension means for the cage shown in Figs. 9 and 10; and

Fig. 12 is a diagrammatic representation of a slightly modified form of cage and drives therefor.

In practicing my invention, a car 10 is provided with one or more compartments 11 in which the passengers congregate. Generally the compartment 11 has its longitudinal dimension substantially parallel to the longitudinal dimension of the car as shown in Figs. 1 and 2 and, in some instances, the compartment is substantially of the same width as the width of the car. Generally the compartment 11 is provided with a central aisle 12, and with seats 13 which people may occupy on each side of the aisle 12. In the particular embodiment shown in Figs. 1 and 2, the compartment 11 is a dining compartment, and is therefore provided with tables 14.

In order to cool the air in the compartment 11, air cooling means or devices 15 are provided in the car at each end of the compartment 11. These air cooling devices are preferably located along the vertical axis of the compartment in the upper portion of the compartment, and are so constructed that they discharge air in the form of blasts 16 and 17 which travel in opposite directions along opposite sides of said compartment and above the normal height of the persons seated in the seats 13. The air cooling devices 15 are provided with air intake means 18 located along the vertical axis of the compartment, and, in this particular embodiment, the air intake means includes the door-way 19 and the opening 20 in the rear of the air conditioning means 15, so that the blast of air from the opposite unit or device is induced into the center of the aisle and then into the air conditioning devices without producing cold drafts which are likely to strike any person occupying the seats 13.

The air cooling means or devices 15 may be of any suitable construction and, in this particular embodiment, include blowers 21, driven by a motor 22, which blow air through the casing 23. The casing 23 contains a refrigerant coil or evaporator preferably including tubes 24 and vertical fins 25. The air is forced by the fans 21 between the tubes and fins and is discharged in the form of a blast into the compartment 11. In front of the evaporator there is provided a grille more particularly shown in Figs. 6, 7, and 8. This grille includes a plurality of horizontally disposed plates 26 which are provided with upwardly disposed deflectors 27. The plates 26 and a plurality of vertically disposed baffles 28 and 29 cooperate to form the blasts. In this particular embodiment, the vertically disposed baffles 28 and 29 are in the same vertical plane as the plates 26 and are assembled by passing the baffles 29 through the holes made in the plates 26. The larger number of vertically disposed baffles, 29 are disposed to direct the air towards the side of the car while the smaller number of baffles 28 converge toward the baffles 29 and thus tend to produce a concentrated blast along the sides of the car.

By the foregoing construction a circulation of air is maintained in the upper portion of the compartment 11, but the lower portion which is occupied by the passengers, is substantially quiescent and free from any severe blasts which are

likely to cause any discomfort, the cold air from the upper turbulent zone settling gently into the quiescent zone below and thus cooling the entire compartment 11.

Fresh air may be introduced into the compartment 11. This may be accomplished by connecting the insulated compartment 15', in which the devices 15 are placed, with the outside temperature by means of a conduit 15'' provided with an adjustable valve 15''' and an air filter of any suitable construction. The sub-atmospheric pressure produced by the suction of the fans 21, withdraws air not only from the compartment 11, but also from the outside of the car through the conduit 15'' and discharges the same mixed with the air from the compartment 11, through the cooling device 15, into the compartment 11.

The evaporators or cooling coils in the devices 15 may have a refrigerant circulated therethrough. This refrigerant may be cold brine or water, but preferably I use a volatile refrigerant which is evaporated in the coils 25. The refrigerant evaporated flows through the lines 30 to a refrigerant liquefying unit 31. This refrigerant liquefying unit 31 may include a compressor 32 driven by an electric motor 33, which compressor discharges compressed refrigerant to a condenser 34, the condensed refrigerant flowing to a liquid refrigerant reservoir 35 from whence the liquid refrigerant flows through the lines 36, 37 and 38 and suitable expansion valves (not shown) to the cooling coils in the devices 15. The liquefying unit 31 may be automatically controlled by a thermostat or hydrostat 39 which controls the operation of the liquefying unit in accordance with air conditions in the compartment 11 by starting and stopping the operation of the motor 33.

