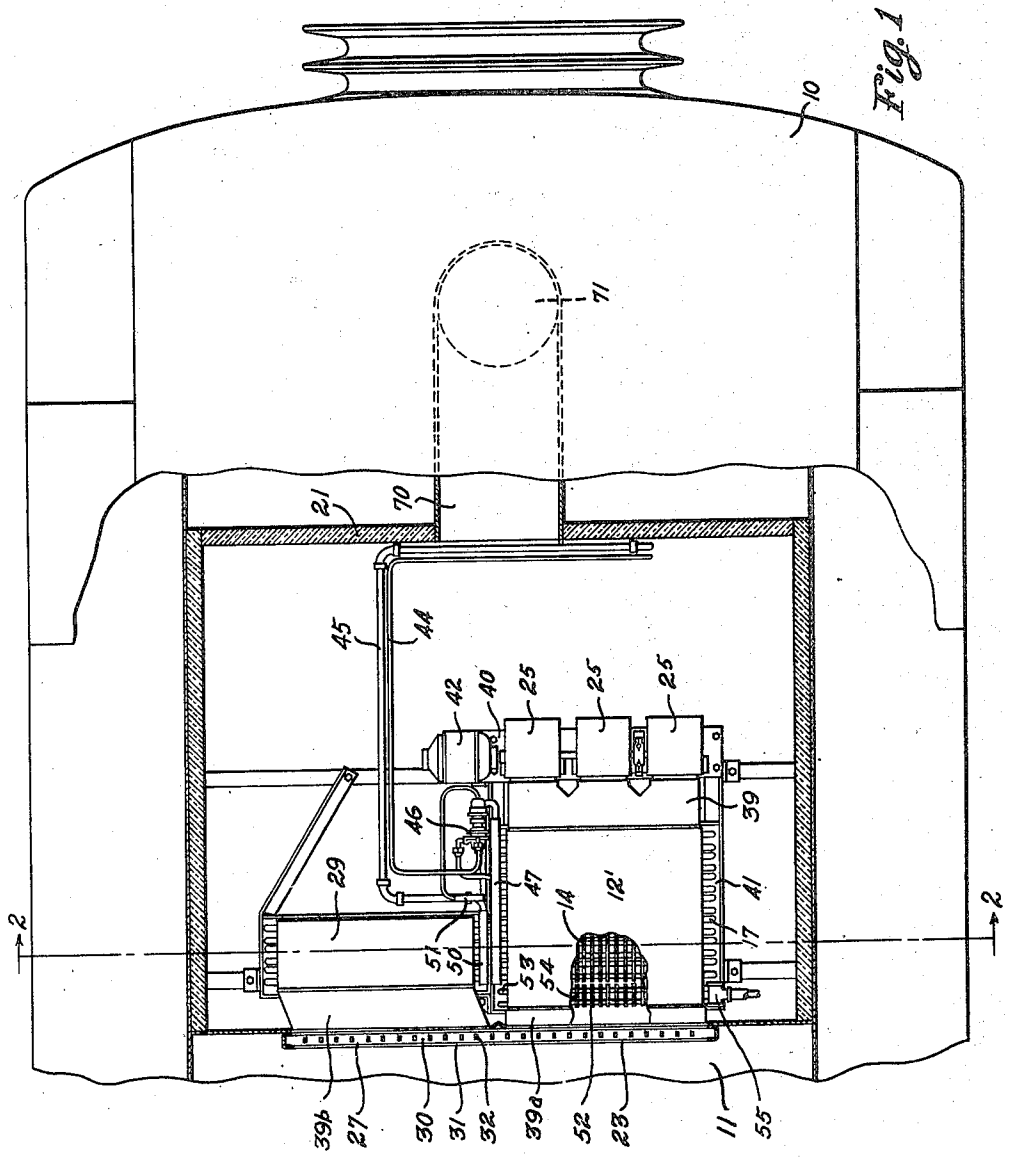
June 28, 1938. C. F. HENNEY 2,122,140

REFRIGERATING METHOD AND APPARATUS

Filed Feb. 19, 1934 5 Sheets-Sheet 1

Fig. 1



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June 28, 1938. C. F. HENNEY 2,122,140