In the particular embodiment shown in Figs. 1 and 2, the car, being a dining car is also provided with a kitchen compartment 40. Because of the amount of heat generated in the compartment 40 by the stoves and other appliances, it is generally uneconomical to maintain this compartment in as cool a condition as the compartment 11. However, it is desirable to maintain an open passageway between the compartments 40 and 11 so that the waiters may pass back and forth without opening a door. Means are provided for preventing relatively warm air to enter compartment 11 from the relatively warm kitchen compartment 40. To this end the passageway (not shown) under the platform 41 is maintained open so that the waiters may pass between the compartments 11 and 40. A blower 42 withdraws air from the outside as shown at 43 and directs it in the form of a blast or jet 44 in front of the passageway under the platform 41. The blower 45, driven by the motor 46 withdraws air from the compartment 40 and is made of larger volumetric capacity than the blower 42 and thus tends to create a slightly sub-atmospheric pressure within the compartment 40. This insures the passage of a slight amount of air from the compartment 11 to the compartment 40, sufficient to compensate for the difference in the volumetric capacities of the blowers 42 and 45. This action prevents any warm air from passing to the kitchen to the dining compartment. The introduction of a large quantity of outside air through the blower 42 into the compartment 40 tends to prevent a rise in temperature in this compartment very much above the outside atmospheric temperature. By this construction proper and economical ventilation and cooling are provided for the various compartments of the dining car.

Sometimes, particularly during mild weather, it is desirable to provide a small amount of heating in the passenger compartment, the amount being less than that generally provided by the usual heating equipment of the car. Under such conditions, the cooling equipment described with respect to Figs. 1 and 2 may be modified slightly, as shown in Figs. 3 and 4, so that the equipment may be used to provide the slight amount of heating required. To this end, the casing 23*a*, corresponding to casing 23 in Fig. 2, is provided with a heating coil section 50, made of pipe having fins similar to the construction shown in Fig. 8. This section 50 is supplied with steam through the pipe 51. The supply of steam is regulated by a thermostat 52 placed in the compartment 11*a*, similar to compartment 11 in Figs. 1 and 2. A motor-driven fan 53 is placed in front of the heating section 50, with the axis of the fan 53 turned slightly down as indicated in Fig. 4. This construction, when used for heating, directs the heated air downwardly and elevates the temperature of the entire compartment uniformly both at the bottom of the compartment as well as at the top. This heating structure is provided at both ends of the compartment as indicated in Figs. 3 and 4.

The heating equipment above described, may also be used with the regular heating equipment of the diner, or with additional heating equipment specially installed near the floor of the compartment 11*a*. Thus one or more radiator sections 54 are placed along the sides of the compartment 11*a* adjacent the side walls, and these radiators receive steam from any suitable source of supply either in parallel or in series with the heater section 50. These radiator sections are supplied by steam lines 55 controlled by automatic or hand valves 56 which are also provided with by-passes at 57 so that water condensed in coils 50 may by-pass to the discharge trap 58 even when the radiator sections 54 are not used.

The fan 42*a*, corresponding to the fan 42 of Figs. 1 and 2, is provided with openings which may be selectively connected either to the outside of the car or to the inside of compartment 40*a*. When the weather is too cold outside, so that it would be uncomfortable to introduce only outside cold air through the fan 40*a*, the opening to the outside may be partly or fully closed and the opening to the inside of compartment 40*a* may be partly or fully opened so that a part of the air, at least, is recirculated from the compartment 40*a* and down through the jet 44*a*. Under such conditions, the speed or capacity of the fan 45*a* is reduced so that it will not withdraw too much air from the compartment 11*a* but will merely maintain a slightly lower pressure in compartment 40*a* than in the compartment 11*a*.

Fig. 5 shows, in an enlarged view, those portions which have been added to Figs. 3 and 4 in order to change the cooling portions into heating and/or cooling portions. It is to be understood, that under certain conditions, it may be desirable to use both the cooling coils and the heating sections 50*a* at the same time. This happens where the dry bulb temperature is not very high, but where the relative humidity is excessive. Under these conditions, it may be desirable merely to remove some of the humidity from the air, and this may be accomplished by cooling the air while passing through the cool-

ing coils, and reheating it to substantially its original temperature. When so desired, this can be accomplished by operating the cooling coils and the heating section 50a, and not using the radiators 54.

While the refrigerant liquefying units have been diagrammatically shown in the ends of the car in Figs. 1 to 5 inclusive, it is preferable to suspend the refrigerant liquefying unit underneath the car in a cage 70. This cage is made of angle irons and sheet metal covers as generally indicated in Figs. 9 and 10 and is suspended from the framework of the car with the longitudinal axis of the cage substantially parallel with the longitudinal axis of the car. The compressor is in the form of a four cylinder reciprocating compressor 71 having a flywheel 72 connected by a plurality of V-belts 73 with a pulley 74 driven by a motor which has a D. C. section 75 and an A. C. section 76, the axis of the motor extending through and being connected to the fan 77. The D. C. leads 78, 79 together with their field armature exciting lead 80 are connected to the electrical system of the car, while the A. C. leads 81 are connected to proper starting controls mounted on the car, to which a lead from the station current may be attached when the train stands idle at the station.

The cage 70 is formed by angle irons at all of the corner edges and is provided with openings 82 and 83 at the ends and with an opening 84 at the side adjacent the center of the car. A condenser 85 is placed at the opening 82, and a similar condenser, not shown, is placed at the opening 83. The fan 77, depending on the direction of rotation, either forces air through the opening 84 into the cage and then out through the openings 82 and 83, or, conversely, causing air to flow into the openings 82 and 83, through the cage, and out through the opening 84. In either case, the various parts of the refrigerant liquefying unit are cooled by the flow of air. The compressor 71 discharges compressed refrigerant through the pipe 86 to the condenser 85 and through the pipe 87 to the condenser, not shown, in the opening 83. From the condensers the condensed refrigerant flows into the two receivers 88 from whence the liquefied refrigerant flows by a suitable pipe 88a to the evaporation or evaporators which cool the car, the evaporated refrigerant returning through the pipe 89, insulated at 90 and through the valve 91 into the compressor 71.

The cage is provided with a removable cover 92 on the side away from the center of the car for access and repair. Suitable supports 93 at the upper and lower corners of the cage extend from the cage and hold in place vertical baffles 94, which are of substantially the same vertical extent as the cage 70 and which are converged slightly towards each other as indicated in Fig. 10. These baffles 94 protect the condensers in the openings 82 and 83 from flying stones, etc., and permit the flow of air propelled by fan 77 out of the openings 82 and 83 regardless of the direction of travel of the car without interference from the air blast due to car motion.

The cage 70 may be supported from the framework of the car. Thus the angle irons 100 and 101 of the cage 70 may be provided with openings 102. On the underside of the angle iron 101, there are provided a plurality of rubber washers 103, in each of which there is embedded a metal sleeve 104. The bolt 105 passes through the sleeve 104 and car frame 106 and hangs the cage on the car frame 106 of the car. The angle irons 100 and 101 are secured to other frame members 107 of the cage 70 as indicated in Fig. 11. By this construction the cage is supported on rubber mountings which dampens the transmission of noise from the cage to the car.