REFRIGERATING METHOD AND APPARATUS

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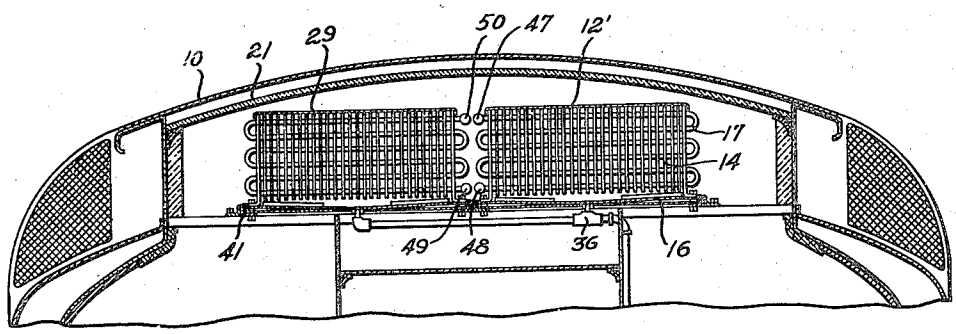

Fig. 2

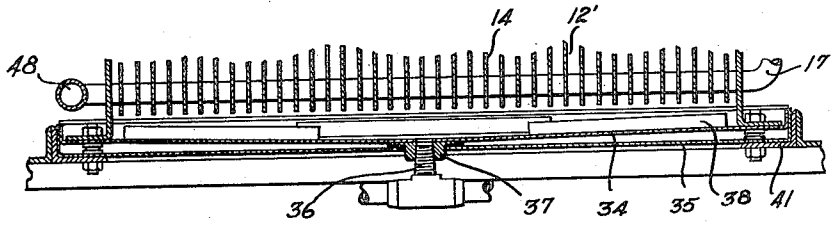

Fig. 5

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June 28, 1938. C. F. HENNEY 2,122,140

REFRIGERATING METHOD AND APPARATUS

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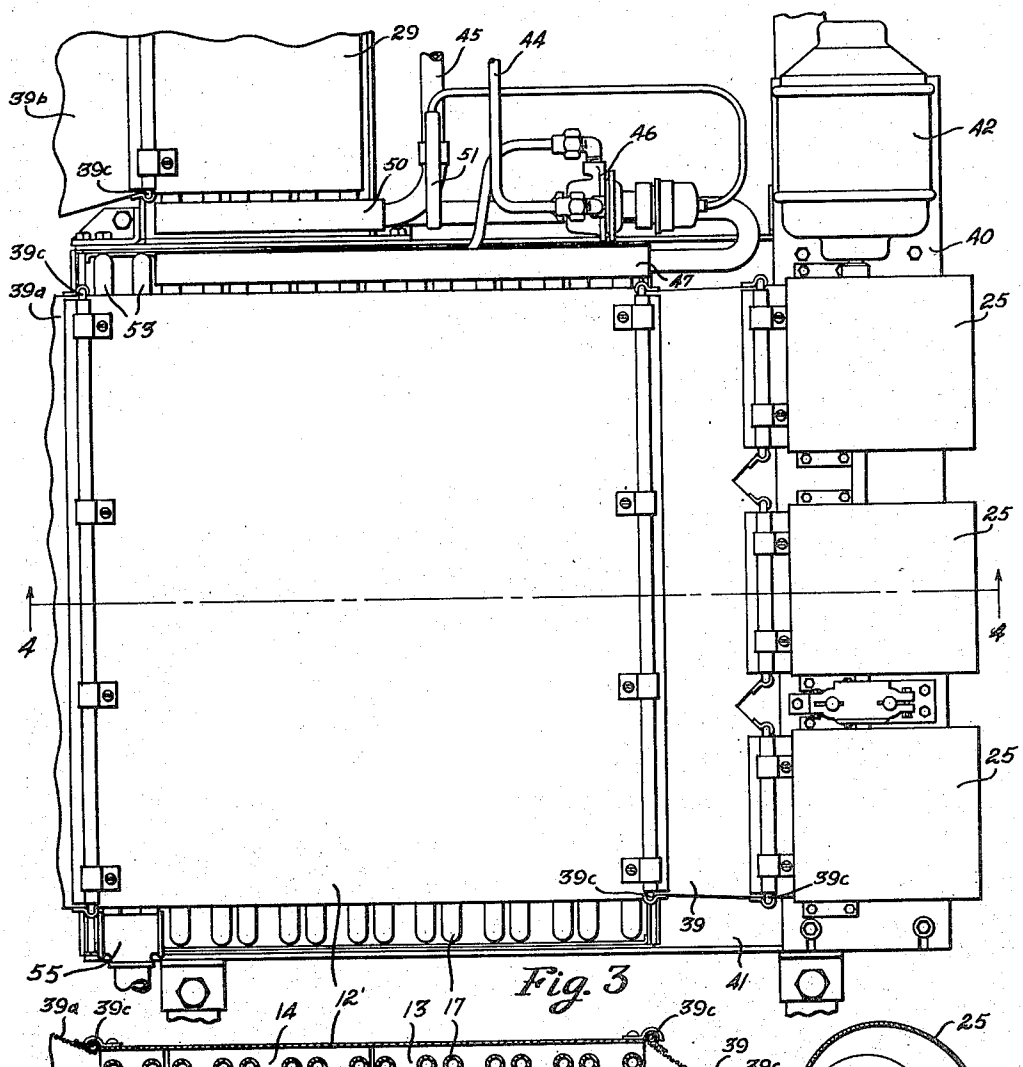

Fig. 3

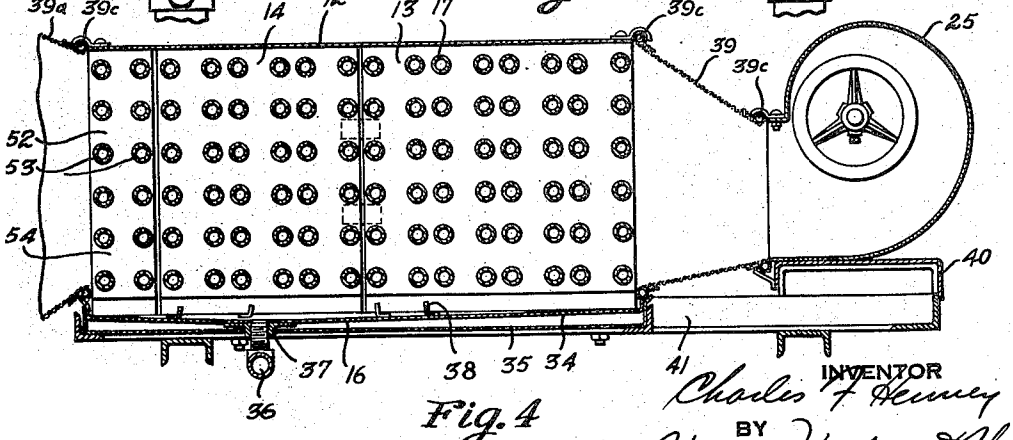

Fig. 4

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June 28, 1938. C. F. HENNEY 2,122,140