In the modification shown in Fig. 12, a form of cage and drive is provided in which the compressor 110 may be driven from the axle of the car or from an electric motor energized from the station current. To this end, the car axle 111 drives an electro-magnetic clutch 112. The magnetic clutch 112 is energized from any suitable source of electric current, for instance from the battery 113 or dynamo 114 of the regular electric system of the car which is operated by the belt drive 115 from the axle. The switch 116 is used to energize or de-energize the clutch 112. The motor 117 is of the type which may be operated from commercial current at the station when the train is stationary, and is connected to a proper starting panel 118. The leads 119 may be connected to a suitable plug which may be plugged into the line current at the station. The handles 120 and 121 may be connected mechanically, so that when the motor 117 is started by means of the handle 120, the magnetic clutch 112 is de-energized by the simultaneous operation of the handle 121.

The cage shown in Fig. 12 is slightly modified in that the condenser openings 122 and 123 are placed respectively at the end and side of the cage while the fan 124 is placed at the end of the cage. These changes make the cage shown in this figure adaptable to car construction where the cage shown in Figs. 9 and 10 is not adaptable. The fan 124 may blow air into the cage or withdraw air from the cage. The condensers shown in the openings 122 and 123 receive compressed refrigerant in parallel from the line 125 connected to the compressor 110, and the condensers discharge liquid refrigerant into the receiver 126 from whence liquid refrigerant flows through the line 127 to the evaporators in the car, the evaporated refrigerant returning through the line 128. As indicated in the drawings, belts 129, 130 and 131 connect the shaft 132 with the compressor 110, motor 117 and fan 124 respectively.

While the embodiments of the invention as herein disclosed, constitute preferred forms, 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. A car having a compartment of a width substantially equal to the width of the car and a length substantially greater than the width of said compartment, an air cooling member in said car at each end of said compartment having air discharge means directing blasts of cooled air in opposite directions, along opposite sides of said compartment and above the normal heighth of persons occupying the sides of the compartment, air intake means for said members, heating means at each end of said compartment and fans located at each end of said compartment, each of said fans having a downwardly directed heated air discharge.

2. A car having a compartment of a width substantially equal to the width of the car and a length substantially greater than the width of said compartment, an air cooling member in said car at each end of said compartment having air discharge means directing blasts of cooled air in opposite directions, along opposite sides of said compartment and above the normal heighth of

persons occupying the sides of the compartment, air intake means for said members, each of said air cooling members having air heating means, and fans located at each end of said compartment in front of said air discharge means, each of said fans having a downwardly directed air discharge.

3. A car having a compartment of a width substantially equal to the width of the car and a length substantially greater than the width of said compartment, an air heating member in said car at each end of said compartment having air discharge means directing blasts of air in opposite directions, along opposite sides of said compartment and above the normal heighth of persons occupying the sides of the compartment, air intake means for said members, and fans located at each end of said compartment in front of said air discharge means, each of said fans having a downwardly directed air discharge.

4. A car having a compartment to be cooled, means for cooling said compartment including an evaporator, a cage suspended under said car, openings in said cage, a condenser at one of said openings, a reversible fan for circulating air into and out of said cage located at another of said openings, a compressor in said cage, a live axle drive for said compressor and fan reversing with reversal of said car, said compressor, condenser and evaporator being in refrigerant circulating relationship.

5. A car having a refrigerant liquefying unit suspended beneath its floor and including a box-like cage having a substantially closed side along the side of the car and having openings towards the ends and center of the car, a compressor within said cage, condensers at certain of said openings and a fan at one of said openings, said condensers being connected to said compressor, and baffles between said box and the ends of said car.

6. A car having a compartment, an air cooling member in said car at one end of said compartment having air discharge means directing a blast of cooled air along one side of said compartment and above the normal height of persons occupying the side of the compartment, air intake means for said member, heating means at said end of said compartment and a fan located at said end of said compartment having a downwardly directed heated air discharge.

7. A car having a refrigerant liquefying unit suspended beneath its floor and including a box-like cage having a substantially closed side along the side of the car and having openings towards the ends and center of the car, a compressor within said cage, condensers at certain of said openings and a fan at one of said openings, said condensers being connected to said compressor, and baffles protecting the end openings, said baffles converging slightly toward each other.

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