REFRIGERATING METHOD AND APPARATUS

Filed Feb. 19, 1934 5 Sheets-Sheet 4

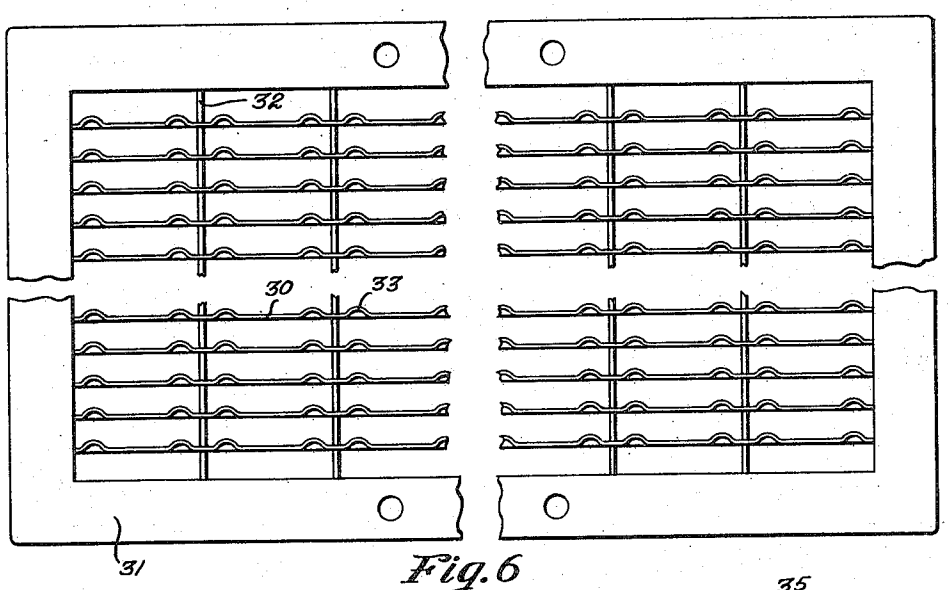

Fig. 6

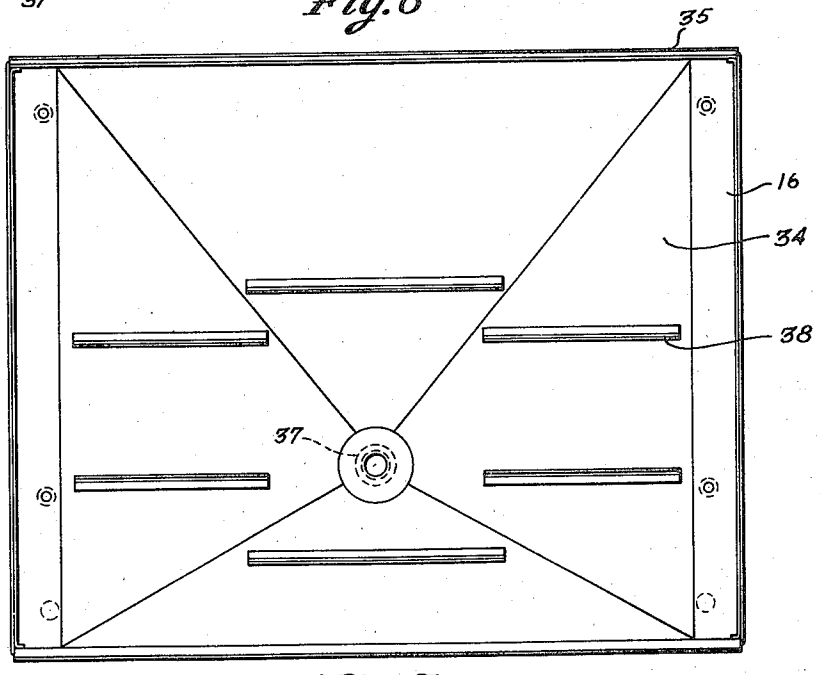

Fig. 7

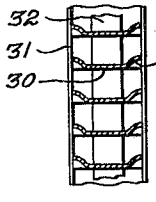

Fig. 8

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June 28, 1938. C. F. HENNEY 2,122,140

REFRIGERATING METHOD AND APPARATUS

Filed Feb. 19, 1934 5 Sheets-Sheet 5

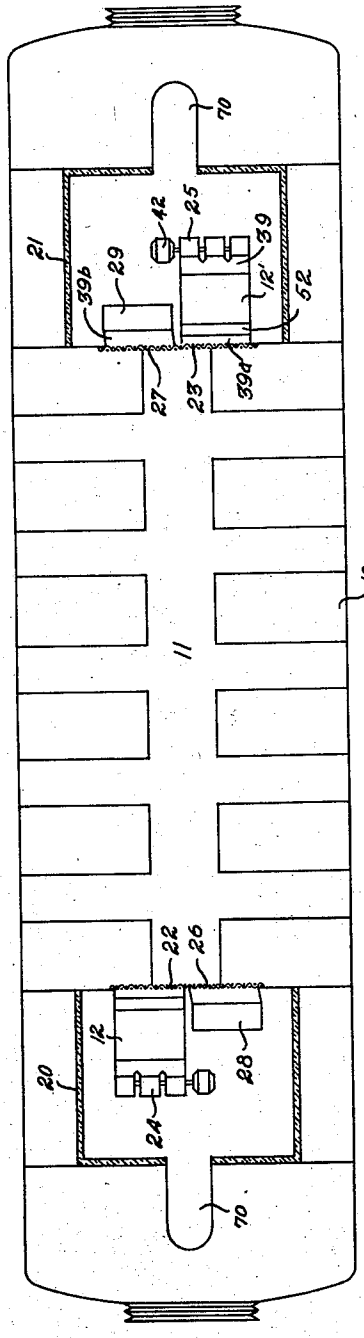

Fig. 9

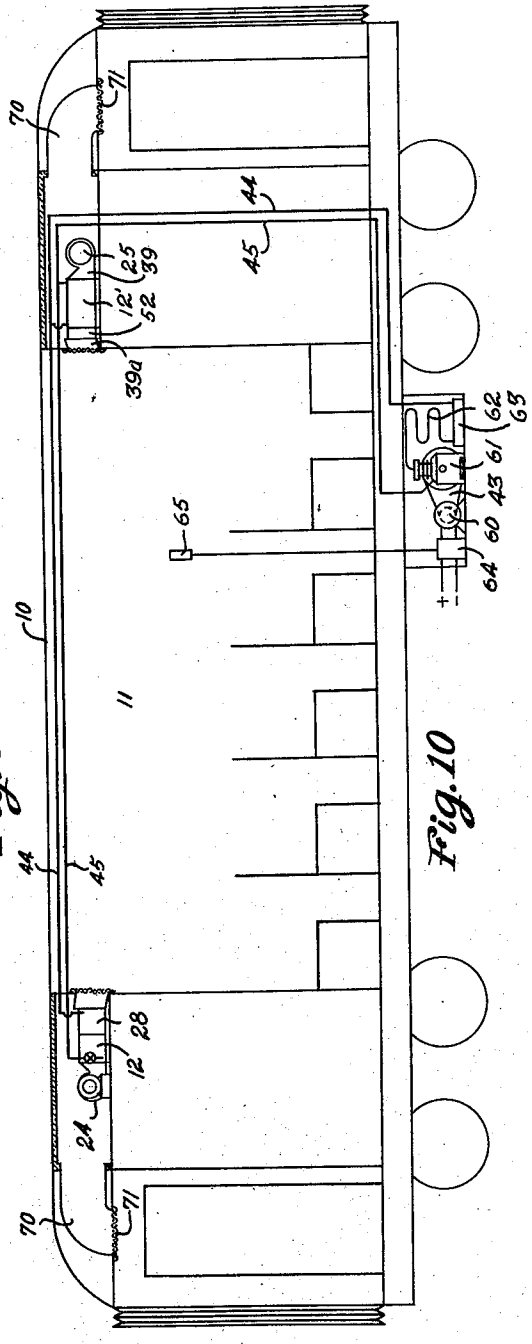

Fig. 10

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Patented June 28, 1938 2,122,140

UNITED STATES PATENT OFFICE

2,122,140

REFRIGERATING METHOD AND APPARATUS

Charles F. Henney, Dayton, Ohio, assignor to General Motors Corporation, Dayton, Ohio, a corporation of Delaware

Application February 19, 1934, Serial No. 711,834

9 Claims. (Cl. 62—176)

This invention relates to refrigeration, and more particularly to the conditioning of air for enclosures such as railroad cars and the like.

It is among the objects of this invention to provide a method and apparatus for conditioning air economically, with the elimination of long air ducts and without danger of discharging into the enclosure moisture removed from the air being conditioned.

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 plan view, partly in horizontal cross-section, of the end of a car embodying features of my invention;

Fig. 2 is a vertical cross-sectional view taken substantially along the line 2—2 of Fig. 1;

Fig. 3 is an enlarged plan view of a portion of the apparatus shown in Fig. 1;

Fig. 4 is a vertical cross-sectional view taken along the line 4—4 of Fig. 3;

Fig. 5 is a vertical transverse cross-sectional view of a portion of the apparatus shown in Fig. 4;

Fig. 6 is a vertical elevation of a grille to be placed in front of the air conditioning apparatus;

Fig. 7 is a plan view of the drip pan to be placed under the refrigerated surfaces;

Fig. 8 is a vertical cross-sectional view of a portion of the grille shown in Fig. 6;

Fig. 9 is a diagrammatic plan view, partly in diagrammatic cross-section, of a car embodying features of the invention; and

Fig. 10 is a vertical diagrammatic view of the car shown in Fig. 9.

In general, my invention includes the conditioning of air in an enclosure, in which people assemble, by passing air for the enclosure between a plurality of substantially parallel, vertically disposed surfaces which are refrigerated below the temperature of the air being conditioned, but above 32° F. to avoid freezing moisture on the surfaces. These refrigerated surfaces are constructed to provide free trickleways between the surfaces to permit the trickling or draining of moisture condensed on the surfaces from the air as it passes between the surfaces. Preferably the air, thus conditioned, is delivered into the enclosure in the form of a blast above the normal head zone of the occupants of the enclosure, although it is within the purview of this invention that the air may be delivered in other forms where it is desired to utilize but a portion of the advantages or economies of the invention. Means are provided for gathering the moisture condensed on the surfaces and at the same time preventing the air from sweeping the moisture into the blast and thus discharging droplets of moisture into the enclosure where people are assembled.

In order that the invention may be understood, and not for the purpose of limiting the scope thereof, the form of the invention now preferred is more specifically described. In applying the invention to a railway car 10 having a passenger enclosure 11, the conditioning device or devices are placed at each end of the car. These devices may include similar casings 12 and 12', through which a stream of air is caused to flow, and from which the air is caused to be discharged in the form of a blast in the zone above the head zone of passengers in compartment 11. The casings 12 and 12' are provided with a plurality of substantially parallel vertically disposed surfaces or fins 13 and 14, it being understood that these surfaces may be integral throughout their length if desired. These surfaces are so constructed as to provide free trickleways to permit the gravitational flow of moisture into the drain pan 16 placed below these surfaces. One way of providing free trickleways includes a plurality of horizontally disposed refrigerant pipes 17 transversely disposed to the fins or surfaces 13 and 14 and provided with good thermal contact with these surfaces. A refrigerant of proper temperature is caused to circulate through the pipes 17 and thus refrigerate these surfaces. Preferably the temperature and flow of the refrigerant is automatically governed, as hereinafter more fully described, that the temperature of the surface is normally below the temperature of the air being conditioned, but above 32° F.

If desired, the devices for conditioning the air for the enclosure 11 may be placed in insulated compartments 20 and 21 placed at each end of the car adjacent to the passenger compartment 11. The casings 12 and 12' are placed adjacent the air discharge openings 22 and 23 respectively so that the conditioned air for the compartment 11 is discharged in the form of parallel and oppositely directed blasts in the zone above the head zone of the passengers in compartment 11. Suitable blowers 24 and 25 are provided for causing the air to flow through the casings 12 and 12'.

If desired, additional refrigerating means may be provided at the air intakes 26 and 27 between

the passenger compartment 11 and the insulated compartments 20 and 21 respectively. These may include cooling coils 28 and 29, respectively, which may be similar but symmetrically disposed with respect to each other. The opening 26 is disposed longitudinally opposite to the opening 23 and the opening 27 is disposed longitudinally opposite the opening 22 in such a manner that oppositely directed parallel blasts of air are caused to flow between the insulated casings 20 and 21 above the passengers, the cool air falling gently down into the lower portion of the compartment 11 and thus maintaining it at the desired temperature. If desired, grilles may be placed at the openings 22, 23, 26 and 27; and preferably these grilles are of the character indicated in Figs. 6 and 8. These grilles may include a plurality of substantially parallel horizontally disposed plates 30 held in frame 31 by means of bars 32. These plates 30 may also have baffles or bends 33, upwardly directed, which impart to portions of the air stream or blast an upward inclination and thus overcome the tendency for the blast to fall directly upon the passengers.

The drain pan 16 is preferably insulated to prevent condensation of moisture on the underside. Thus it may include two plates 34 and 35 through which a drain pipe 36 extends by proper fitting 37. Transverse baffles 38 are placed on top of the pan 16, which baffles prevent moisture from being swept by the air blast through the openings into the compartment 11.

The casings 12 or 12' may be connected by cloth conduits 39 with the discharge openings of the blowers 24 or 25 which are mounted on a channel member 40 secured to angle irons 41 upon which the casing 12 is mounted. The blowers 24 or 25 are driven by means of electric motors 42 also mounted on the channel iron 40. The casings 12 and 12' are connected to the openings 22 and 23 by means of cloth funnels 39*a* and coils 28 and 29 may be connected to the openings 26 and 27 by means of funnels 39*b*. These funnels may be attached by rods 39*c* at their extremities. The coils 28 and 29 may be provided with outer casings similar to casings 12 and 12' and with drain pans similar to pans 16.

Preferably the refrigerant circulated through the pipes 17 is a volatile refrigerant circulated and liquefied by means of a refrigerant liquefying unit 43 mounted underneath the car. The liquefied refrigerant flows through the liquid refrigerant line 44 and the evaporated refrigerant returns to the unit 43 through the evaporated refrigerant line 45. Line 44 is connected to an expansion valve 46 which discharges into a header 47 to which the transverse pipes 17 are connected, the transverse pipes being in the form of a plurality of parallel sinuous lengths passing several times through the surfaces 13 and 14 and being connected to a lower header 48. Where the intake air openings 26 and 27 are also provided with coils, the lower header 48 is connected to a header 49 by means of a pipe which in turn is connected to a plurality of parallel sinuous pipes forming the coils 28 or 29 and which terminate in the upper header 50 which is connected to the evaporated refrigerant line 45. The expansion valve 46 is preferably of the thermostatic expansion type being controlled by a thermostatic bulb 51 placed adjacent the discharge from the header 50. The thermostatic bulb 51 throttles the valve 46 whenever the flow of refrigerant through the coils is sufficient to refrigerate the bulb 51 below a predetermined temperature. This tends to maintain a supply of liquid refrigerant in all of the coils, but prevents its presence in the suction line between the bulb 51 and the liquefying unit 43. The construction of the coils 28 and 29 may be substantially similar to that of the refrigerant coils in casing 12, but may be of smaller size as to depth as indicated in the drawings.

If desired a heating section 52 may be placed adjacent the air discharge openings 22 and 23 made of two or more banks of steam pipes 53 similar in construction to the refrigerant pipes and having substantially parallel vertical fins 54, in alignment with the fins or surfaces 13 and 14. The pipes 53 may be sinuous in form, connected to headers 55 at their upper and lower ends, the headers being connected to the usual steam system of the train. This heating coil may be used in the winter as an aid in heating the car, or may be used to temper the air refrigerated in the refrigerant coils, if it is desired to provide air of reduced relative humidity and slightly higher temperature during the summer.

The capacity of the refrigerant liquefying unit 43 is coordinated with respect to the heat absorbing power of the evaporators 12, 28 and 29 to automatically maintain the temperature of the refrigerated surfaces below the temperature of the air being conditioned but above 32° F. For example the unit 43 may include a motor 60 driving a compressor 61 which discharges compressed refrigerant to condenser 62 and receiver 63. The motor 60 is controlled by the starting controller 64 actuated by a thermostat 65 placed in the compartment 11. The normal speed of the motor 60 and capacity of the compressor 61 and condenser 62 are such that these temperatures are maintained at the refrigerated surfaces while the unit 43 is operating and the proper volume of air is passing the refrigerated surfaces. When the temperature of the air being conditioned is such that the refrigerated surfaces might fall below 32° F. then the temperature in the compartment 11 is such that the thermostat 65 stops or reduces the speed of motor 64.

If desired a certain portion of fresh air may be introduced into the compartment 11. This may be accomplished by providing inlets 70 to the compartments 20 and 21, which inlets may have their intakes provided with filters 71 and connected to the vestibules of the cars.

While the form of embodiment of the 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 conditioning air in an enclosure in which people assemble which comprises passing air for said enclosure in a horizontal direction between a plurality of substantially parallel vertically disposed surfaces having free trickleways between said surfaces located in a horizontal zone above the heads of occupants in said enclosure and refrigerated below the temperature of the air being conditioned and above 32° F., delivering said air in the form of a blast above the normal head zone of occupants in said enclosure thermally insulating a space below said surfaces and removing moisture condensed from said air below said surfaces.

2. The method of conditioning air in an enclosure in which people assemble which comprises passing air for said enclosure between a

plurality of substantially parallel vertically disposed surfaces having free trickleways between said surfaces located in a horizontal zone above the heads of occupants in said enclosure and refrigerated below the temperature of the air being conditioned and above 32° F., delivering said air in the form of a blast above the normal head zone of occupants in said enclosure, removing moisture condensed from said air below said surfaces, simultaneously and similarly conditioning another portion of air for said enclosure in a laterally and oppositely disposed zone and discharging said portion in a blast laterally oppositely disposed to said first named blast.

3. In combination, a car having a passenger compartment, an insulated compartment at the end of the car above the normal head zone of passengers in the car, air intake opening between said passenger compartment and said insulated compartment, a first cooling coil adjacent said intake opening, a blower in said insulated compartment, an air discharge opening between said insulated compartment and said passenger compartment through which said blower discharges and a second cooling coil adjacent said air discharge opening.

4. In combination, a car having a passenger compartment, an insulated compartment at the end of the car above the normal head zone of passengers in the car, air intake opening between said passenger compartment and said insulated compartment, a first cooling coil adjacent said intake opening, a blower in said insulated compartment, an air discharge opening between said insulated compartment and said passenger compartment through which said blower discharges, and a second cooling coil adjacent said air discharge opening, one of said coils including a plurality of substantially parallel, vertically disposed refrigerated surfaces having free trickleways between said surfaces.

5. The method of conditioning air for an enclosure which comprises causing air to flow horizontally through a plurality of relatively narrow vertically disposed parallel substantially straight cooling zones having free trickle-ways along the sides of the zones, while conveying a refrigerant transversely to said zones and maintaining the same at such a temperature that boundaries of said zones are maintained below the temperature of the air but above 32° F., and delivering said air to an enclosure above the normal head room of persons in said enclosure.

6. The method of conditioning air in an enclosure in which people assemble which comprises passing air for said enclosure between a plurality of substantially parallel vertically disposed surfaces having free trickle-ways between said surfaces located in a horizontal zone above the heads of occupants in said enclosure and refrigerated below the temperature of the air being conditioned and above 32° F., delivering said air in the form of a blast above the normal head zone of occupants in said enclosure, collecting the moisture condensed from the air in a receptacle below said surfaces, and arresting the horizontal flow of condensate in said receptacle.

7. A device for conditioning air comprising a casing, means for flowing a stream of air through said casing, a plurality of substantially parallel vertically disposed surfaces extending integrally substantially throughout the vertical heights of said casing and having free trickle-ways between said surfaces, horizontal refrigerating conduits passing through said surfaces for refrigerating said surfaces, means for automatically maintaining the refrigerant in said conduits below the temperature of the air being conditioned and above 32° F., a receptacle for collecting the condensate below said surfaces, and means for arresting the horizontal flow of condensate in said receptacle.

8. A device for conditioning air comprising an evaporator, means for flowing air horizontally through said evaporator, a receptacle below said evaporator for collecting condensate formed on said evaporator, and means in said receptacle for arresting the horizontal flow of condensate in said receptacle.

9. A device for conditioning air comprising a casing, means for flowing a stream of air horizontally through said casing, a plurality of substantially parallel vertically disposed surfaces extending integrally substantially throughout the vertical height of said casing and having free trickleways between said surfaces, horizontal refrigerating conduits passing through said surfaces for refrigerating said surfaces, means for supplying a volatile refrigerant to said horizontal conduits, and means for automatically maintaining the refrigerant in said conduits below the temperature of the air being conditioned and above 32° F.

CHARLES F. HENNEY.